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Effects of Mergers and Acquisitions on Business Firm Concentration

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When firm sizes are distributed according to the Pareto law, mergers or acquisitions may either increase or decrease business concentration as measured by the slope, on a double-log scale, of the distribution. Whether mergers and acquisitions will increase or decrease concentration depends upon the size distribution of the acquired assets among the firms that survive. Some data from the U.S. economy are consistent with a set of conditions under which industrial concentration is unaffected by mergers, thus offering an explanation for the observed fact that the overall concentration of U.S. firms, as measured by the slope of the Pareto curve, has not changed substantially since the turn of the century. The findings challenge the widely held view that mergers "obviously" increase concentration and reduce competition.

1. Introduction

It is the central purpose of this paper to explain a paradox: On the one hand, mergers and acquisitions of industrial firms have been exceedingly numerous in the U.S. economy during the past sixty or seventy years, and during the last several years they have reached epidemic proportions. On the other hand, the most careful studies of the degree of industrial concentration in U.S. industry over this same period show that overall concentration, as measured by the slope of the Pareto curve, has remained substantially constant—perhaps has even decreased, but certainly has not increased to an important extent. We propose to show that these two sets of facts—a high rate of mergers and acquisitions, on the one hand, and constancy of a concentration measure, on the other—far from being paradoxical or contradictory, follow from quite plausible (and empirically supported) assumptions about the merger and acquisition process.

Since the fact that the actual level of concentration has tended to remain approximately constant is contrary to popular folklore, we wish to call attention to the careful studies of this matter by Prof. M. A. Adelman, who reported his findings at the 1964 hearings of the U.S. Senate Subcommittee on Antitrust and Monopoly. Adelman concludes that the concentration ratio averaged over industries "appears to have declined substantially from 1901 to 1947, and not to have changed much since then" (U.S. Senate 1964, p. 231). With respect to a more recent period, he says, "I do not see any possible escape from the conclusion that 'overall concentration' in the largest manufacturing firms has remained quite stable over a period of 30 years, from 1931 to 1960. I cannot conceive of any circumstances which could so affect the statistics that they failed to register an increasing concentration, taking place over so long a period of time" (U.S. Senate 1964, p. 237). Finally, he laments the lack of "a logically consistent theory explaining why concentration should be stable. If we had the theory, then the actual past constancy would be a verification, and we would have some reason to think that if the conditions remained the same, the result should too" (U.S. Senate 1964, p. 240).

It is our aim to provide the logically consistent theory that Adelman calls for. To do so, we must begin with the known facts about the distribution of firms by size.

It has been known for many years that the relation between the size S of a firm (measured by sales or gross assets) and the rank order R of the firm by its size in a population (for example, an industry, a nation, etc.) can be expressed approximately by the equation:

$$SR^{\beta} = A \,, \tag{1}$$

where β and A are constants (Pareto law). Taking logarithms (to any base),

$$\log S = \log A - \beta \log R \,, \tag{2}$$

and we see that $\log S$ and $\log R$ are linearly related as shown in figure 1, where $\log A$ is the intercept at the vertical axis and $\beta = \tan \Theta$.

From (1) we see that the size ratio of two firms S_1/S_2 is equal to the reciprocal of $(R_1/R_2)^{\beta}$, that is, the rank ratio R_1/R_2 raised to the power β. Thus, as the rank is doubled from R to $2R$, the size is decreased from S to $S/2^{\beta}$. In such a distribution, the largest firm sells 2^{β} times as much as does the second largest firm, the latter selling 2^{β} times as much as does the fourth largest firm, and so on (if sales are used as the size measure). Therefore, the larger the β, the greater the difference in size between two firms with a given ratio of their ranks.

This constant β, then, may be used as a measure of the degree to which business is concentralized in the larger firms in an industry or an economy. In contrast to other types of concentration measures, which require an arbitrary cutoff point (for example, the market share of the 5, 25, 50, or 100 largest firms, etc.), the concentration measure β takes advantage of the linearity of the relationship between $\log S$ and $\log R$ to

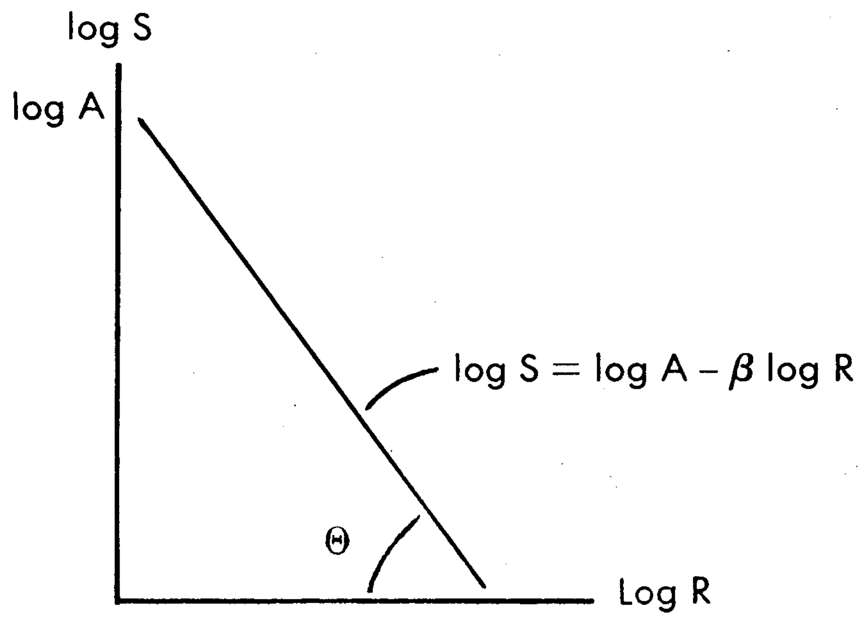

FIG. 1.—Pareto distribution of firms (R = rank of the firm; S = size of the firm; $\beta = \tan \Theta$, the concentration measure).

avoid setting such a cutoff point. A previous study of overall distributions (Simon and Bonini 1958), using data from the 1956 *Fortune* directory and Hart and Prais (1956),[1] indicates that for British firms $\beta = 0.474$ and for U.S. firms $\beta = 0.448$.

In this paper, we want to analyze the effects of mergers and acquisitions on the overall firm size distribution, in particular their effects on the concentration measure β. For this purpose, we shall develop in the next section a mathematical model of the effects of mergers and acquisitions on the concentration measure β and then, in Section 3, analyze empirical data on large firms in the United States to see what they show about the actual effect of mergers and acquisitions.[2]

In Section 2, we shall be particularly interested in determining conditions under which the concentration measure will be unaffected by mergers and acquisitions, while in Section 3 we shall show that these conditions are reasonably satisfied by data on mergers and acquisitions in the United States in 1956 and 1957—thus providing an explanation for the observed stability over time of the concentration measure.

2. A Model

We can calculate the effects of mergers and acquisitions on the concentration measure as though the merger process occurred in two stages. In the first stage, we determine the size distribution after removal of the

[1] Here, β is related to the ρ used in Simon and Bonini (1958) by $\beta = 1/(1 + \rho)$.

[2] A more complete model would also take account of spin-off and divestiture, but we shall not undertake this extension of the theory here.

firms that disappear or are acquired (we shall call them "acquired firms") through mergers and acquisitions in a given period. Then in the second stage, we determine the size distribution after the market shares or the assets of the acquired firms have been distributed among the surviving firms.[3] Total sales or assets of all the firms are conserved over the two stages, taken together.

A. In order to proceed with the first stage, let us compare the firm size distribution of all firms in the population with the firm size distribution of surviving firms, that is, firms other than acquired firms. We make the assumption that both distributions are of the form given by (1), involving a linear relation between log S and log R. If we let R be the premerger rank of a surviving firm with size S and let R' be the postmerger rank of the firm, we have:

$$\log S = \log A - \beta \log R \tag{3}$$

and

$$\log S = \log A' - \beta' \log R' , \tag{4}$$

where A' and β' are the parameters for the postmerger distribution. Note that S, the size, is unchanged, since the assets of the acquired firms have not been distributed in this first stage. From these two equations, we can express R' in terms of R:

$$\beta' \log R' = \log \frac{A'}{A} + \beta \log R , \tag{5}$$

from which we get:

$$R' = \left(\frac{A'}{A}\right)^{1/\beta'} R^{\beta/\beta'} . \tag{6}$$

The fraction of the firms with rank R or smaller that survives is

$$\frac{R'}{R} = \left(\frac{A'}{A}\right)^{1/\beta'} R^{(\beta/\beta')-1} , \tag{7}$$

and the marginal survival probability is

$$\frac{dR'}{dR} = \frac{\beta}{\beta'}\left(\frac{A'}{A}\right)^{1/\beta'} R^{(\beta/\beta')-1} . \tag{8}$$

This is the survival probability of a firm with initial rank R and size $S = AR^{-\beta}$.

Note that $\beta' = \beta$, that is, no change occurs in the concentration measure if and only if the survival probability is the same for all firms. For in this case, dR'/dR becomes independent of R. [$R^{(\beta/\beta')-1} = R^0 = 1$.] In

[3] Ideally, we would like to obtain the correlated data of the size of acquiring firms distributed by the size of acquired firms and analyze their relation. However, such data are very difficult to obtain (see, however, Federal Trade Commission 1955). Furthermore, since we are interested in the effects of mergers and acquisitions on the concentration measure, rather than in the growth of individual firms, the above two-stage analysis is adequate for our purposes.

general, the ratio of the survival probabilities of two firms whose rank ratio is R_1/R_2 is given by $(R_1/R_2)^{(\beta/\beta')-1}$. For each doubling of rank, the survival probability is reduced by the factor $2^{(\beta/\beta')-1}$. Thus, the concentration measure after the disappearance of acquired firms would be doubled if the survival probability of a firm of rank $2R$ were only $2^{1/2-1} = 0.7$ times as large as the survival probability of a firm of rank R. Similarly, in order to cut in half the concentration measure after the disappearance of acquired firms, the survival probability of a firm of rank $2R$ must be $2^{2-1} = 2$ times as large as the survival probability of a firm of rank R.

B. Having analyzed the disappearance process, let us move on to the second stage and analyze the allocation process, the process of allocating the market share or the assets of acquired firms among the surviving firms. If we let S be the preallocation size of a firm whose postmerger rank is R' and S'' be the postallocation size of the firm, we have

$$\log S = \log A' - \beta' \log R' \tag{4}$$

and

$$\log S'' = \log A'' - \beta'' \log R' , \tag{9}$$

where A'' and β'' are parameters of the postallocation distribution. From these two equations, we can express S'' in terms of S:

$$\log S'' = \log A'' - \frac{\beta''}{\beta'} \log A' + \frac{\beta''}{\beta'} \log S , \tag{10}$$

from which we get:

$$S'' = A''(A'^{-\beta''/\beta'})S^{\beta''/\beta'} . \tag{11}$$

Thus, the ratio of new to initial size, due to the allocation, is

$$\frac{S''}{S} = A''(A'^{-\beta''/\beta'})[S^{(\beta''/\beta')-1}] . \tag{12}$$

Note that $\beta'' = \beta'$, that is, there is no change in the concentration measure if and only if each surviving firm increases its size, as a result of allocation, by a constant percentage of its preallocation size. The ratio of the percentage growth of two surviving firms whose preallocation sizes are S_1 and S_2 is given by $(S_1/S_2)^{(\beta''/\beta')-1}$. If $S_1 = 2S_2$, the percentage growth of the larger firm is $2^{(\beta''/\beta')-1}$ times that of the smaller firm. Thus, in order to double the concentration measure, after allocation, the percentage growth of a size $2S$ firm must be $2^{2-1} = 2$ times as large as the percentage growth of a size S firm. Similarly, in order for the concentration measure to decrease by one-half, the percentage of a size $2S$ firm must be $2^{1/2-1} = 0.7$ times that of a size S firm.

3. Empirical Data

Empirical data for estimating the effects of mergers and acquisitions on the concentration measure are scarce. However, we were able to make crude estimates of the effects in the following manner.[4]

A. First, we selected from the mergers and acquisitions reported by the Select Committee on Small Business (U.S. House of Representatives 1962) those that took place in 1956 and 1957. The sales volumes of acquired firms in 1956 and 1957 were obtained from *Moody's Industrial Manuals* (1956, 1957), and they were grouped by sales volume as shown in table 1. The frequencies are compared with the distribution of 1955 sales volumes of firms reported in the *Fortune* directory for 1956 prior to the mergers and acquisitions in question.

The fact that the survival probabilities (C) are all close to each other and show no apparent trend seems to indicate that β' is not much different from β.[5] There are substantial fluctuations in the disappearance rates (D), but the absolute numbers are small (B) and the fluctuations lie within sampling error and are not systematically related to firm size.

B. In the second stage, we took the same data of the Select Committee on Small Business (U.S. House of Representatives 1962) for mergers and acquisitions that took place in 1956 and 1957. They are classified by the sales volumes in 1960 of the acquiring companies. Therefore, we calculated the total sales volume of all firms that were acquired by firms whose sales volume in 1960 fell in a specified size group (see table 2). This total for acquired firms was then compared with the total sales volume of all firms in the corresponding size group (based on the *Fortune* list for 1960). It is not apparent from these data that there is any substantial correlation between the size and growth rate by allocation. On the whole, the growth rate is relatively independent of size.

TABLE 1

SURVIVAL PROBABILITIES OF LARGE AMERICAN FIRMS, 1956–57, BY SALES VOLUME GROUPS

Sales Volume	Total Number of Firms in *Fortune* 500 (A)	Number of Firms Acquired in 1956–57 (B)	Survival Probability (C) ($C=[A-B]/A$)	Disappearance Rate (D) ($D=B/A$)
Above $500 million	73	2	.973	.027
$500–$200 million	108	6	.944	.056
$200–$100 million	126	4	.968	.032
$100–$55 million	193	7	.964	.036

[4] Mr. Arvind Jain helped us in preparing the data.

[5] $\chi^2 = 1.24$, where $\chi^2_{.25}(3\text{ df}) = 1.21$ and $\chi^2_{.50}(3\text{ df}) = 2.4$.

TABLE 2

RATIO OF SALES VOLUME OF ACQUIRED FIRMS TO TOTAL SALES OF FIRMS CLASSIFIED IN SALES VOLUME GROUPS

Sales Volume	Sales Volume of Firms in *Fortune* 500 (*A*)	Total Sales Volume of Acquired Firms, Acquired by Firms in the Specified Sales Group (*B*)	*B/A*
Above $500 million..	$130,077 million	$4,305 million	.0331
$500–$200 million...	43,411 million	582 million	.0157
$200–$100 million...	21,513 million	808 million	.0376
$100–$72 million....	9,723 million	157 million	.0161

Obviously, we need more data to make a definitive statement about the effect of mergers and acquisitions on the concentration measure. However, our analysis does suggest tentatively that mergers and acquisitions do not greatly affect the Pareto curve slope. We shall consider some implications of this hypothesis from the overall viewpoint of the firm size distribution in the next section.

4. Gibrat's Law for Mergers and Acquisitions

Intuitively, it appears to be unreasonable that mergers and acquisitions should not affect the concentration measure. However, that they need not can be well illustrated by the following example. Suppose that each firm in a population whose size distribution is given by (1) merges with another firm of equal size.[6] A firm of size S with rank R before merger now becomes a firm of size $S'' = 2S$ with rank $R'' = R/2$. The new distribution after mergers is, then,

$$\log S'' = \log A'' - \beta'' \log R'' .$$

By substituting $S'' = 2S$ and $R'' = R/2$, we obtain

$$\log 2S = \log A'' - \beta'' \log \frac{R}{2} ,$$

or

$$\log S = \log (A'' 2^{\beta'' - 1}) - \beta'' \log R . \tag{13}$$

By comparing this with (2), we see that

$$A'' = 2^{1-\beta''} A \tag{14}$$

and

$$\beta'' = \beta . \tag{15}$$

Thus, the concentration measure is unaffected, although the intercept at the log S axis (the size of the largest firm) is changed from A to $2^{1-\beta''} A$.

[6] Although the distribution given in (1) implies that the size of each firm is different from every other firm, let us here assume that two firms with "nearly" equal size merge.

Therefore, the size ratio of a large firm (rank R_1) and a small firm (rank $R_2 > R_1$) remains at $(R_1/R_2)^\beta$, unaffected by mergers.[7] This size ratio for a given rank ratio is one of the most important aspects of business concentration, since it expresses a relative strength of a larger firm over a smaller firm. The concentration measure β thus expresses this important aspect. It is with respect to this concentration measure that we want to see the effects of mergers and acquisitions on the firm size distribution. Of course, our results do not imply constancy of different concentration measures that might be used to measure other aspects of concentration, for example, share of assets held by N largest firms.

If we plot the firm size distribution of the 500 largest firms in the *Fortune* list over the last twenty years or so, we see that the concentration as measured by the shape of the Pareto curve is relatively unchanged.[8] This supports Gibrat's law—that the growth rate is independent of size. The annual growth of the firms takes the form of a parallel upward shift in the size distribution, the degree of shift depending on the growth rate that is applicable to all firms regardless of their size. However, this observation supports Gibrat's law for the overall growth of firms but not necessarily for the growth by mergers and acquisitions alone. The overall growth of firms consists of internal growth (due to mergers and acquisitions) and external growth (due to growth from sources outside the population). That overall growth satisfies Gibrat's law does not necessarily mean that internal growth and external growth each satisfy Gibrat's law individually, since deviations from the law may cancel with each other to produce an overall Gibrat's effect. However, our data and analysis support the proposition that the internal growth alone does follow Gibrat's law. This implies that the external growth also follows Gibrat's law, since, if a parallel overall shift in the distribution consists of two parts, one of which is a parallel shift, the remaining part must also be a parallel shift.

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[7] The total number of firms in the population appears to be cut in half. However, if the population is defined by using a minimum size as a cutoff point, and if the mergers-with-equals are assumed also to take place among the subminimal firms, the total number of firms in the population after mergers is greater than half of the total number of firms in the population before mergers, due to new firms attaining above-minimum size by merger.

[8] The actual distributions have some curvature. See the discussions in Ijiri and Simon (1964, 1967), which explain how such curvatures may result from assumptions on the growth of firms.

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