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SIZE, GROWTH, AND STRUCTURAL CHANGE
IN THE MEAT PACKING INDUSTRY

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Introduction

A thorough analysis of structural change must encompass many structural
dimensions. Most recent market structure analyses have been cast in a broad,
aggregate setting. The approach of the National Commission on Food Marketing
is classic evidence.[1]

Our aim in this paper is not to rehash all the descriptive findings and
conclusions of our efforts in Phase VI of NCM-25 and Phase I of NCM-36.
We refer you to the publications if you are so inclined.[2] In this paper we
are interested primarily in discussing how we came to the results and point out
what we feel to be significant features of the analysis. We would hope by this
means to raise questions and provide room for discussion.

Basically, there are four steps to our analysis. The first is description of
the changing structure of the meat packing industry using selected structural
dimensions observed over the time period analyzed. Second is explanation of
how and to a degree why these changes came about. Third is projection of future
structure of the industry. Fourth is the extraction of economic implications from
the whole process.

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This paper is limited primarily to the changing characteristics of the size distribution of the federally inspected livestock slaughtering industry and to the two major processes underlying these changes: firm growth patterns and entry and exit patterns. In the analysis, characteristics of size structure were captured in several ways -- by concentration ratios, Lorenz curves, and statistical measurements of the size distribution. This paper focuses on the size distribution. We believe that an industry size distribution is an important structural dimension which helps to understand structural change and, as we will argue later, may relate to performance of the industry.

Our work centered on the slaughter sector of meat packing, because we interpreted NCM-36 to be interested primarily in the demand side of the livestock market. All slaughter firms were not represented. The study included only those firms conducting slaughter under federal inspection (FI). This included all slaughter firms which entered interstate trade and thereby participated in the national meat market. These firms did the majority of livestock slaughter. In 1962, FI slughter accounted for more than 83 percent of total head of livestock slaughtered. The proportion of slaughter under federal inspection has been growing since then. Developments and trends pertaining to FI firms carry broader general-ization with respect to the entire industry. There is no reason to believe that major trends and characteristics reflected by FI firms would be altered if non-FI firms were included in the data.

If non-FI firms were included, the industry size distributions would probably show a greater number of small firms, a smaller average size, and perhaps some-what greater variation in size. Growth trends and patterns would probably be little different, although the smaller firm groups would perhaps have a slightly lower average rate of growth. This is suggested because it is usually a necessity to enter interstate trade to sell output as a firm grows larger. The size at which it is necessary to enter interstate trade sets a practical limit to growth of non-FI firms.

For the most part, data are from the 1950-62 period. The major reason for using this period was that data from these years were readily available. Moreover, it is a rather desirable period for study. Many industry changes began appearing soon after 1950. Although most were the result of forces operating before 1950, significant impact began during this period. No claim is made that it is a particularly representative period of economic interaction in the slaughter industry. More importantly for assessing the projections, one cannot be sure that impact of economic forces in 1950-62 will be duplicated in the future.

In brief, the scope of this paper is limited in several dimensions. It is limited in industry coverage, in time covered by the data, in extent of analysis, and in prediction of the future.

Measurement of Size Distribution

The concentration ratio is a common structural characteristic. Changes in concentration of slaughter activity are well documented. However, to develop a point, we will review the trends which took place in this variable over the time period studied.

We looked at concentration in terms of the 4 and 10 largest firms. Firm size was measured in number of head, annual slaughter. To assess total size for all species we converted to average dressed weight. FI dressed weight was calculated for each state. National average FI dressed weights were adjusted to state FI dressed weight by using the ratio of state commercial to national commercial dressed weight.

There is substantial difference in concentration among livestock species. Concentration in all sectors declined, but sheep slaughter remained the most highly concentrated sector. Concentration of total FI slaughter in the four largest firms declined from 51% to 33% during 1950-62. The same ratio for cattle slaughter declined from 52% to 28%; for hogs, from 49% to 37%; for calves, from 58% to 44%; for sheep, from 70% to 62%. Other data showed concentration of FI meat processing in the largest firms declined from 35% to 32% during 1961-64.

While nationalconcentration ratios may be relevant for the dressed meat market, local-market concentration is the more relevant statistic with respect to the livestock market. We recognized in approaching this question that we had a

problem of identifying relevant "local markets". We used the regional breakdown

identified in NCM-25. Thus, regional concentration ratios are indicative of

broad area differences.

Concentration was greatest in New England -- ranging from 77% for cattle

to virtually 100% for hogs in 1962. In the East North Central region the four

largest FI firms slaughtered only 30% of the cattle and 37% of the hogs. The

ratios tended to be declining in all regions except New England. However,

calf and sheep slaughter concentration increased in the West North Central

region and sheep slaughter concentration increased in the East North Central

region.

These differences in regional and species changes in concentration ratios

are largely explained by the pattern of new entry into the industry. A large

proportion of the new entry from new capital took place in the North Central

and Plain areas where concentration declined the greatest. This, of course,

raises the question as to whether the time period selected -- a period of marked

expansion in beef feeding -- tended to dominate the situation in such a way

that if some slow-down occurs in rate of increase in livestock production a

readjustment toward concentration by the largest firm may occur. Entry patterns

show this could be especially true for the North Central area of the United States.

Having looked at concentration, we took a more intensive look at changing

size structure. Between 1950 and 1962, there was a moderate increase in average

size of all FI slaughter firms. Relative size variation among firms showed virtually no change. There were, however, different trends among segments of the industry. While cattle slaughter firms grew more equal in size, calf, sheep, and hog slaughter firms grow less equal.

Statistics on the size distribution were calculated on logs of firm size. There are, basically, two reasons for using logs of firm size in this way. One reason is that the size distributions tend to approach normal distributions when size is expressed in logs. Thus, the statistical characteristics of the distribution tend to be more reliable measures, particularly when making comparisons among distributions. It was deemed important to have a good measure of mean size and variation to more fully describe size structure than could be done with concentration ratios. Inasmuch as it is possible to separate total change in mean and variance into changes among entering, exiting, and persisting firms, it was possible to assess the contribution of each group to changing size structure of the industry. The other reason for using logs stems from interest in the growth of firms. If firms in all size classes have an equal proportionate rate of growth, the industry size distribustion will become log normal. Hence, an assessment of the log normality of the distribution is an ex post measure of growth equality.

Changes in the size distribution reflect entry, exit, and growth. Increase in average firm size occurred from two sources: a) growth, or increasing average size of the group of firms which were in the industry in both 1950 and 1962; and b) the group of entering firms had a larger average size than the group of exiting firms.

Whi le overall firm size variation was roughly the same in 1962 as in 1950, there were different tendencies in size variation among groups. Variation in size among the group of persisting firms increased. Meanwhile, the group of entering firms was decidedly less unequal in size t'-an the group of exiting firms. There were, of course, different characteristics among entering, exiting, and persisting firms in each of the species segments of the industry.

In general, small FI slaughter firms were growing much faster than large firms during 1950-62. On the average, firms in the four smallest size classes more than tripled their size. Meanwhile, firms in the four largest size classes less than doubled their size. Among small firms there was also much larger variation in growth rates than among large firms. Among species segments of the industry there were also different growth trends. But, only in the calf slaughter segment were average growth rates equal among size classes. Patterns of growth also varied among the sub-periods within 1950-62, evidencing differences in both mean and variance of growth rates.

Firm Growth Analysis

It was hypothesized that there would be a measurable relation between growth and a set of variables often associated with firm growth. For these purposes, a multiple regression model related growth to initial size, vertical integration into meat processing, horizontal integration into multi-species slaughter, geographic dispersal of plants, and the firms prior growth record.

The regression model, with coefficients for 1950-62, is as follows:

$$G = 190.63 - 41.96S - .43V - 4.92H + .93N \qquad \begin{array}{l} R^2 = .16 \\ Sy = 60.54 \end{array}$$

Where:

G = ratio of size of firm in 1962 to size of firm in 1950

S = size of firm in 1950 (log of total pounds, dressed weight slaughtered)

V = ratio of processing to slaughter in 1961 (vertical integration index)

H = number of species slaughtered in 1950 (horizontal integration index)

N = number of plants operated in 1950

Considering the low R^2 (coefficient of multiple correlation), the model obviously does not incorporate a substantial explanation of growth. But, the high negative coefficient on initial size and the positive coefficient on number of plants is of interest. It also appears that the index of horizontal integration has a greater association with growth than does the index of vertical integration.

The same model was estimated for the periods 1950-54, 1954-58, and 1958-62 (with the addition of the prior growth variable for the 1954-58 and 1958-62 models) to see if significant differences appeared in the relationships as among different time periods.

Following these four calculations, it appears that size as such is inversely correlated with growth, even after separating its association from vertical and horizontal integration, spatial spread of plants, and prior growth.

In all periods, there is a negative coefficient on the variable reflecting vertical integration. The coefficient is small, but persists. It, therefore, appears that the greater the extent to which firms were involved in processing, the less they grew in slaughter.

There also appears to be an inverse relationship between growth and horizontal integration as it is represented by number of species slaughtered. But the nature of the relationship is unclear. For the entire 1950-62 period and for 1950-54, there was a rather sizable negative coefficient on the variable. For 1958-62 the negative coefficient was quite small. For 1954-58 the coefficient became positive. During 1954-58, growth tended to be positively related to number of species slaughtered, which is in direct conflict with the rationale for the hypothesis on horizontal integration.

The relationship between growth and prior growth is almost zero. It is of interest that the sign of the coefficient on prior growth is negative, suggesting that, insofar as there is a relationship, firms which grew more in a prior period tended to grow less in a current period.

While this analysis was useful in quantifying some growth factors, it clearly does not answer the question of why slaughter firms grow. The most striking characteristic is the inverse relation between size and growth rates. There is an inverse relation between size class and both mean and variance of growth. Although the strong inverse relation did not appear in all segments of the industry, it was quite strong in cattle slaughter and calf slaughter.

Even though this study did not make a full investigation into all causes of growth, a line of reasoning does appear to fit the growth pattern. We suggest it is useful to think of three sets of factors relevant to growth. These are: 1) intra-firm factors, which are technical or organizational attributes of the individual firms in the industry; 2) inter-firm factors, which are the commonly-considered structural or organizational attributes of the industry; 3) institutional factors, which are constraints which public policy places on business firm behavior. Within these headings we suggest there are a number of possible causes of the observed growth patterns.

To summarize our impressions, we think the following are important:

a) Scale economies, operating in a perverse way, i.e. small firms have a powerful incentive to grow out of their small size to attain the same advantages possessed by larger firms and thus have a higher rate of growth.

b) Patterns of technological change, favoring new firms, i.e. technology in former years was such that it favored the construction of large integrated meat packing plants. New technology has fostered development of smaller, specialized slaughter plants which were operated as firms.

c) More investment alternatives available to large firms so they have a greater probability of placing a bundle of investment capital elsewhere.

d)   Advantage possessed by small firms in the labor market. These

include community relations, low rate of seniority, etc.

e)   Public anti-trust policy, constraining actions of large firms.

Further research would be necessary for more thorough evaluation. However,
the factors fit the patterns of size change observed.

Size Structure Projection

As the growth analysis was originally conceived, it was anticipated that it
would lead to identification of associated variables such that further precise
predictions of future size structure could be formulated. This appears not to be
the result. The analysis did show that initial size is by far the most important
associated variable among those analyzed. The Markov-chain technique employed
to project size distributions assumes that the probability of change in size depends
solely on initial size of the firm. Hence, we apparently cannot appreciably improve
on the predictability of the Markov procedure.

We looked at entry, exit, and growth intensively through matrices. These
matrices also provided the vehicle for projecting future size structure. Shifts
in entry, exit, and growth patterns within the 1950-62 period were analyzed
through comparison of projections developed for different sets of years within
the period. These projections revealed substantial changes in the matrix of
entry, exit, and growth during the time period studied.

If the 1950-62 growth patterns were to continue, a somewhat different slaughter industry size structure would emerge in a few years. By 1998, more than half of all the FI slaughter firms would be in what is now the largest size class. A less radical change in size structure of FI cattle slaughter firms is implied by the projections. By 1998, the majority of firms slaughtering cattle would be still grouped near the middle size classes. Projected size structure of calf, sheep, and hog slaughter firms are only moderately different from 1962. If 1950-62 growth patterns continue in each of the industry segments, there will be a few more firms larger than the present average, and a few less smaller firms. But the change is not great.

Observations on entry, exit, and growth of slaughter firms form a "life-cycle" model of firms in the industry. This life-cycle is one in which a firm enters the industry at a small size, stays small for a few years as management gains experience, then either fails or has a period of rapid expansion to optimum plant size. The concept further suggests that the sum of barriers to entry plus growth as the firm moves from small to optimum is less than the barrier against entering directly at the optimum. This idea was substantiated in this research where it was clearly indicated that on the average firms which entered by using "new" capital did so at a level less than optimum and also grew further than firms of equal size already in the industry at the beginning of the time period. Some time later, the firm may again grow internally by adding more plants or externally by merger -- these processes involving a different set of factors in and constraints on expansion than the growth of the single plant firm to optimum size.

It must be noted that our observations are from data gathered during a

period of generally expanding livestock production. It would appear that this

is of critical importance. Since agricultural processing firms handle all the

supply offered (i.e., price adjusts to c!;ar the market), expanding livestock

production necessarily implies a growing slaughter industry. This also leads us

to postulate equality of growth as a performance norm -- but we shall get to that

point later.

Implications

Let us now return to a discussion of the concept of growth in the slaughter

industry. We have used it as a descriptive concept, detailing the degree to which

firms of various sizes and various resource endowments have survived and prospered.

By this method we traced the sources of changing size structure of the slaughter

industry. Examination of changing industry size structure through growth analysis

was very helpful in understanding causes of change.

But we would like to suggest that growth concepts also have normative

implications. We pointed out that if growth is randomly distributed with respect

to size, the resulting industry size distribution is log-normal. Consequently,

analysis of log-normality of the size distribution has definite implications about

patterns of growth. If the size distribution is log-normal, it is probable that firms

in all size classes have experienced common mean rates of growth.

We suggest the growth concept has normative implications from two per-spectives. First, growth is a widely-held goal in American society. In a macro sense, growth may be said to be nearly a universal objective of firm management, stockholders, and private entrepreneurs. Analysis of growth with respect to size portrays the degree to which small and large firms are attaining the goal. More particularly in the meat packing industry, it reveals the degree to which small firms are obtaining a "fair share" of expanding livestock production.

The other perspective from which growth has normative implications is through the sequence of equal proportionate growth generating a log-normal size distribution. The conditions necessary for equality of growth closely resemble the conditions of pure competition. There is one notable exception; the dynamics of shifting resource supply in livestock slaughter. If most conditions of pure com-petition prevailed, and if livestock supply to slaughterers were allowed to shift, equal proportionate growth among sizes would be expected. A measure of departure from equal growth is in this sense a measure of departure from the normative state of pure competition.

Statistical tests on the degree of difference of growth among size classes indicate that both the mean and variance of growth rates were significantly different. Hence, the "dynamically competitive" growth norm is not met. Small slaughter firms grew significantly faster than large firms during 1950-62. However, public policy may have an interest, not merely in providing an equal opportunity for small firms, but in ensuring an industry of many competing firms. The apparent growth success of small firms indicates that this performance norm is being satisfied.

Other performance data is available, published by the National Commission on Food Marketing. These data show profit rates in the slaughter industry to be lower than in food processing, generally. There is rather low advertising expenditure in the slaughter industry. In recent years there has been considerable influx of new technology. This information, coupled with the growth data, indicates that performance of this slaughter industry is favorable in at least some important dimensions.

Concluding Questions

1. The most obvious question with respect to this analysis centers on whether economic conditions during 1950-62 allow one to go beyond projecting what kind of size structure we will have if conditions remain the same. Will livestock production increase as much and in the same regional patterns? Will the discrepancy in use of advanced technology and optimum location be as wide between the "established larger firm" and the "smaller new firm"? Will larger slaughter firms continue to move toward meat processing at the expense of slaughtering? Changes in these conditions could reverse the size distribution picture developed in 1950-62.

2. Does the life-cycle model advanced in this paper indicate the need for a somewhat new approach to the concept of barriers to entry? The mere entry of a new firm in an industry growing from small to optimum may not be as relevant

concept as the ability to stay in the industry after reaching some advanced growth level. We suggest in this paper based on research in this project that the rate of turnover of new entrants indicates that the barriers to "staying" may be somewhat higher than barriers to "entry".

3. What other measurable factors affecting firm growth ought to be included in growth analysis?

4. Does the normative model of firm growth offer an empirical contribution to Bainsian industrial organization research?

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