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Structural analysis of the North Central Region grain industry

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STRUCTURAL ANALYSIS OF THE NORTH CENTRAL REGION GRAIN INDUSTRY

by

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INTRODUCTION

Theoretical Framework

National anti-trust policy has been predicated upon the postulate that big enterprise is synonymous with powerful enterprise. This influence has led to the belief that power should be limited. The norm of pure competition through atomistic industries, has been proposed as a desirable objective in maximizing the efficiency of output commensurate with social welfare. Structural changes toward concentration of the control of business have been generally decried for reasons of anti-competitiveness among participating firms. The market domination of a small group of firms, with their potential monopoly power, has led to a desire to redress speculated distortion of economic performance.

The organization or structure of an industry of competing enterprises is thought to be a determining influence of intra-industry performance. Structure, in this discussion, will mean those characteristics which seem to strategically determine the relations of buyers and sellers in the market (3, p. 7). The measurable indicator of structure considered in this study is the degree of concentration of business activity, described by the number and size distribution of firms in the market. To be comprehensive of business activity, both buyer and seller concentration will be emphasized.

Problems and Objectives

The flow of grain through marketing channels is an institutional process that is changing at an increasing rate. Changes in the organization of marketing agencies influence the efficiency of the marketing

system in all of its functions. Structural analysis of the nature and extent of changes facilitates decision making at both the micro and macro levels.

The general objectives of this study are to determine the direction and magnitude of the major changes in firm organization and other developments associated with the structural changes in the North Central Region (NCR) grain marketing industry. More specifically, for each major type of ownership, each sub-industry, and the entire NCR grain industry, attempts will be made to: (1) assess the changes in concentration through time, (2) analyze these changes into basic components, and (3) assess the relative importance of the components.

Method and Procedure

Research was conducted under the auspices of the technical committee for Cooperative Regional Research in grain marketing in the North Central Region (NCM-30). Both NCM-10 and NCM-19 provided the starting point for research for the NCM-30 regional project. Contributions to the project were also made by the Marketing Economics Division, USDA.

The importance of the North Central Region grain marketing industries in the United States is illustrated by the fact that in both 1954 and 1959 about 2/3 of nation-wide selected grain production was accounted for by these states (43, p. 2). These were corn, soybeans, wheat, oats, barley, and sorghum. The 11 states were:

Illinois	Minnesota	Ohio
Indiana	Missouri	South Dakota
Iowa	Nebraska	Wisconsin
Kansas	North Dakota	

Surveys were taken of NCR grain marketing plants for years 1954

and 1960. Volume data were obtained in terms of bushels of grain. Merchandising volume indicates both domestic and export volumes. For processors, volume data represented grain volume input utilized in the processing activities. Qualification of all plants was determined by the following definition:

GRAIN MERCHANDISERS. Plants reselling raw grain who receive less than 50 percent of their grain direct from farmers. Plants qualifying under this definition were primarily subterminal and terminal elevators.

GRAIN PROCESSORS. Plants with a minimum daily processing capacity not less than 50 tons and who dispose of at least 50 percent of their processed products through wholesale channels.

A total of 578 and 598 plants qualified in 1954 and 1960 respectively. Plants were classified into three categories: (1) plants doing grain merchandising only, (2) plants doing grain processing only, and (3) plants doing both. Processing plants were further classified on the basis of type of processing activity (Table 1). Firms not only were classified on the basis of single or multi-plant operations, but also as to whether co-operative or non-cooperative type of ownership. Multi-plant firm classification required at least 2 qualifying plants in the region. Non-cooperative firms included single proprietorships, partnerships, and corporations. For lack of a more meaningful word, the term "other" is used to signify all firms in the non-cooperative form of ownership category.

Degree of seller concentration is approached on an intra-industry basis since cross-demand schedules between industries have a priori slope

Table 1. Merchandising and processing industry codes for North Central Region plants and firms

Code	Industry or Industry Combinations
00	Grain merchandising only
01	Feed manufacturing
02	Flour milling
03	Oilseed processing
04	Dry milling for food
07	Alcohol manufacturing or distilling
12	Wet corn milling
13	Malting or brewing
01-04	Feed manufacturing and dry milling for food
01-13	Feed manufacturing and malting
02-01	Flour milling and feed manufacturing
02-04	Flour milling and dry milling for food
02-13	Flour milling and malting
02-03-04	Flour milling and oilseed processing and dry milling for food
01-02-04	Feed manufacturing and flour milling and dry milling for food
03-01	Oilseed processing and feed manufacturing
03-04	Oilseed processing and dry milling for food
03-12	Oilseed processing and wet corn milling
12-13	Wet corn milling and malting

zero. This, and the presence of immobile and non-substitutional resources between firms in different industries was the rationale involved in delineating the merchandising and processing industries when the survey was designed.

Degree of buyer concentration was approached in terms of regional concentration since regional volumes of grain represented raw grain inputs to the firm. On the buyer side merchandisers and processors are considered to be in the same buyer-of-grain market.

REVIEW OF LITERATURE

Concentration of productive activity among few firms has been subject to controversy for its application in evaluating industry performance. Recently, emphasis has been placed on the relative size of the firm, in contrast to the traditional concern with the absolute size. Fellner (11, p. 42) emphasized that pure competition develops when no firm is large enough relative to the market to affect the relevant market variables to an extent that any other firm would be influenced by the effect. This concern for inter-firm relationships has not necessarily indicated the importance of concentration measurement. Fellner indicates (11, p. 22) there is no basis, as yet, for quantitative appraisal or categoric statements concerning the importance of increases or decreases in concentration for competitive performance of the economy. Although it is possible to exaggerate the significance of fewness, "any value theory which neglects the phenominon of fewness is sufficiently incomplete to be highly misleading" (11, p. 23).

Measurement of concentration assumes a more positive role in evaluating industrial performance when efficiency of the productive process is at issue. Bain (3, p. 159) has considered the proportion of industry output produced by an optimal size firm. However, the criterion of efficiency as the determinant of desirable levels of concentration rests on the assumption of the shape of the long-run average cost curve, as well as the relationship of firm costs to the level of concentration. Thus, conclusions formed from concentration considerations become complicated by unique changes in industry periphery. That is, firm inter-

relationships and aggregate effects are so complex and varied through time that concentration must be studied against the backdrop of all phases of the particular industry's structure.

Stigler's survivor technique (42) violates this approach. His optimum size criteria consists of intertemporal concentration ratio comparisons for firms of various sizes. He says, "an optimum size that cannot survive in rivalry with other sizes is a contradiction,...." He would regard declining market shares of various size classes of firms to be indicative of inefficient firm size of each class. However, declining market shares and firm size are not necessarily positively correlated; as evidenced by a situation in which industry output increases at a faster rate than does firm output.

The basis for efficiency evaluation in terms of concentration, as previously indicated, rests with the hypothesis held concerning the shape of the long-run average cost curve. Marshall's observations (28, chps. 8-13) of a firm's growth processes were perhaps the first logical considerations of the interaction of scale economies leading to a conjecture concerning the shape of the long-run average cost curve. He observed: (1) economies of skill, (2) economies of machinery, and (3) economies of materials. These economies, and additional emphasis on the management factor and decay of facilities shed light on the reasons for firm growth as well as explaining varying rates of size mobility within an industry. Bain has considered these economies and recognizes their effects in dictating a minimal optimal size. He has pushed a bit further by suggesting that these determinants of firm growth explain why firms

tend toward a particular size relative to the total industry. That is, these forces induce firms to seek maximal efficiency associated with an optimum size and number of firms within an industry. Thus Bain related structural analysis to the evaluation of industry efficiency, which is an important determinant of desirable social performance. The applicability of concentration analysis extends beyond firm efficiency. As indicated in the introduction intra-industry power relations, whether actual or potential, become the variables carefully scrutinized under public policy.

As suggested by Bain and Stigler, an optimal firm size may in actuality mean a minimal optimal scale. This follows if the more recent hypotheses (3, p.153) (19) of minimum long-run average costs extending over wide ranges of output are accepted. Saving (38) says this range may be wide or as narrow as one optimum scale, depending on the firms' production functions. Production functions may be homogeneous of degree 1 in the neighborhood of a single output, in the neighborhood of several outputs, over a range of possible outputs, or over all possible outputs. The range of optimal scales for these categories becomes increasingly wide. He points out that particular types of production functions need not be specified to insure competition. Thus wide ranges of optimal scales and thus wide varieties of firm sizes, are not inconsistent with standard competitive behavior.

Growth processes, of course, are not exclusively internal. External growth processes are also important structural relationships. Merger activity, "... the absorption of smaller, independent enterprises

by large concerns" (26) have been both horizontal and vertical. "There are no large American companies that have not grown somewhat by merger and probably very few that have grown much by the alternative method of internal expansion" (18, p. 69). Lintner and Butters (26) found that, "the importance of external expansion in promoting concentration has never been more clearly revealed than in the acquisition movement that is taking place at the present time." (1950) However, they concluded that since 1940, other factors such as retained earnings and the availability of outside capital have potentially much greater effects on concentration than mergers have had.

The most basic question involved in the measurement of size distributions of firms concerns the unit of measurement that is the indicator of firm size (12). Volume of production has been used since it is the unit of importance from which actual inter-firm power relations are established. Traditional market share analysis indicates power relations by utilizing volume data (9) (37). Size measures of percent capacity utilized supplement volume by indicating actual with potential power relations. Firm assets are similarly used to test potential inter-firm relations since assets reflect the depth of productive activity measured by the productive resources employed. Use of asset data is limited because of: (1) non-uniformity of the investment component of assets between firms (32), (2) changing price levels, and (3) limitations of obtaining asset data. Florence (12) found conflicting conclusions from the Hart and Prais study (17) by using a second type of asset data. The two were market values and net tangible assets. Adelman (1) indicates

the measure of size to be used depends largely on the information desired in the comparative analysis.

Both comparative statics and dynamic models are used for size distribution measurement (17). Dynamic models are more refined analytical techniques, emphasizing rank changes and relative size mobility. Hart (15) draws a distinction between the statistical approach and the enumerative approach. The former, being superior, summarizes significant changes of large numbers of firms, while the latter enumerates data based on small numbers of firms.

Static models primarily summarize industry concentration at a point in time. Obviously, firm size mobility cannot be evaluated by these models. Both number of sellers and dominance of the few (11) are static concentration components. For economic analysis, Blair (4) emphasizes dominance since fewness, in itself, may not affect performance unless extended to market control. Plant as well as firm concentration is important since their relationship is indicative of the extent to which plant economies of scale operate (44). Concentration can be analyzed for identical firms through time periods or for the changing group of largest firms, the former somewhat analogous to Hart's enumerative approach. The latter lacks consideration of firm size mobility, which is indicative of competitive market structure (9).

The controversy surrounding the use of the Lorenz curves for static comparisons hinges on the percentage distribution of both the number and market share of firms. Blair (4) contends the slope of the curve depends on the effect of changes in firm numbers on the dispersion which

may invalidate the curves' use for forming conclusions. Hart and Prais (15) (16) (17) argue that concentration is determined by the position of the curve, but conclusions as to competition based on this concentration must be made in light of changes in firm numbers. Thus absolute concentration ratios should be supplemented with other statistical methods incorporating relevant variables not fully considered in a single concentration measure. Blair's cumulative concentration curve, plotting cumulative proportion of industry activity against successively smaller firms, emphasizes firm numbers in revealing the critical number for market share inequality. Other statistical tools have been proposed to eliminate the possible ambiguity of single concentration measures.

Dynamic models employing Hart's statistical approach have been developed in an attempt to analyze size mobility between time periods. This is the problem of business concentration in a dynamic context (16) and indicates the rigidity of predetermined structure. Dynamic models attempt to test: (1) the relationship of growth rates to firm size, (2) the effects of mergers on rigidity, (3) the effects of births and deaths on mobility, and (4) the extent to which firms change rank order.

The assumption on which many dynamic models are based, due to Gibrat, is that the distribution of the logarithims of firm size is approximately normal (2) (22). The four implications (16) of Gibrat's law are: (1) large, medium, and small firms have the same average proportionate growth, (2) the dispersion of growth rates around the common average is the same for these groups, (3) the distribution of proportionate growth rates is lognormal, and (4) the variance of the distribution increases

with time. Mansfield's analysis (27) of the steel, petroleum, and tire industries found, contrary to the law, that the variance of growth rates was inversely related to firm size. Hymer and Pashigians study (19) of the relationship of firm size and growth rates found similar results. Penrose (32) similarly postulated that diminishing returns to proportionate growth rates eventually set in as size increases. This relationship can be explained by settled technology (27), increasing administrative tasks, and the impact of environmental conditions (32).

Saving (38) argues the law has no economic explanation since variable growth rates depend on factor supply adjustment to changes in demand. The magnitude of the growth rate would depend on the elasticity of factor supply of the firm. Champernowne (5) found the distribution of incomes to have a non-increasing variance. This led him to consider the alternative stochastic model. Kalecki (22) proposed a modification to prevent the variance from increasing for possible stochastic application of the law. Rosenbluth (36) objected that this does away with the law of proportionate effect.

Dynamic models embodying the law of proportionate effect were developed by Hart and Prais (15) (16) (17). Intertemporal variance comparisons indicate changes in the inequality of the distribution and thus concentration changes of the industry. Because of its simplicity and relationship to various static and dynamic models, the law of proportionate effect serves as a useful tool of economic analysis. One important limitation is that it is insufficiently flexible to incorporate firm births and deaths.

Other dynamic statistical models deal with the level of and changes in the rate of size mobility. These models emphasize changes in the identity of rank positions, especially of large firms. Rank correlation (6) trends of multiple year distributions are meaningful indicators of fluid and dynamic business leadership (23). Joskow (20) emphasized the necessity of studying rank shift data against the backdrop of the particular industry. However, rank correlation comparisons do not indicate size stability if the entire industry is growing. Further, firm mobility may be exaggerated if firms are of equivalent size. Joskow determined fluidity by measuring the off-diagonal elements of a transition matrix of rank class changes. This matrix illustrated the various rank changes that comprised the correlation coefficient.

A dynamic probabalistic model first applied to economic phenomena by Champernowne (5) is the Markov process. This stochastic model is useful for determining internal firm mobility including entry and exit. All economic forces determining firm growth are lumped into one variable -- firm size (1). The transition probabilities and the initial distribution together enable the stationary state to be computed. This projection device is useful for determining, under present growth rates, the equilibrium industry structure, as well as observed industry movement toward this end. Adelman (1) first applied the Markov analysis to the size distribution of firms. Prais (33) calculated the average time spent in given classes to determine relative rates of mobility and specified the perfectly mobile industry for comparative purposes. Adelman subsequently

redefined this comparative device and termed it the index of industrial mobility. Judge and Swanson (21) have experimented with the use of absorbing chains to determine rates of growth before firms were absorbed by specified states. This approach, however, is hardly plausible.

Prior to Adelman, rejection of the Markov model for firm data, by Hart and Prais (17), apparently resulted from the observed increasing variance of survivors. They also were hesitant about arbitrary division of a continuous variable (firm size) into discreet classes. They regarded the lognormal as the most applicable theoretical model. An increase in variance indicated absense of regression in firm size and thus the residual variance became useful. Saving (38) similarly regarded constant transition probabilities as unrealistic on the basis of long-run, short-run supply function relationships. Variable growth rates develop through time by varying reactions to changes in demand. Varying reactions developed because inter-firm long-run supply elasticity varies. Simon and Bonini (40) introduced entrants with relatively smaller variances to stabilize the variance through time. Collins and Preston (6), admitting the evidence contrary to constant variance, point to the stationary state as a useful projection, surrounded with simplifying assumptions. Newman and Wolfe (29) state that the stationary state does not imply that all firms are in equilibrium. This is illustrated by varying rates of size mobility, births, and deaths. They regard the transition matrix and therefore size mobility as deterministic and a function of economic variables.

Rosenbluth (36) and Hart (16) held differing opinions as to the applicability of a stochastic model to Canadian firm data. The difference

resulted from a failure to agree on the importance of the stochastic component of the growth process. Both authors and Padberg (30) indicate the plausibility of the model depends, in part, on the extent to which environmental factors dictate firm growth. If energy, ambition, and ability are chief factors, the model would be inappropriate since firm growth would surely depend on the firms' past history. Galbraith (13) has referred to these environmental factors as primary determinants of firm growth.

Theory to substantiate these various schools of thought is in the early stage of development. Stochastic models do provide structural information in addition to other static and dynamic models but do so at the expense of simplifying and unrealistic assumptions with regard to firm behavior and reactions to industry environment.

COMPARATIVE STATICS ANALYSIS

Regional Analysis of Firm Ownership, Organization, and Size

Analysis of change in concentration for various regional firm sub-groups will be undertaken to determine structural changes of important NCR grain industry components. Changes in the aggregate distribution of plants, firms, and volumes between 1954 and 1960 illustrate major organizational developments in various market areas. Industry sub-group analysis is by major type of ownership and firm organization. Evaluation of regional concentration by this intertemporal distribution analysis cuts across industry lines and thus becomes an integral part of the analysis of buyer concentration.

Table 2 illustrates the distribution of plants, firms, and volume between co-ops and "others" and the changes since 1954. The cooperative form of firm ownership is much less important than "others" but became relatively more important since 1954. The relative increases, however, are much less than absolute increases since industry totals increased appreciably. Throughout most of the comparative statics discussion relative changes rather than absolute will be emphasized.

Table 3 indicates that for co-ops, the single and multi-plant firms have mixed and changing importance. Single-plant firms became relatively more important, especially in terms of volume.

Table 4 shows that for "others", multi-plant firms are more important in terms of volume than is true for co-ops. Although in terms of plants and firms, multi-plant firms were less important in 1954, increases in plants and decreases in firms caused multi-plant operations to become

Table 2. 1954 and 1960 distribution of plants, firms, and volume between co-op and "other" firms

	1954				1960			
	Co-ops		"others"		Co-ops		"others"	
	number	percent	number	percent	number	percent	number	percent
plants	48	8.3	530	91.7	59	9.9	539	90.1
firms	28	8.2	315	91.8	35	11.6	266	88.4
	(000 bu)							
volume	156,970	8.4	1,720,297	92.6	274,747	12.2	1,976,583	87.8

Table 3. 1954 and 1960 distribution of plants, firms, and volume for co-ops between single and multi-plant firms

	1954				1960			
	single plant		multi-plant		single plant		multi-plant	
	number	percent	number	percent	number	percent	number	percent
plants	18	37.5	30	62.5	24	40.7	35	59.3
firms	18	64.3	10	35.7	24	68.6	11	31.4
	(000 bu)							
volume	51,290	32.7	105,680	67.3	138,042	50.2	136,705	49.8

Table 4. 1954 and 1960 distribution of plants, firms, and volume for "others" between single and multi-plant firms

	1954				1960			
	single plant		multi-plant		single plant		multi-plant	
	number	percent	number	percent	number	percent	number	percent
plants	252	47.5	278	52.5	194	36.0	345	64.0
firms	252	80.0	63	20.0	194	72.9	72	27.1
	(000 bu)							
volume	435,041	25.3	1,285,256	74.7	405,551	20.5	1,571,032	79.5

increasingly important. The relative increase in multi-plant volume was caused by the increased number of multi-plant firms and not due to growth of the large, predominantly "other" firms.

Co-op single-plant firms

The 1954 and 1960 distributions of single-plant co-ops are given in Table 5. This table gives the percentage distributions of plants, firms, and volumes by industry. These percentage comparisons should be considered in light of the single-plant co-op volume increase of 250%. Grain merchandising is most important on a volume basis and is losing importance on a firm (plant) basis to the processing industries. The characteristic of co-ops, as is illustrated, is the lack of product heterogeneity of the distribution.

Table 5 and subsequent similar tables also illustrate changes in the relative importance of supplementary processing activities with merchandising. Higher concentration in processors performing merchandising activities would indicate backward integration tendencies only if merchandising indicates an additional auxiliary stage. Integration is being defined here as additional auxiliary stages within the output structure of the firm (14, p. 80). That is, the addition of and/or increases in merchandising must indicate an increase in grain acquired from processor-owned facilities that perform an activity of seperable ownership potential. However, there was very little relation between the tendency to acquire grain through company owned facilities and the tendency to merchandise. Thus tendencies toward backward integration are not indicated by tendencies for processors to merchandise.

Table 5. 1954 and 1960 percentage distribution of single-plant co-op firms, plants, and volumes

		00	01	02	03	03-01	Total Processor
Processors	Firms[a]						
	1954	38.9	16.7	-	22.2	11.1	50.0
	1960	29.2	25.0	-	8.3	4.2	37.5
	Volume						
	1954	55.2	10.8	-	7.9	21.9	40.6
	1960	81.6	6.2	-	1.6	1.9	9.7
M. & P.[b]	Firms						
	1954	-	-	-	5.5	5.6	11.1
	1960	-	16.6	-	4.2	12.5	33.3
	Volume						
	1954	-	-	-	1.4	2.8	4.2
	1960	-	2.6	-	2.7	3.4	8.7

[a]Distribution of firms is the same as distribution of plants.

[b]Merchandising and Processing

The importance of diversification in terms of concentration in more diversified activities can be observed from Table 5. In this study diversification is defined as an increase in the relative importance of heterogeneous markets served by the firm (14, p. 8). The increased concentration of the more heterogeneous industry combinations illustrates that diversification is becoming more important for the co-op single-plant subgroup. This analysis is only indicative of significant diversification tendencies since: (1) an increase in merchandising is only one activity through which market heterogeneity can be obtained, (2) summarizing total firm changes masks individual firm tendencies, and (3) firms are merely classified as merchandisers and the level of or extent of change in the product mix is not specified.

In this and subsequent sections additional analyses were conducted in which co-op single-plant firms were individually traced and classified on the basis of firm net changes in number of merchandising and/or processing activities. This process involved tabulating individual firm changes and neglects relative sizes of firms. The hypothesis was that the mean of the differences of number of per-firm activity (industry) additions was zero. Snedecor's (41, p. 49) t-tests of differences was employed. The mean difference, 0.4, was significant at the .01 probability level. On the average, firm product mix was more heterogeneous.

An additional t-test was conducted on differences between 1960 and 1954 firm product diversification ratios to measure the significance of the change in product mix. The firm diversification ratios were defined to be the ratio of non-primary product volume divided by total firm volume.

For single-plant co-op survivors the mean of the differences was not significantly different from zero. (For this and subsequent sections survivors mean firms qualifying in both time periods. Births and deaths mean firms qualifying only in 1960 or 1954 respectively.) The inclusion of births resulted in a significant difference at the .1 level. Thus births were more diversified than the 1954 co-op single-plant average.

Co-op multi-plant firms

Table 6 illustrates that multi-plant co-ops are shifting importance away from merchandising and into processing. Total volume increased by about 30 percent. Diversification, in contrast to co-op singles, became less important in terms of concentration in more heterogeneous industry combinations. The number of co-op multi-plant firms was too small to run t-tests. Tabulation of the data indicated no change in the average number of firm activities, and a slight increase in the average product mix.

Total co-op

Table 7 illustrates the relative importance of single and multi-plant co-op firms for the various industries. The distributions for both 1954 and 1960 sum to unity. By comparing the relative magnitudes of the figures for each industry, the changes in importance of multi versus single plant operation can be assessed. Further, horizontal comparisons assess the importance of each type of operation (industry) in the co-op distribution. The presence of multi-plant economies is questionable, but if they exist, they were not explcited by co-op firms between 1954 and 1960. Diversification became more important for co-op firms both in increasing

Table 6. 1954 and 1960 percentage representation[a] of multi-plant co-op firms, plants, and volumes

			00	01	02	03	Total Processor
Processors	Plants	1954	66.7	16.7	3.3	-	20.0
		1960	57.1	25.7	2.9	5.7	34.3
	Firms	1954	50.0	25.0	6.2	-	31.2
		1960	38.9	33.3	5.6	11.1	50.0
	Volume	1954	84.9	1.2	1.6	-	2.8
		1960	69.5	11.9	1.5	15.7	29.1
M. & P.	Plants	1954	-	10.0	-	3.3	13.3
		1960	-	5.7	-	2.9	8.6
	Firms	1954	-	12.5	-	6.3	18.8
		1960	-	5.6	-	5.5	11.1
	Volume	1954	-	11.2	-	1.1	12.3
		1960	-	.3	-	1.1	1.4

[a]Multi-plant firms may be represented in more than one industry.

Table 7. 1954 and 1960 percentage representation of co-op single and multi-plant firms, plants, and volumes

		00	01	02	03	03-01	Total Processor
	Plants						
	1954	14.6	6.3	-	10.4	6.2	37.5
	1960	11.9	16.9	-	5.1	6.8	40.7
Single	Firms						
Plant	1954	20.6	8.8	-	14.7	8.8	52.9
Firms	1960	16.7	23.8	-	7.1	9.5	57.1
	Volume						
	1954	18.0	3.5	-	3.1	8.1	32.7
	1960	41.0	4.5	-	2.1	2.6	50.2
	Plants						
	1954	41.6	16.7	2.1	2.1	-	62.5
	1960	33.9	18.6	1.7	5.1	-	59.3
Multi	Firms						
Plant	1954	23.5	17.6	3.0	3.0	-	47.1
Firms	1960	16.7	16.7	2.4	7.1	-	42.9
	Volume						
	1954	57.2	8.3	1.1	0.7	-	67.3
	1960	34.6	6.1	0.7	8.4	-	49.8

concentration in more diversified activities and individual firm activity increments.

"Other" single-plant firms

Table 8 indicates the wide diversity of industries in the "other" single-plant firm distribution. In contrast to co-ops, grain merchandising is of lesser relative importance than for co-ops but is increasing in importance. No other important changes were observed for the various industries. Total "other" single-plant volume declined by about 7%. In terms of concentration in more heterogeneous industry combinations, diversification was of lesser importance in 1960. t values similar to those previously introduced were computed. The mean of the increase in firm activities, 0.1, was significantly greater than zero at the .01 level. Thus there was a significant tendency for firms to diversify. However, the mean of the increase in firm diversification ratios (per-firm product mix) was not significantly different from zero. The latter product mix stability accounted for the declining importance of diversification in terms of concentration in heterogeneous operations.

"Other" multi-plant firms

Table 9 illustrates an increase in the importance of merchandising activities. An 18% increase in total multi "other" volume was observed for this group of firms that control 2/3 of total industry volume. Comparing the widely diverse distributions, stability in market share of the processing sector prevailed. Diversification, in terms of concentration in more heterogeneous operations, was unimportant. The aggregate

Table 8. 1954 and 1960 percentage distribution of single-plant "other" firms, plants, and volume

Industry	Processors				M. & P.			
	Firms 1954	Vol. 1954	Firms 1960	Vol. 1960	Firms 1954	Vol. 1954	Firms 1960	Vol. 1960
00	19.4	24.0	29.4	34.7	-	-	-	-
01	15.8	5.0	14.5	5.4	15.4	5.4	15.0	4.4
02	11.5	12.7	10.3	9.7	3.6	5.3	3.6	4.3
03	4.4	4.8	3.1	3.6	5.2	6.1	2.6	4.1
04	2.0	5.8	2.6	6.6	.4	.1	-	-
07	2.4	1.9	1.5	1.8	.4	.6	-	-
12	2.4	11.9	2.6	11.7	-	-	-	-
13	4.7	3.9	5.2	3.7	-	-	1.0	3.6
01-04	.8	.1	.5	.1	.8	.2	1.5	1.0
01-13	.4	.3	-	-	-	-	-	-
02-01	2.0	1.7	1.0	.2	3.6	1.1	3.1	1.1
02-04	1.2	1.7	.5	.1	-	-	-	-
02-13	-	-	-	-	-	-	-	-
02-03-04	-	-	-	-	.4	1.0	-	-
01-02-04	-	-	-	-	-	-	-	-
03-01	.4	.1	.5	.1	1.6	.9	.5	.9
03-04	.4	2.9	-	-	.4	.1	.5	.4
03-12	-	-	-	-	-	-	-	-
12-13	.4	2.4	.5	2.6	-	-	-	-
Total Processor	48.8	55.2	42.8	45.6	31.8	20.8	27.8	19.7

Table 9. 1954 and 1960 percentage representation of multi-plant "other" firms, plants, and volumes

Industry	Processors						M. & P.					
	Plants		Firms		Volume		Plants		Firms		Volume	
	'54	'60	'54	'60	'54	'60	'54	'60	'54	'60	'54	'60
00	36.7	37.7	24.2	24.2	37.6	41.6	-	-	-	-	-	-
01	11.1	14.8	10.9	14.4	3.6	2.4	4.7	3.8	8.6	6.9	1.6	1.3
02	15.1	13.6	10.9	9.4	11.5	10.6	5.8	4.3	5.5	5.7	7.3	7.2
03	9.0	7.8	10.2	10.0	9.2	9.1	1.1	1.4	2.3	2.5	2.9	3.3
04	2.1	1.7	3.9	3.7	1.3	.6	-	.6	-	1.2	-	1.0
07	1.1	1.4	1.6	1.9	.4	.6	-	-	-	-	-	-
12	1.1	1.2	.8	1.2	4.6	4.8	-	-	-	-	-	-
13	1.4	1.4	3.1	1.2	.7	.7	.7	.6	1.5	1.2	1.2	.8
01-04	1.8	.6	2.3	1.2	3.6	1.3	.3	1.4	.8	3.2	.3	1.4
01-13	-	-	-	-	-	-	-	-	-	-	-	-
02-01	.4	.6	.8	1.2	.1	.4	.3	.6	.8	1.2	.1	.4
02-04	.4	.6	.8	1.2	.3	.5	.7	.3	1.6	.6	1.2	.4
02-13	-	-	-	-	-	-	.4	-	.8	-	.6	-
02-03-04	.4	-	.8	-	.1	-	-	.3	-	.6	-	.5
01-02-04	-	.3	-	.6	-	.1	.4	.3	.8	.6	.6	.5
03-01	2.1	.9	2.3	1.2	2.4	1.3	2.5	2.9	3.9	3.1	5.8	5.1
03-04	-	.3	-	.6	-	1.2	-	-	-	-	-	-
03-12	-	-	-	-	-	-	.4	.6	.8	1.2	3.1	2.9
12-13	-	-	-	-	-	-	-	-	-	-	-	-
Total Processors	46.0	45.2	48.4	47.8	37.8	33.6	17.3	17.1	27.4	28.0	24.6	24.8

stability was associated with internal industry changes. Both increasing and decreasing importance of diversification was observed for different component industries. Again a t test was employed to find that the mean of the increase in firm activities, 0.19, was significant at the .01 level. The average increase in per-firm volume diversification (product mix) was not significantly different from zero. The inclusion of births into the product mix values yielded a significant mean increase. Thus births were more diversified than the 1954 "other" multi-plant average.

Total "other"

Table 10 illustrates the changing importance of multi-plant firms. A 23% increase in multi-plant volume as well as increases in plants and firms in this category was observed. As previously indicated, both vertical and horizontal comparisons can be made from the table. Both increases and decreases are observed for changes in importance of multi-plant firms for component industries. The more important industries, (in terms of volume) has more pronounced increases in multi-plant emphasis. Obviously these increases in importance developed because percentagewise, increases in multi-plant firms, plants, and volume were greater in the particular industry than for the "other" total. The latter increased by 19%. Thus changes for component industries are understated, a 19% increase was necessary to maintain the same relative importance. Table 10, total column, summarizes these changes, and as illustrated, multi-plant firms are becoming more important.

All firms

Table 11 permits static summary comparisons to be made of the

Table 10. 1954 and 1960 percentage distribution of "other" plants, firms, and volume

Industry	Single-plant Firms						Multi-plant Firms					
	Plants		Firms		Volume		Plants		Firms		Volume	
	'54	'60	'54	'60	'54	'60	'54	'60	'54	'60	'54	'60
00	9.2	10.6	12.9	16.1	6.1	7.1	19.2	24.1	8.1	11.0	28.1	33.0
01	14.9	10.6	20.8	16.1	2.6	2.0	8.3	11.9	6.6	9.6	3.9	2.9
02	7.2	5.0	10.0	7.6	4.6	2.9	10.9	11.5	5.5	6.8	14.0	14.2
03	4.5	2.0	6.3	3.1	2.7	1.6	5.3	5.9	4.2	5.6	9.1	9.9
04	1.1	.9	1.6	1.4	1.5	1.3	1.1	1.5	1.3	2.2	1.0	1.3
07	1.3	.6	1.8	.8	.6	.4	.6	.9	.5	.8	.3	.4
12	1.1	.9	1.6	1.4	3.0	2.4	.6	.7	.3	.6	3.4	3.8
13	2.3	2.2	3.1	3.4	1.0	1.5	1.1	1.3	1.6	1.1	1.4	1.2
01-04	.8	.7	1.0	1.1	.1	.2	1.1	1.3	1.0	2.0	2.9	2.1
01-13	.2	-	.3	-	.1	-	-	-	-	-	-	-
02-01	2.6	1.5	3.7	2.2	.7	.3	.4	.7	.5	1.1	.1	.7
02-04	.6	.2	.8	.3	.4	.1	.6	.6	.8	.8	1.2	.7
02-13	-	-	-	-	-	-	.2	-	.3	-	.5	-
02-03-04	.2	-	.3	-	.2	-	.2	.2	.3	.3	.1	.4
01-02-04	-	-	-	-	-	-	.2	.4	.3	.6	.4	.5
03-01	.9	.4	1.3	.5	.3	.2	2.5	2.4	2.1	2.0	6.1	5.1
03-04	.4	.2	.5	.3	.8	.1	-	.2	-	.3	-	1.0
03-12	-	-	-	-	-	-	.2	.4	.3	.6	2.3	2.3
12-13	.2	.2	.3	.3	.6	.5	-	-	-	-	-	-
Total Processors	47.5	36.0	66.3	54.6	25.3	20.5	52.5	64.0	33.7	45.4	74.7	79.5

Table 11. 1954 and 1960 distribution of plants, firms, and volume between single and multi-plant firms

	1954				1960			
	single plant		multi-plant		single-plant		multi-plant	
	number	percent	number	percent	number	percent	number	percent
Plants	270	46.7	308	53.3	218	36.5	380	63.5
Firms	270	78.7	73	21.3	218	72.4	83	27.6
	(000 bu)							
Volume	486,331	25.9	1,390,936	74.1	543,593	24.1	1,707,737	75.9

changing importance of multi-plant firms. In summary, single-plant firms accounted for about 75% of all firms, and multi-plant firms 75% of regional volume. Co-op multi-plant firms averaged 3 and 3.2 plants per firm in 1954 and 1960 respectively, while "other" multi-plant firms averaged 4.4 and 4.8. Multiple regression analysis developed at a later point indicated plant volume (Table 43). For all firms, in total, increases in importance of multi-plant firms are observed for plants, firms, and volumes. The conjecture could be made that this increasing importance was due to the presence of multi-plant economies of size. Cost data to verify this is unavailable, however.

From Table 1 it was apparent that co-op firms have assumed greater importance in the region. Table 12 illustrated the changing importance of co-op firms relative to "others" for single plant firms. In total, for single-plant processors, no change in importance was observed, while co-op merchandisers were a great deal more important in 1960. Merchandisers, both co-op and "others" assumed a much greater share of single-plant volume in 1960. Table 13 illustrates that for multi-plant processors, co-ops were more important in 1960 while merchandising co-ops were slightly less important in 1960.

Dominance Analysis by Industry

The previous analysis centered on changes in distribution of plants, firms, and volumes and places particular emphasis on consideration of all grain buyers in the various grain merchandising and processing categories. This analysis of firms was employed with the primary objective of

Table 12. 1954 and 1960 percentage distribution of single-plant firms, plants, and volumes

Industry	Co-op				Other			
	Firms 1954	Vol. 1954	Firms 1960	Vol. 1960	Firms 1954	Vol. 1954	Firms 1960	Vol. 1960
00	2.6	5.8	3.2	20.7	18.1	21.5	26.1	25.9
01	1.1	1.2	4.5	2.3	29.2	9.2	26.1	7.3
02	-	-	-	-	14.0	16.2	12.5	10.4
03	1.9	1.1	1.4	1.1	8.9	9.7	5.1	5.7
04	-	-	-	-	2.3	5.3	2.3	4.9
07	-	-	-	-	2.6	2.2	1.4	1.4
12	-	-	-	-	2.2	10.7	2.3	8.7
13	-	-	-	-	4.4	3.5	5.4	5.5
01-04	-	-	-	-	1.4	.3	1.8	.8
01-13	-	-	-	-	.4	.3	-	-
02-01	-	-	-	-	5.2	2.5	3.6	.9
02-04	-	-	-	-	1.1	1.5	.4	.1
02-13	-	-	-	-	-	-	-	-
02-03-04	-	-	-	-	.4	.9	-	-
01-02-04	-	-	-	-	-	-	-	-
03-01	.1	2.6	1.9	1.3	1.9	.9	1.0	.7
03-04	-	-	-	-	.8	2.7	.5	.3
03-12	-	-	-	-	-	-	-	-
12-13	-	-	-	-	.4	2.2	.5	1.9
Total Processor	4.1	4.7	7.8	4.7	75.2	68.0	62.9	51.7

Table 13. 1954 and 1960 percentage representation of multi-plant firms, plants, and volumes

Industry	Co-op						Other					
	Plants		Firms		Volume		Plants		Firms		Volume	
	'54	'60	'54	'60	'54	'60	'54	'60	'54	'60	'54	'60
00	6.5	5.3	5.6	3.9	6.5	5.6	33.1	34.2	21.5	21.8	34.7	38.2
01	2.6	2.9	4.2	3.9	.9	1.0	14.3	16.8	17.6	19.0	4.9	3.4
02	.3	.3	.7	.6	.1	.1	18.9	16.3	14.6	13.4	17.3	16.5
03	-	.8	-	1.6	-	1.3	9.1	8.4	11.1	11.1	11.2	11.4
04	-	-	-	-	-	-	2.0	2.1	3.4	4.5	1.2	1.5
07	-	-	-	-	-	-	1.0	1.3	1.4	1.7	.4	.5
12	-	-	-	-	-	-	1.0	1.1	.7	1.1	4.2	4.4
13	-	-	-	-	-	-	2.0	1.8	4.2	2.2	1.7	1.4
01-04	-	-	-	-	-	-	1.9	1.8	2.0	3.9	3.6	2.5
01-13	-	-	-	-	-	-	-	-	-	-	-	-
02-01	-	-	-	-	-	-	.6	1.0	1.4	2.2	.1	.8
02-04	-	-	-	-	-	-	1.0	.8	2.1	1.7	1.4	.7
02-13	-	-	-	-	-	-	.3	-	.7	-	.6	-
02-03-04	-	-	-	-	-	-	.3	.3	.7	.6	.1	.4
01-02-04	-	-	-	-	-	-	.3	.6	.7	1.2	15	.6
03-01	-	-	-	-	-	-	4.2	3.4	5.6	3.9	7.6	5.9
03-04	-	-	-	-	-	-	-	.3	-	.6	-	1.1
03-12	-	-	-	-	-	-	.3	.5	.7	1.1	2.9	2.7
12-13	-	-	-	-	-	-	-	-	-	-	-	-
Total Processor	3.2	4.0	5.6	6.1	1.1	2.4	57.2	56.5	67.3	68.2	57.7	53.8

illustrating the changing distributions of plants and volumes among various classes of all firms. This analysis is supplemented with a related phenomenon: dominance of the few. Since "fewness" is an arbitrary term, which, in different firm arrays may denote different numbers of firms, the term "dominance of the few" will accentuate dominance, although fewness will be considered. This section will investigate the dominance of firms in various delineated industries in the NCR grain industry. The dominance analysis in this section will be approached with summary techniques evaluating the changing domination of largest firms. The number of largest sellers is grouped in 3 categories: the largest 4, 8, and 20 firms. These categories are used as a basis for distinguishing oligopolistic industries according to the degree of seller concentration (3, p. 32). Thus component industry concentration is evaluated in an attempt to determine the degree of seller concentration in the various markets. On the seller side it is these groups of firms that are competing, and intra-industry concentration indicates deviations from desirable market structure for that industry.

Table 14 provides an overall view of industry distribution of volume among various grain processing industries for both time periods. A cursory examination indicates the volume concentration of grain merchandising relative to each of the other processing industries. This table is particularly useful in assessing the significance to the entire grain industry of changing domination in the grain-buyer market of the various industries. It permits weighing of various internal concentration changes to explain the dynamics of aggregate changes.

Table 14. Annual volume and percentage distribution of grain merchandised and processed, North Central Region

	Grain Merch. 00	Feed Mfg. 01	Flour Mill. 02	Oilseed Proc. 03	Dry Mill.® Cereal Mfg. 04	Dist.® Alcohol Mfg. 07	Wet Corn Mfg. 12	Malt.® Brew. 13
1954 Volume	870,930	141,653	319,535	262,361	90,245	15,247	134,050	43,246
% of Volume	46.4	7.6	17.0	14.0	4.8	00.8	7.1	2.3
% of Proc. Vol.		14.0	31.8	26.0	9.0	1.50	13.3	4.3
1960 Volume	1,136987	123,876	311,962	322,695	98,412	16,081	157,623	51,866
% of Volume	51.2	5.6	14.0	14.5	4.4	0.7	7.1	2.3
% of Proc. Vol.		11.4	28.8	29.8	9.1	1.5	14.6	4.8

All firms

Table 15 initiates the dominance study by comparing market shares of grain industry subgroups for a few large firms between 1954 and 1960. For the aggregate of merchandising and processing industries, defined to be the NCR grain marketing industry, concentration is only moderately high. This generalization is made from Bain's criterion of high concentration (3, p. 32) in which the largest eight firms account for between 2/3 and 3/4 of industry volume. The largest 20 firms accounted for just more than 50 percent of industry volume. Decreasing market shares indicate a decline in importance of the largest firm groups. The top 4 firms had different firm identities in the merchandising and processing categories for both time periods, although there was a small overlap for the top 8 and top 20. This overlap was 2 and 3 firms for respective time periods for the largest 8 and 3 and 4 for the next largest 12. Thus only a trivial tendency existed for firms to be extremely large in both merchandising and processing. In 1954 the number of firms represented in merchandising and/or processing was 457. Thus 118 firms both merchandised and processed. The 1960 total was 401 with 100 firms in the more diversified category. The 18 firm decline was one of the factors contributing to the slight tendency for NCR firms, in total, to specialize.

All processors

The decline of total firms from 343 to 301 was primarily accounted for by the grain processing subgroup. The decline of firms performing processing activities was associated with a decline in market share of the top 4 and 8 firms. These characteristics necessitated declining processing

Table 15. Market share of large firms in the grain marketing industries, North Central Region, 1954

Classification		Number of Firms	Percent of total volume of grain accounted for by large firms		
			4 largest	8 largest	20 largest
Merchandisers and Processors	'54	343	25.2	37.6	56.1
	'60	301	21.6	33.9	55.7
Merchandisers	'54	195	45.4	55.4	71.3
	'60	185	33.2	49.8	70.8
Processors	'54	262	22.3	37.4	57.0
	'60	216	19.0	33.1	60.0

Table 16. Market share and degree of specialization of large grain processing firms, North Central Region, 1954

Firms		Plant Total	Number of Plants Processing	Volume Processed	Percent of Region	Specialization ratio
4 largest	'54	30	25	224,890	22.3	89.4
	'60	47	36	211,134	19.0	76.7
8 largest	'54	80	61	375,887	37.4	62.8
	'60	94	65	367,737	33.1	59.3
20 largest	'54	144	113	573,237	57.0	65.4
	'60	195	139	665,908	60.0	61.4

volumes for the largest 8 firms, while the other 12 firms increased volume by 100 million bushels. Increases in total plants, including processing plants, for all size groups led to significant average plant volume declines. Average plant processing volume declined by 3 million (33%) for the 4 largest firms whose plants process, by 800 thousand for the largest 8, and 500 thousand for the largest 20. These average plant declines were associated with increases of 4, 10, and 25 merchandising plants for the respective size categories.

The specialization ratios given in Table 16 are merely summaries of the distribution of product mix between merchandising and the total of all processing activities. For specific industries these ratios are computed by dividing the total volume of grain input to the specific processing activity by total firm volume. For specific industries these ratios are definite indicators of diversification tendencies by the various size groups of firms. However, for the aggregate processing sector the ratios are not complete indicators of diversification since all processing volumes are summed into one value: total processing volume.

For these large groups of processors there was no important backward integration as might have been suggested by the increasing importance of merchandising. Specific vertical integration data, defined as percent of grain procured from company owned plants, was available only for 1960 so noncomparative analyses could be made. Forward integration for all processors, defined as percent of grain and/or processed products disposed through company owned plants was more prevalent.

In summary:

1. The largest 8 grain processors controlled a slightly declining share

of industry processing volume.

2. The processing volume of firms smaller than the largest 4 increased relative to these 4.
3. Substantial average plant volume declines occurred for the largest 20 and were greatest for the top 4, while increased volume developed by increasing the number of plants.

Flour millers

Analysis of grain processing dominance characteristics was undertaken without regard for component processing industries. These internal characteristics of the aggregate processing array will briefly be discussed in the order of volume importance of processing industries, as illustrated in Table 14. Table 17 summarizes the dominance characteristics of large flour milling (02) firms. This industry was similar to the processing subgroup in terms of declining concentration of the largest firms. Both a decline in market share and average plant volume is apparent. Firms smaller than the largest 4 grew relative to these four.

Specialization ratios were lower than the average of all processors and declined for all size groups. The declines of all size groups was associated with increases of small non-specialty plants that caused increases in market share but had little effect on specialization. These non-specialty plants were primarily entrants. Diversification tendencies developed not only through merchandising operations, but other processing activities as well. Appendix 1 shows the primary diversification activity to be merchandising, and this tendency has increased relative to other processing possibilities. In fact the flour milling volume share declined.

This tendency to merchandise was unrelated to backward integration.

Soybean processors

Large soybean processors (03) demonstrated very little change in moderate concentration, but, contrary to previous processors, increasing specialization ratios. Increases of plants were primarily accounted for by non-specialty activities. Appendix 2 shows the importance of merchandising relative to other non-specialty processing activities. Both a tendency to decrease the share of non-specialty processing activities and increase merchandising and soybean processing is observed. Substantially larger average plant processing volume and additional soybean plants not only caused increased specialization but increased market shares as well. Total oilseed processing plants declined by 15%, caused by a total firm decline, while total plants operated by the top 20 firms increased. The largest processors were substantially vertically integrated, especially in the disposition of processed products.

Feed manufacturers

Feed manufacturers (01) exhibited distinguishing changes among the top 4 firms as illustrated in Table 19. Similar to soybean firms, the specialization ratios increased sharply, but contrary to other processors, total plants declined. This decline was primarily plants that performed non-specialty activities. Table 14 indicates declining total volume for feed manufacturers, so the 4 largest, with constant volume, increased its share of the market. Firms smaller than the largest 4 illustrate diversification inclinations and little change in the moderate concentration.

Table 17. Market share and degree of specialization of large flour milling firms, North Central Region, 1954-55 60

Firms		Plant Total	Number of Plants Flour mill.	Volume Flour Milling	Percent of Region	Specialization ratio
				Thous. bu.	Percent	Percent
4 largest	'54	47	22	114,430	35.8	48.0
	'60	51	25	106,914	33.6	40.1
8 largest	'54	63	36	173,440	54.3	56.0
	'60	87	45	192,374	60.5	45.8
20 largest	'54	98	61	248,220	77.7	55.9
	'60	118	67	277,116	87.1	52.6

Table 18. Market share and degree of specialization of large oilseed processing firms, North Central Region, 1954-55 60

Firms		Plant Total	Number of Plants Oilseed Proc.	Volume Oilseed Proc.	Percent of Region	Specialization Ratio
				Thous. bu.	Percent	Percent
4 largest	'54	47	16	112,564	42.9	29.6
	'60	65	22	143,359	41.8	38.7
8 largest	'54	81	31	173,504	66.1	32.5
	'60	91	37	226,789	66.7	38.5
20 largest	'54	111	45	227,524	86.7	34.7
	'60	138	50	314,354	92.4	40.9

Table 19. Market share and degree of specialization of large feed manufacturing firms, North Central Region, 1954-60

Firms		Plant Total	Number of Plants Feed Mfg.	Volume Feed Mfg.	Percent of Region	Specialization Ratio
4 largest	'54	34	21	54,910	38.8	31.9
	'60	26	18	54,210	43.3	52.9
8 largest	'54	48	30	70,050	55.8	35.9
	'60	66	36	69,617	55.6	22.4
20 largest	'54	103	56	108,852	76.9	19.2
	'60	124	61	91,964	73.4	17.0

Table 20. Market share and degree of specialization of large wet corn milling firms, North Central Region, 1954-60

Firms		Plant Total	Number of Plants Wet Corn Mill.	Volume Wet Corn Mill.	Percent of Region	Specialization Ratio
4 largest	'54	7	6	103,540	77.2	80.1
	'60	13	6	108,875	69.1	77.2
8 largest	'54	11	10	130,250	97.2	80.8
	'60	17	10	146,138	92.7	80.8
20 largest[a]	'54	12	11	134,050	100.0	81.3
	'60	21	12	157,623	100.0	80.6

[a]1954 = 9 firms, 1960 = 10 firms.

Appendix 3 suggests that merchandising and other processing activities were each important in these trends. An increase in number of non-specialty plants accounted for the diversification trend. Firms smaller than the largest 4 are losing significance in feed manufacturing and are making compensatory volume increases in other operating activities. Vertical integration, in terms of disposition of processed products, was important.

Wet corn millers

Wet corn milling (12) is highly concentrated and specialized. There were only 9 firms in the industry in 1954, and 4 of them controlled over 3/4 of total volume. Table 20 denotes since 1954 these 4 had declining concentration. A slight trend toward diversification has developed, primarily with non-specialty processing plant increases. Appendix 4 suggests that wet corn millers perform very little merchandising and moderate non-specialty processing. The small diversification trend has developed around entrants of small plants, primarily in soybean processing, and apparently none in an integration chain.

Dry millers and cereal manufacturers

This industry (04) is highly concentrated (Table 21) and is increasing this characteristic. The 4 largest tend to be specialized. This characteristic is increasing, associated with declines of volume and plants of non-specialty activities, except soybean processing (Appendix 5). For smaller firms, diversification again developed by increasing the number of non-specialty plants, primarily soybean processing. Vertical integration was employed to a moderate degree.

Malters and brewers

Malting and brewing firms (13), Table 22, are similarly highly concentrating and diversification occurred by operating more wet corn milling plants (Appendix 6). Average processing plant volume increases accounted for increased total volume. Concentration changed little.

Distillers and alcohol manufacturers

This industry (07), Table 23, indicates very few firms and high concentration. Mergers were not responsible for firm number declines. Specialization is relatively low, and merchandising is the diversification activity (Appendix 7). The largest 4 firms have increased domination significantly and vertical integration is high, especially for disposition of processed products.

Grain merchandisers

Analysis of grain merchandising concentration is important in evaluating structural changes in the NCR grain industry since merchandising volume accounts for over half the volume distribution in 1960. Further, merchandising volume is three to four times greater than the largest processing industry. Table 24 indicates declining concentration for the top 4 with smaller declines for the top 8 and 20. Specialization ratios declined for the three size groups, but contrary to the processing industries, the 4 largest firms operated a declining number of plants. A slight decline in the specialization ratio for the largest 4 was associated with an increase in average plant merchandising volume. This ratio decline developed due to a decrease of 14 merchandising plants and an increase of

Table 21. Market share and degree of specialization of large dry milling and cereal manufacturing firms, North Central Region, 1954-60

Firms		Plant Total	Number of Plants Dry Milling Cereal Mfg.	Volume Dry Milling and Cereal Mfg.	Percent of Region	Specialization Ratio
				Thous. bu.	Percent	Percent
4 largest	'54	8	6	52,900	58.6	70.5
	'60	7	6	58,779	59.6	77.2
8 largest	'54	24	11	72,425	80.3	45.4
	'60	45	13	84,620	85.8	39.2
20 largest	'54	57	26	89,835	99.5	30.5
	'60	84	26	98,386	99.7	28.3

Table 22. Market share and degree of specialization of large malting and brewing firms, North Central Region, 1954-60

Firms		Plant Total	Number of Plants Malt. and Brew.	Volume Malt. and Brew.	Percent of Region	Specialization Ratio
				Thous. bu.	Percent	Percent
4 largest	'54	8	7	25,576	59.1	73.0
	'60	11	8	33,550	62.4	59.7
8 largest	'54	15	11	37,276	86.2	69.4
	'60	17	13	46,730	86.9	59.2
20 largest	'54[a]	28	21	43,246	100.0	56.9
	'60[b]	25	20	53,775	100.0	62.5

[a]Data from 18 firms.

[b]Data from 16 firms.

Table 23. Market share and degree of specialization of large distilling and alcohol manufacturing firms, North Central Region, 1954-60

Firms		Plant Total	Number of Plants Distilling Alcohol Mfg.	Volume Distill. and Alcohol Mfg.	Percent of Region	Specialization Ratio
				Thous. bu.	Percent	Percent
4 largest	'54	6	5	10,450	68.5	47.4
	'60	6	5	13,542	84.2	55.2
8 largest	'54	10	9	15,227	99.9	56.8
	'60	9	8	16,082	100.0	59.4
20 largest[a]	'54	11	10	15,247	100.0	56.8
	'60[b]	9	8	16,082	100.0	59.4

[a]Data from 9 firms.

[b]1960 data from 6 firms.

Table 24. Market share and degree of specialization of large grain merchandising firms, North Central Region, 1954-60

Firms		Plant Total	Number of Plants Merch.	Volume Merch.	Percent of Region	Specialization Ratio
				Thous. bu	Percent	Percent
4 largest	'54	72	59	395,230	45.4	88.1
	'60	61	45	379,459	33.2	85.0
8 largest	'54	10[illegible]	78	482,240	55.4	79.3
	'60	107	82	568,758	49.8	75.8
20 largest	'54	135	100	620,850	71.3	79.4
	'60	144	112	808,247	70.8	78.4

3 processing plants. For the next 16 largest, the reverse was true; diversification developed on the basis of average processing volume increases. Similar to large processing firms, specialization declines with the size of firm. However the rate of decline was much greater for processors.

Both forward and backward integration is prevalent for large merchandisers. Similar to large processors, forward integration is more important than backward. However the levels are higher for both for large merchandisers.

In summary:

1. The grain merchandising industry, being moderately concentrated, is becoming less concentrated, especially among very large firms.
2. The bulk of merchandising volume is controlled by more diversified firms.
3. The largest 20's diversification developed primarily by increases in average processing plant volume.
4. The largest 4 firms had higher rates of diversification than did smaller firms.
5. Substantial average plant volume increases occurred for the largest 20.

Regional Dominance Analysis

Lorenz curve measurements of concentration

Aggregate analysis of the largest firms in the NCR Grain Industry from Table 25 reveals no tendency for increasing the number of plants per

firm for the largest 8 but an increasing trend for less-large firms. Total volume increased, and deconcentration occurred for all subgroups. Realizing the extreme limitations on aggregate analysis of the grain industry caused by restricting the empirical study to the largest 20, expansion of the scope of observation allows use of Lorenz and cumulative concentration curves. The Lorenz curve is a compound of two percentage distributions: the percentage distribution of industry volume and the percentage distribution of the total number of firms. Obviously the slope and height of the curves will vary not only with the percentage of productive activity controlled by given percentages of firms, but also with the total number of firms. As previously indicated, there exists conflicting arguments of the applicability of Lorenz curves (4) (15). These arguments hinge on the conclusion of market performance effects due to a changing number of firms. A single coherent theory is necessary to validate market performance implications of Lorenz curve observations.

Table 25. Market share of large grain merchandising and processing firms, North Central Region, 1954-60

Firms		Number of Plants	Volume Merchandised and Processed	Percent of Region
			Thous. bu.	Percent
4 largest	'54	70	472,863	25.2
	'60	69	486,763	21.6
8 largest	'54	114	705,573	37.6
	'60	115	763,122	33.9
20 largest	'54	179	1,052,722	56.1
	'60	204	1,225,084	55.7

Cross-purchase schedules between firms may be used to indicate the effect of a changing number of firms on concentration conclusions developed from the Lorenz curves (31, p. 38). Since concentration indicates firm power relations, actual or potential, the change in number of firms will be a relevant factor in the interpretation of Lorenz curves only if power relations are affected by the change. The slope of cross-purchase schedules indicates the power relations between NCR firms' purchasing interrelationships. A change in number of firms associated with, a priori, cross-purchase schedules of slope zero would indicate the change in number was not important for Lorenz curve evaluation.

Competition throughout the grain trade has been assessed as very keen, and trading by members of each branch is very extensive. Little business is conducted without knowledge of competition, because the search for small price advantages causes buyers to canvas sufficiently to test the market, and that activity, at the same time, alerts rivals of the business (39, p. 50). The intensity of competition may vary between processing industries due to diverse processing activities dictating different demands for particular quantity, quality, and kinds of grain by firms. Processors must survey the entire market to consider all phases of the desired grain and its relation to other grains, and the central pricing system facilitates this procedure (39, p. 55). Thus considerable distances exist between many processors and supply areas, which means broad geographical limits to a firm's competitive supply region. Since the change in total firms was attributed primarily to changes in the processing subgroup, the slope of cross-purchase schedules would be affected

by changes in the number of processing firms. These power relation considerations indicate that not only is dominance an important factor of conduct and performance of the grain industry but changes in relative "fewness" as well.

The Lorenz curve of firms and plants, Figure 1, illustrates two significant trend characteristics. These are increasing and decreasing concentration for different segments of the firm array as measured by the lateral deviation between curves. The focal point occurs at nineteen 1954 firms and seventeen 1960 firms in the size array or 5.7 percent of firms. Firms larger than this experienced slightly declining concentration of total plants while those smaller had increasing concentration. Table 25 illustrates the firm deconcentration of plants best when the figures presented are considered in light of a 3.5% increase of plants and a 12.2% decrease of firms. The hypothesis might be initiated that if economies of multi-plant operations exist (Bain feels they do not), the large firms either did not exploit them or had already obtained the optimum number of plants, whereas smaller firms expanded the number to take advantage of these economies.

The Lorenz curve relating percentage of firms to percentage of volume is given in Figure 2. These percentage distributions indicate deconcentration for the largest 23 percent of 1954 and 1960 firms and increasing concentration for the smallest 77 percent. In terms of actual numbers, concentration declined for the top 20 firms as is illustrated by the cumulative concentration curve in Figure 3. This curve relates the proportion of the industry's total volume accounted for by the largest 100

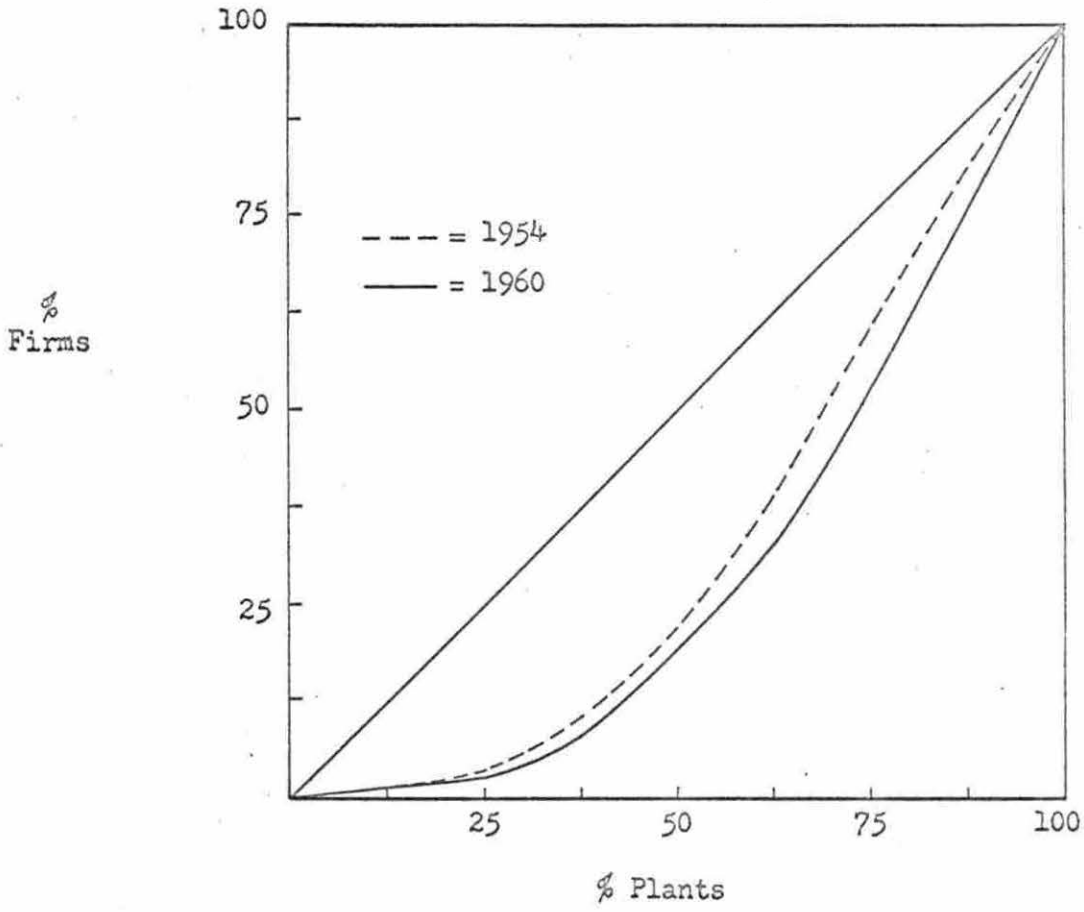

Figure 1. Lorenz curves of firms and plants

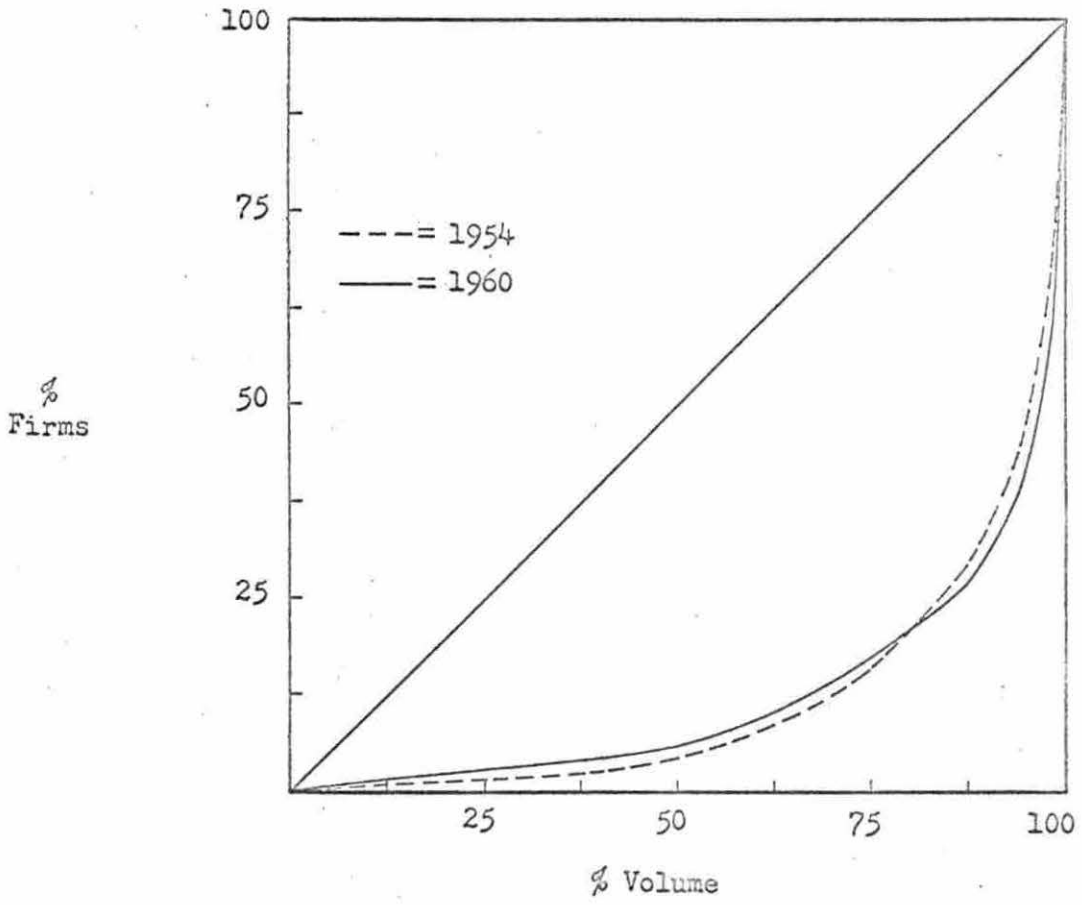

Figure 2. Lorenz curves of firms and volumes

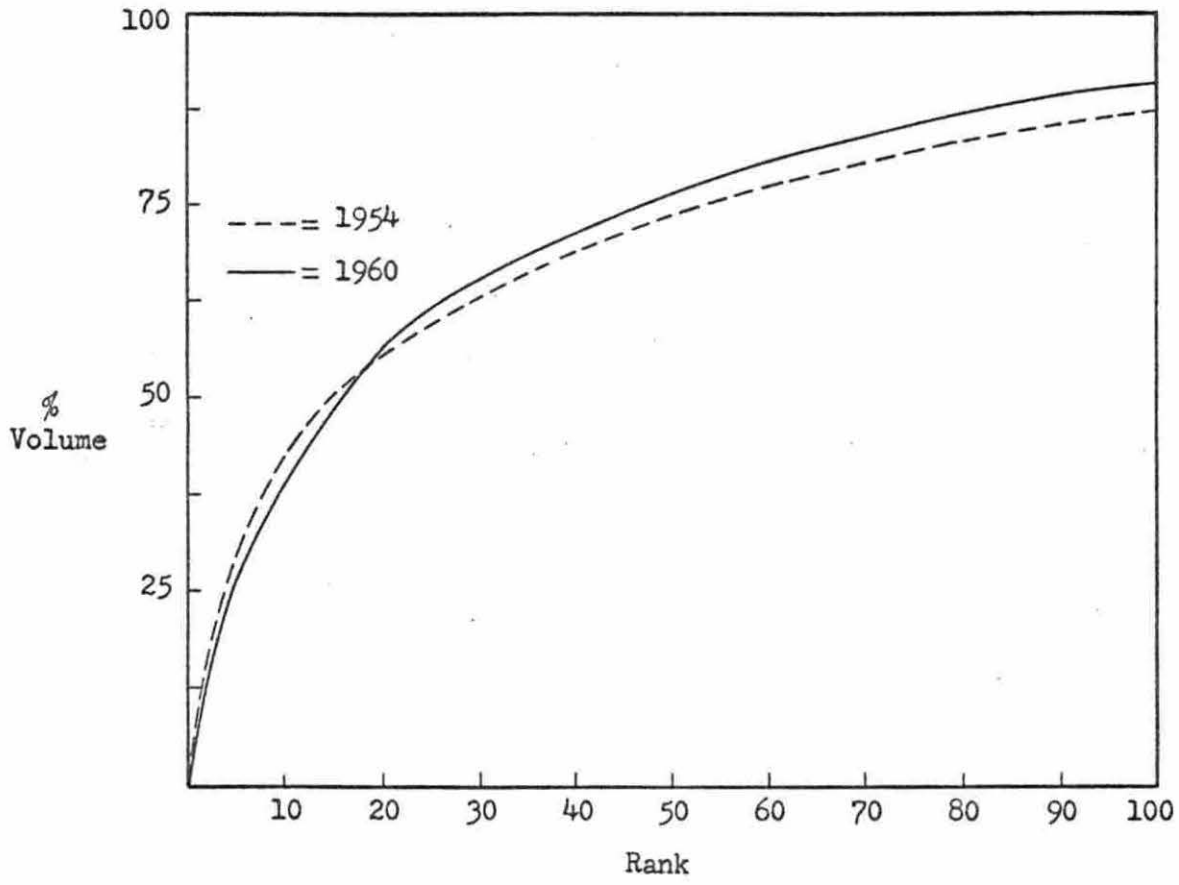

Figure 3. Cumulative concentration curves for NCR grain industry firms

firms in descending order of size on a cumulative basis. This declining concentration conclusion for the largest 20 is further verified by criteria used by Prais (35) that the largest twenty 1960 firms grew at a less than average rate. In terms of significant changes by segments of the firm array, the largest firm accounted for the bulk of the deconcentration while the other top ranking firms remained about the same.

Thus the Lorenz curve masks the true concentration tendencies since the top 23 percent of firms did deconcentrate in total, but only as a result of the deconcentration of the largest firm and small relative declines by other firms toward the bottom of the top 77 firm distribution. In fact, had the largest firm (which was 3 times the size of the average firm in the top 20) not declined absolutely, concentration for the largest firms would have shown increases. Declining concentration is somewhat magnified by the Lorenze curve in terms of absolute numbers since the decline in total firms for the 1960 array means a given percent of total firms contains a smaller number of firms. Even though the largest firm was responsible for the apparent deconcentration, its effects were reflected through the cumulative nature of the curves. The increasing concentration observed for the center 50 percent of firms of the array (Figure 2) is similarly understated in terms of growth of a given number of firms. This is true because the center 50 percent, for 1960 had 21 fewer firms than the same segment in 1954.

For comparative analysis of a given group of firms, Figure 3 is obviously more appropriate. The entire array is considered in Figure 2. Single concentration ratios are equivalent to ordinates of Figure 3.

Structural analysis cannot be meaningfully approached by a concentration ratio that provides an answer to the question, "has concentration increased or decreased?" Analysis of Lorenz and cumulative concentration curves is necessary to answer the additional questions, "which group of firms significantly changed, what was the direction of change, and what was the aggregate effect on the distribution?"

Birth and death effects on concentration

The importance of the changing size of the business population has been illustrated. The effects on concentration to this point have been the net effects of firms entering and leaving the industry. Births and deaths of firms have been defined such that firms not qualifying for the defined industry in 1954 but qualifying in 1960 are births and vice versa for deaths. This process develops by the following methods: (1) changing ownership, (2) changing qualifications of firms, or (3) new grain firms.

The change components of the net decline of 42 firms consisted of 83 births and 125 deaths. Entrants' volume comprised 8 percent of the 1960 volume while extants' volume comprised 14 percent of the 1955 volume. Table 41 shows the effects of births and deaths on various subgroup cumulative concentration ratios. The first two subgroups correspond to the ordinates of 10 and 50 on Figure 3. The difference between rows 1 and 2 is due to deaths, the difference between rows 3 and 4 is due to births, and the difference between rows 2 and 3 measures the change in concentration among surviving firms. As might be supposed from above, deaths had a greater effect on the 1954 distribution than births did on the 1960 array.

Table 26. The effects of births and deaths on the observed concentration ratios

	Top 10 % Vol	Top 50 % Vol	Top 100 % Vol	Top 200 % Vol
Total, 1954	.423	.738	.873	.971
Survivors, 1954	.491	.829	.942	.999
Survivors, 1960	.421	.812	.946	.997
Total, 1960	.388	.765	.910	.988

Comparing Table 26 with Figure 4, the Lorenz curve for survivors, survivors did not account for the increasing concentration of the smallest 77 percent of firms (Figure 2) since the relevant sectors of the Lorenz curves are indentical in Figure 4. However the declining concentration of the largest 23 percent of firms (Figure 2) was attributed to survivors. It is apparent from Table 26 that for all subgroups births and deaths affected the level of concentration. For the largest 23 percent births and deaths did not account for the lateral deviation between curves, which measures the change in concentration but did account for increasing concentration of a smaller firm. For this group of smaller firms for both time periods, the average birth and death volume was lower than the total of survivors and births in the group. This of course increases the concentration of 1954 survivors and decreases 1960 survivors slightly so that the two curves in Figure 4 coincided. These two opposite effects and largely the effects of deaths caused the increasing concentration among smaller firms.

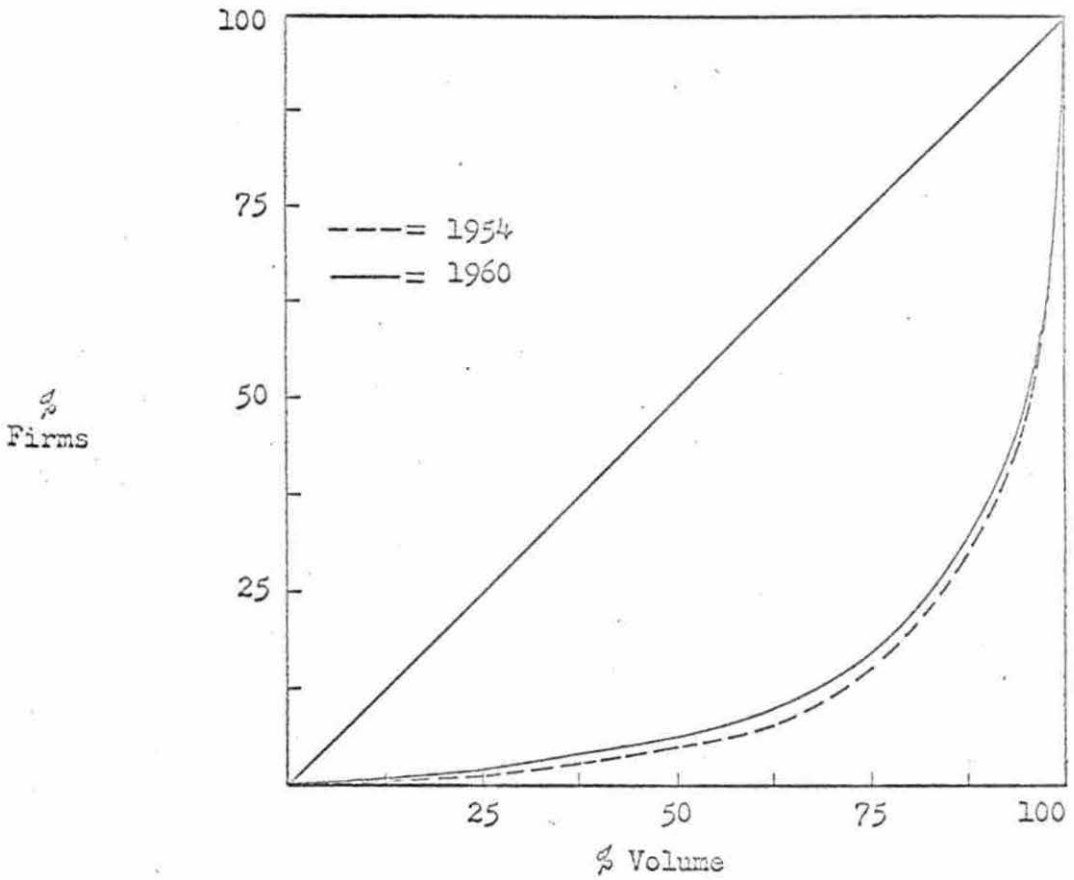

Figure 4. Lorenz curves of firms and volumes for survivors

Table 27. The effects of mergers on the observed concentration ratios

	Top 10 % Vol	Top 50 % Vol	Top 100 % Vol	Top 200 % Vol
Total, 1954	.423	.738	.873	.971
Total, 1954 less acquired	.465	.791	.910	.986
Total, 1960 less acquired 1960 Vol.	.350	.767	.910	.988
Total 1960	.388	.765	.910	.988

Merger effects on concentration

Table 27 illustrates the effects of mergers on the concentration ratios for various groups of firms. Structural changes due to mergers will be dealt with more completely later. By subtracting the acquired from the 1954 total, the sole effects of the loss of these 46 firms on 1954 concentration is observed. For all groups of firms the effect was to increase concentration. The difference between rows 1 and 3 illustrates what would have happened to concentration between 1954 and 1960 had no mergers occured. If none had occured, only the top 10 would have had declining concentration. The difference between rows 3 and 4 shows the effects on 1960 concentration due to mergers. For the top 10, mergers decreased concentration while for the next 40, mergers increased concentration, the net effects for the top 50 being negligible. For other groups, mergers had no appreciable effects on concentration. The above effects on concentration were such because only 20 percent of the acquired volume was

absorbed by firms in the top ten 1960 ranks, while 75 percent of the acquired volume became part of the 11 through 50 ranking firms.

DYNAMIC ANALYSIS OF INDUSTRY STRUCTURE

Dynamic analysis of industry structure deals with statistical comparisons of size distributions as well as evaluating the components of the change of size distributions. Not only will changing concentration be evaluated but the mobility of industry structure as well. Further, the characteristic growth processes of NCR grain industry firms will be discussed.

Variance analysis

The statistical approach to measurement of NCR grain industry concentration employs various statistical techniques to explain the dynamics of concentration changes. The statistical approach (15) relates concentration to the inequality of the size distribution. The variance of the logarithms of firms' volumes, being a measure of relative dispersion, is an appropriate measure of concentration changes if the firm distributions are log-normal. To test log-normality the 1954 and 1960 distributions were set up similar to the Hart and Prais analysis (17). Sixteen size classes were employed and the upper limit of each class was twice the upper limit of the preceding class (Appendix 8).

The results obtained were in logarithms to the base two, since taking this log of each class interval transforms each interval to unity. Skewness and kurtosis were tested by the g_1 and g_2 statistics respectively (41, p. 201). The resulting t tests for both distributions were non-significant at the .01 level, and the hypothesis of log-normality was not rejected. The 1954 distribution illustrated an excess of firms

near the mean and far from it, with a depletion in the flanks. In 1960 the depletion had been filled and the excess of firms far from the mean had vanished. This change in depletion was an important attribute of the resulting structural changes and will be discussed later at greater length. The means and variances of various groups of firms are shown in Table 28. The results are given in terms of logs to the base two, taken as deviations from an average size of 453,600 bushels. Equation 1 (17) gives the combined variance of two collections of firms so that the causes for the 1954-1960 change may be assessed.

$$\sigma_T^2 = w_1\sigma_1^2 + w_2\sigma_2^2 + w_1w_2 (\bar{x}_1 - \bar{x}_2)^2, \qquad (1)$$

where w_1 and w_2 are the proportions of the firms in the two groups. The resulting decline in variance and therefore overall business concentration was due to:

(1.) the births that replaced the deaths had both a smaller mean and variance, and

(2.) both the mean and variance of survivors declined.

These results, relating the variance to concentration, were very similar to those developed previously using pure concentration ratios.

Gibrat's Law of proportionate effect

Analysis of the size and growth of grain firms leads to a discussion of the law of proportionate effect due to Gibrat and discussed subsequently by other authors (17) (22) (27) (35). The log-normal curve is generated by the action of random forces acting multiplicatively on a variate. Thus the growth processes are such that firms grow by randomly distributed proportions of their original size.

The law of proportionate effect not only requires that the distribution of survivors in the two time periods be log-normally distributed, but additional requirements are homoscedasticity and the regression curve of log values having slope one. The distribution of volumes for survivors in both time periods was found to be log-normal. This test was conducted using the g_1 and g_2 statistics. The t tests for both statistics were not significant at the .01 level so there was little evidence of departure from normality. Volume data for 1960 were plotted against 1954 volume on logarithmic graph paper to test homoscedasticity. The resulting conditional distributions of the 1954 volume classes were found to have dissimilar variances by χ^2 tests (27). Further, the slope of the regression line was less than one.

Implications of the law

The law of proportionate effect in itself is of little interest except that the law generates a log-normal distribution of firms, a distribution which closely resembles the distribution of firms in the grain industry. This size-distribution is positively skew, with relatively few large firms and many small firms. The more interesting aspects of Gilbrat's law are the implications of the law to the growth processes of firms. Although the requirements of the law were not explicitly met, a critical examination of the implications of the growth processes leads to a fuller understanding of the growth processes of grain industry firms.

To test the first implication that large, medium, and small firms have the same average proportionate growth, a transition matrix was

constructed to evaluate firm movement to various size classes (Appendix 8). These classes were the same as those used in the previously discussed log-normal distribution. The elements on each diagonal were summed for the three groups of firms and average proportional growth rates computed for each group. The results were similar to others found previously in this study. Small firms, on the average, tended to double their size, while medium and large firms, on the average, were three-fourths their original size. The selection of limits for the three size categories was somewhat arbitrary. However, any change in the limits would have been to include more firms in the small class. This would tend to decrease slightly the average growth rates for small firms, but would also make the growth rates for large firms slightly less negative. Striking difference in growth rates would have existed regardless of the values of class limits.

The second implication that the dispersions of growth rates around a common average is the same for large, medium and small firms was tested graphically by Figure 5. The distributions, though similar, indicate that small firms had a more skewed distribution toward higher growth rates than either medium or large firms.

The third implication that the distribution of proportionate growth rates is log-normal was tested from Table 29. At the .05 level the g_1 statistic was not significant while the g_2 was. As indicated in Table 29, the distribution was nearly symetric but had an excess of moderate deviations.

The fourth implication deals with the dynamic aspects of firm growth. Firm mobility to various size classes through time is such that

the variance increases. Empirical validation of this implication in this study must be restricted to a single transition. The computed variances for survivors were 6.72 and 6.8 for 1954 and 1960 respectively. Following the method used by Hart and Prais (17) equation 2 was used.

$$\mathrm{Var}_{1960} = \beta^2 \mathrm{Var}_{1954} + \sigma_\epsilon^2 \qquad (2)$$

where $\rho^2 = 1 - \sigma_\epsilon^2 / \mathrm{Var}_{1960}$,

and σ_ϵ^2 is the scatter about the regression line. r was calculated from the bivariate distribution described above. This distribution was shown to be log-normally distributed as well as being a sample from the parent bivariate normal. Thus r estimates ρ, and this value, .86, leads to the solution of $\hat{\beta} = .82$. Since $\hat{\beta} < 1$, there is regression toward the mean size for the observed distribution caused by small firms having larger proportionate growth rates.

Thus it appears the law of proportionate effect does not fit the data in this study. Even though the model failed to fit the data, the usefulness of the empirical examination of the implications cannot be denied. The rejection of the fourth implication of increasing variance opens the possibility of applying another theoretical model - the Markov model employing the assumption of constant variance.

Stochastic analysis of industry structure

Statistical analysis of industry structure in a dynamic context is undertaken by a probabalistic approach due to Markov. Changes in the size distribution of firms in the grain industry may be evaluated by observation of firm movement between various size classes for the 1954-1960 time interval. Further, the equilibrium size distribution maybe determined

Table 28. Summary of numbers, means, and variances of NCR grain industry firms, 1954-1960

	Number	$\bar{x}$	σ^2
Total 1954	343	1.42	6.88
Deaths	125	.67	5.46
Survivors 1954	218	2.30	6.72
Survivors 1960	218	1.97	6.18
Births	83	.23	5.33
Total 1960	301	1.49	6.56

Table 29. Proportionate growth rates for NCR grain industry survivors

1960 Volume ÷ 1954 Volume	$\frac{1}{128}$	$\frac{1}{64}$	$\frac{1}{32}$	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	1	2	4	8	16	32
Number of Firms	1	1	0	3	6	22	52	95	20	12	3	2	1

and interpreted as that unique distribution of firms that is independent of the initial distribution. This model was set up with the realization that the forces determining the distribution of grain firms are so varied and complex that the theoretical model selected must either be extremely simplified or hopelessly complicated (5). The application of a Markov chain embodies the former, and though unrealistic simplifying assumptions are made, the value of economic interpretation of the results cannot be

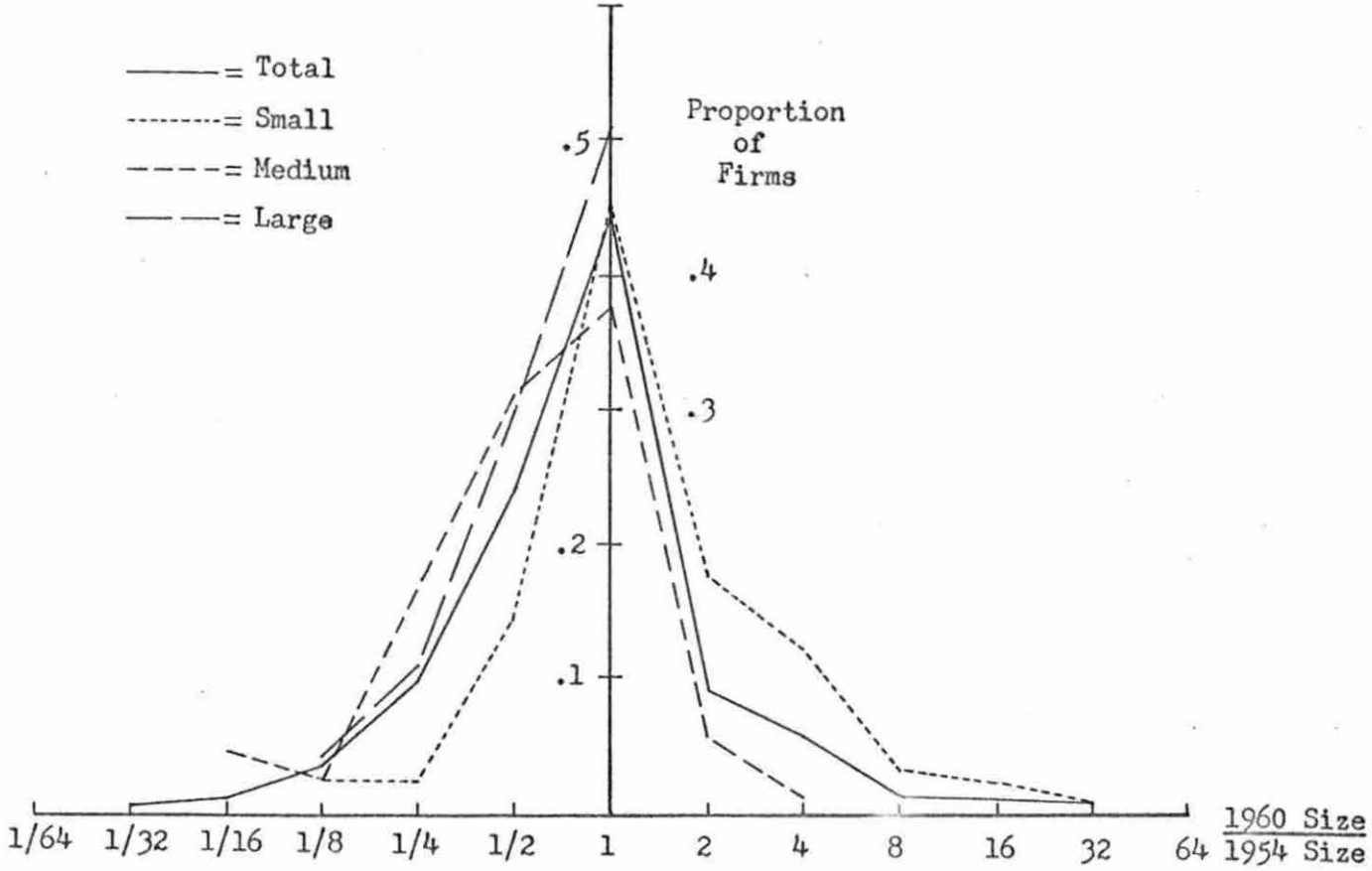

Figure 5. Distribution of proportionate growth rates for small, medium, large, and total NCR grain industry firms

denied. Contributions to the application of stochastic processes to economic phenomena have been summarized in the review of literature and further references will be directed to specific methodological procedures.

The set of different sequences with the associated probabilities is called a stochastic process (conditioned on the starting state). In simple terms the stochastic process is a probability model for time series or a sequence of events (set of events ordered in time) together with the probabilities of these sequences. "Markov processes" is the term applied to a large and important class of stochastic processes (10, p. 369).

Definition

A finite stochastic process (finite number of outcomes) with outcome functions f_0, f_1, ------f_n is a Markov chain process if the starting state given by f_0 is fixed and:

$$\Pr(f_n = S_x \mid f_{n-1} = S_w \wedge f_{n-2} = S_v \wedge \cdots\cdots \wedge f_1 = S_a) = \Pr(f_n = S_x \mid f_{n-1} = S_w) \quad (3)$$

and:

$$\Pr(f_n = S_x \mid f_{n-1} = S_w) = \Pr(f_m = S_x \mid f_{m-1} = S_w) \ (24) \quad (4)$$

for all random outcomes f and time periods $m \geq 1$, $n \geq 2$, and for any possible sequence of outcomes (states) S_a,-----S_w, S_x. This says the outcome is dependent only on the outcome in the immediately preceding time period (equation 3). This dependence is assumed the same for all time transitions (equation 4). The latter assumption is called stationarity. Stationarity of an order of two is implied in this discussion which means the first and second moments are invariant through time. This assumption is restrictive since there is no empirical evidence in this

study that the variance of the distribution remains constant. Unfortunately stationarity and order tests are inapplicable to single transition data. However this restriction will not invalidate the economic usefulness of the model since both the observed transition matrix and equilibrium projections depend on a single transition anyway.

Thus the Markov chain process requires specification of the initial distribution comprised of various states. The process moves successively from one state to another during a time sequence and the transition probabilities, P_{ij}, of moving from S_i to S_j depends only on the state, S_i, it occupied prior to the step. The initial distribution specifies the starting state.

Assumptions regarding the use of the transition matrix are:
(1.) firms engaging in grain merchandising and/or processing can be meaningfully grouped into size classes (states) (21),
(2.) that underlying determinants of change in the size distribution of firms during one time period may be represented by a probability of firm movement from one size class to another which is independent of activity in previous periods (30), and
(3.) observed movements from class i to class j as a proportion of the initial number of firms in class i is a satisfactory measure of the probabilities.
Assumption (2.) is most restrictive since we ignore all changes in supply, demand, technology, institutional policies, etc. over time and merely represent the result of all these forces by one variable - volume of grain input (21). The unit of inquiry, the transition matrix is of the form:

$$P = \begin{array}{c} \\ S_0 \\ S_1 \\ \cdot \\ S_n \end{array} \begin{array}{c} \begin{array}{cccc} S_0 & S_1 & \cdots\cdots & S_n \end{array} \\ \begin{bmatrix} P_{11} & P_{12} & \cdots\cdots & P_{1n} \\ P_{21} & P_{22} & \cdots\cdots & P_{2n} \\ \cdot & \cdots\cdots & \cdots\cdots & \cdot \\ P_{n1} & P_{n2} & \cdots\cdots & P_{nn} \end{bmatrix} \end{array} \qquad (5)$$

where: $\sum_j P_{ij} = 1$ (6)

$P_{ij} \geq 0$ for all i and j (7)

and $P_{ij}^2 = \sum_v P_{iv} P_{vj}$ (8)

Induction yields:

$$P_{ij}^n = \sum_v P_{iv} P_{vj}^{(n-1)} \quad , \qquad (9)$$

or the first step leads the system from S_i to some intermediate state, and the last n-1 steps from the intermediate state to S_j. Relevant theorems for the transition matrix of our regular chain are:

(1.) For any probability vector S_j, $S_j \cdot P^n$ approaches the vector t as n tends to infinity (44, p. 71). The powers P^n actually approach a matrix T, the rows of which are identical and equal to t (24, p. 392).

(2.) The vector t is the unique probability vector such that $tP = t$ (25, p. 71).

(3.) The components of t are all positive (24, p. 392).

Operationally we need to solve the equation:

$$t P = t \qquad (10)$$

given equation 6. Solution is accomplished by assuming the characteristic root equals 1 and by solving:

$$t' = (P_x' - I)^{-1} \begin{bmatrix} 0 \\ 0 \\ \cdot \\ \cdot \\ \cdot \\ 1 \end{bmatrix} \qquad (11)$$

where P_x is the matrix of n linearly independent equations in n unknowns obtained by replacing row n of P by equation 6. Adelman (1) has provided the meaningful interpretation of the equilibrium industry structure as being "statistical in nature for the industry, and dynamic for the individual firm." She further points out movement between strata is not inconsistent with the equilibrium distribution. Entrants and extants to and from particular strata counter-balance opposite effects on relative distribution in the strata.

The model incorporates birth-death tendencies for the observed time period and no projection is made of total firms in equilibrium, which presumably is an important factor in concentration. What can be said is that given the total firms in the stationary state, dominance of given percentages of firms can be evaluated.

A summary of class limits in terms of firm concentration is given in Table 30. The division of the continuous scale of firm volume was set up with two objectives in mind: (1.) have equal numbers of firms in each class for the 1954 array and (2.) the volume width of the classes should decline as firm size declines. The first objective was developed upon the basis that the transition matrix gives useful insights to the dynamic aspects of firm mobility, and thus the matrix should be set up to provide all the meaningful information. The probability definition was manipulated to set:

$$\sum_j a_{1j} = \sum_j a_{2j} = \text{-------} \sum_j a_{7j} \qquad (12)$$

so that comparisons could be made between probabilities for a given column (1960). By doing this we can answer the question: "For a given

Table 30. Class limits for the stochastic matrix

State	Concentration Ratio Range - %	1954 Volume Range 000 Bu.	1960 Volume Range 000 Bu.
S_0	--	--	--
S_1	.45 -.100	8,500-213,000	10,400-190,000
S_2	.166-.449	3,200-8,000	3,800-10,000
S_3	.101-.165	1,900-3,100	2,200-3,700
S_4	.053-.100	1,000-1,800	1,200-2,150
S_5	.028-.052	530-980	600-1,150
S_6	.011-.027	200-500	200-595
S_7	0-.010	0-200	0-230

state in 1960, where did firm movement originate?" The second objective was desired because larger firms are likely to grow by greater absolute amounts than smaller one. This hypothesis stemmed from the expectation that a firm's ability to change size (volume) during this time period would be related to its initial size.

Concentration ratios, rather than absolute volume, were then used to set up the states since power relations are reflected by market shares while absolute volume may not in itself be important. Further, greater inter-period comparability could be obtained from this criteria.

Anderson and Goodman have shown the maximum liklihood estimate of the stationary transition probabilities P_{ij} to be:

$$\hat{P}_{ij} = \frac{a_{ij}}{\sum_j a_{ij}} \qquad (13)$$

where a_{ij} is the number of firms moving from state i to state j.

The above definition of transition probabilities does not extend meaningfully to entrants to the industry since no empirical data was available to specify the number of potential entrants. For purposes of transition matrix observation, the assumption was made that potential entrants was synonymous with actual entrants. Given this total, the transition probabilities may be observed to determine what proportion of entrants enter at what size categories. This would imply P_{00} should be zero since this cell represents the number of potential entrants remaining potential entrants. Implying that P_{00} is zero, and proceding with computations, has no economic consequences on interpretation of the equilibrium vector. Obviously the relationship between P_0 and P_j would be meaningless. It was shown that the relative values of P_j, $j \neq 0$ were unaffected by arbitrary selection of S_{00}. That is, the distribution of existing firms in equilibrium is a function of S_{ij}, i = 0, 1, 2, ---7, j = 0, 1, 2, ---7, i = j $\neq$ 0. Even though in equilibrium a probability for S_0 occurs, it is disregarded and the other probabilities are normalised by multiplying t by a scalar so that:

$$t_j = 1 \qquad (14)$$

The values of P_{ij} were computed, and the matrix is given by equation 15. An unusual observation from this matrix is that with the exception of the largest two classes, all firms have a considerably higher probability of leaving the industry than they do for staying in the same size class. A priori, one would think chances of exit would be higher for smaller firms, but the matrix confirms this only to a limited extent. In fact the middle two classes had higher combined probabilities for exiting

$$P = \begin{array}{c} \\ S_0 \\ S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \\ S_6 \\ S_7 \end{array} \begin{array}{c} \begin{array}{cccccccc} S_0 & S_1 & S_2 & S_3 & S_4 & S_5 & S_6 & S_7 \end{array} \\ \begin{bmatrix} 0 & .048 & .119 & .083 & .083 & .095 & .203 & .369 \\ .224 & .694 & .082 & 0 & 0 & 0 & 0 & 0 \\ .220 & .220 & .500 & .040 & .020 & 0 & 0 & 0 \\ .326 & 0 & .196 & .217 & .152 & .044 & .044 & .021 \\ .460 & 0 & .020 & .140 & .160 & .160 & .040 & .020 \\ .333 & 0 & 0 & .021 & .146 & .271 & .187 & .042 \\ .380 & .020 & 0 & .060 & .060 & .080 & .300 & .100 \\ .620 & 0 & 0 & .020 & .060 & .020 & .060 & .220 \end{bmatrix} \end{array} \qquad (15)$$

than did classes 5 and 6. This a priori consideration is paralleled for entrants and is irrevocably confirmed by observing declining entrant probabilities for successively larger classes. More stability in class movement for survivors is observed for larger firms, and the middle two classes were more mobile than both large and small firms.

$$t = (.182, .157, .087, .101, .100, .164, .209) \qquad (16)$$

The equilibrium vector was computed according to equation 11 and normalization according to equation 14 yielded the values in equation 16. By comparing the 1954 and 1960 distributions, it was found the median firm increased volume slightly but declined in market share. The median firm in 1954 was at the center of S_4 whereas in 1960 it was two-thirds down the S_4 class. Analysis of the equilibrium vector suggests the median firm to be in the same position in S_4 as was found in 1960. These relationships may be observed roughly in Table 31. Figure 6 shows the Lorenz

curve for the seven discrete classes and is similar to Figure 2. The difference is that in Figure 6 the data are grouped rather than approximating a continuous variable. The equilibrium curve, as well as Table 31, show very little change in concentration for the various size categories, and as expected, the small observed change is in the same direction as established in the 1954-1960 transition.

The stochastic matrix may be used to calculate the average mobility of firms in the various S_j states. Observation of the diagonal elements of the matrix (equation 15) suggests that a great deal of size mobility exists since complete absence of mobility would be indicated by $P_{jj} = 1$. Further the more fluid the corporate structure, the shorter the time spent in a given class and the more mobile the industry. Comparing relative rates of mobility for the various states allows a hypothesis to be initiated that level of market share has some relationship to the rate of firm growth. Prais (34) has shown the average time for a firm in the jth state for all S_j firms. That is:

$$T_j = a_j^0 + a_j^0 P_{ij} + a_j^0 P_{jj}^2 + \text{-------} + a_j^0 P_{jj}^n \qquad (17)$$

where a_j^0 is the number of firms in the 1954 S_j states, and P_{jj}, i=1, 2,---n, the consecutive probabilities of remaining in state S_j. Therefore the average firm will remain in the jth state for a period:

$$L_j = \frac{T_j}{a_j^0} = 1 + P_{jj} + P_{jj}^2 + \text{---} + P_{jj}^n = \frac{1}{1 - P_{jj}} \qquad (18)$$

Table 32 is the result of applying equation 18 to the data. Collins and Preston (7) following previous writers, redefined the index of industrial mobility to be such that the probability of entering a particular state is independent of the immediately preceding state. The equilibrium

Table 31. Distribution of firms and volumes for 1954, 1960, and equilibrium

	1954		1960		Equilibrium	
State	% Firms	% Volume	% Firms	% Volume	% Firms	% Volume[a]
S_1	14.28	73	16.61	76.5	18.20	79.26
S_2	14.28	14	16.28	14.31	15.7	13.05
S_3	13.70	6.4	9.3	3.76	8.66	3.31
S_4	14.28	3.54	12.96	2.86	10.08	2.10
S_5	13.70	1.87	11.96	1.44	10.00	1.14
S_6	14.28	.94	15.94	.84	16.44	.80
S_7	14.00	.25	16.94	.28	20.92	.33

[a]Computed on the assumption that the mean firm in each class will possess the same volume in equilibrium as it did in 1960.

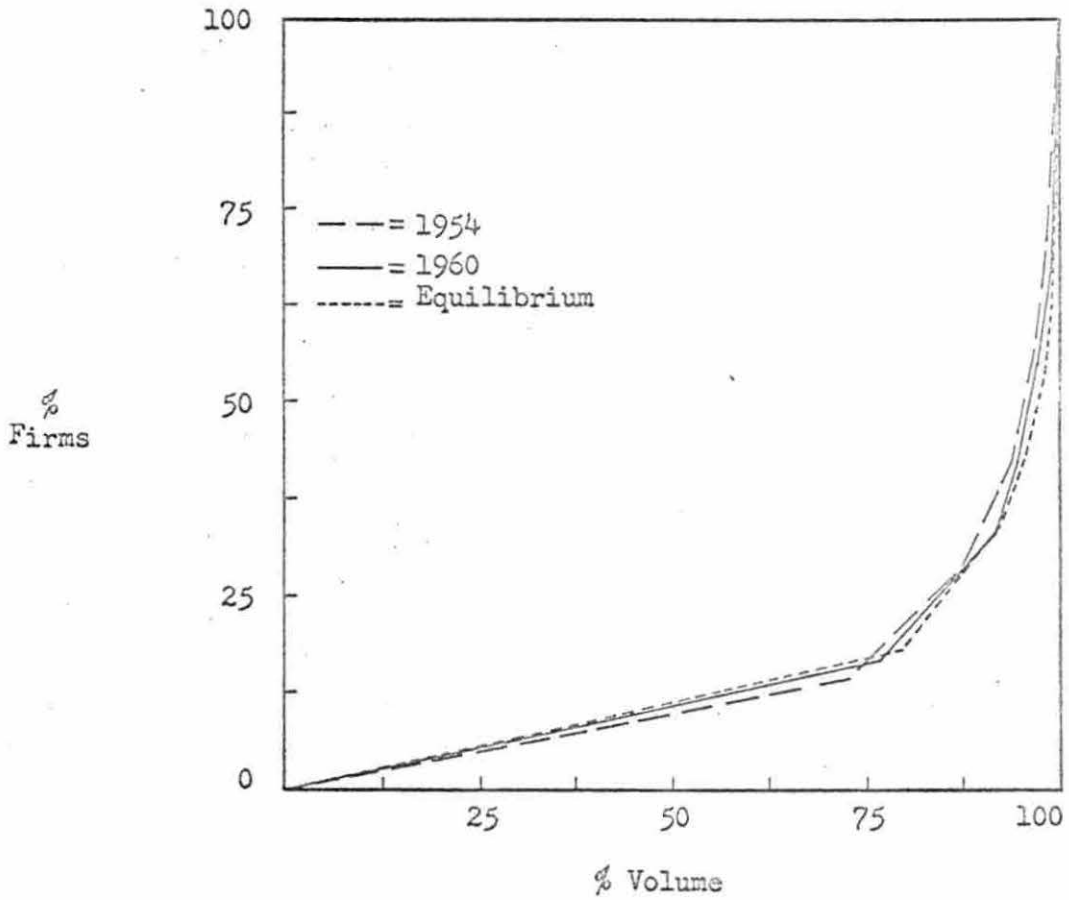

Figure 6. Lorenz curve for seven discrete size classes

Table 32. Mean lifetime for NCR grain industry firms

State	Average (Years)		Perfectly Mobile Industry	Ratio	
	All Firms	Survivors Only		All Firms	Survivors
S_1	3.27	9.52	1.22	2.68	7.80
S_2	2.0	2.79	1.19	1.68	2.35
S_3	1.28	1.48	1.09	1.17	1.36
S_4	1.19	1.42	1.11	1.07	1.28
S_5	1.37	1.68	1.11	1.24	1.51
S_6	1.43	1.94	1.20	1.19	1.62
S_7	1.23	2.37	1.26	1.02	1.88

vector has the desired properties to define such an index as well as provide a basis for comparison when evaluating the above mean lifetimes. The ratios in Table 32 suggest a less fluid corporate structure among large firms, but apparently middle size firms are just as mobile as small firms. Further, the effects of deaths on mobility were removed and the results were for survivors. Removal of birth effects was unnecessary since they do not affect the magnitude of the diagonal elements. Survivors mobility would be expected to be lower than for all firms. Computations suggested survivors were much more stabile. This developed from the large number of deaths, a considerable number of which were large firms. The Collins and Preston index (7) was computed as follows:

$$I = \sum \left[\frac{1 - P_{jj}}{1 - S_j} \right] a_j \qquad (19)$$

where P_{jj} = the probability of firms remaining in state j,

S_j = the initial relative frequency of surviving firms in each size class , and

a_j = the initial relative frequency of volume in each size class.

Thus the actual mobility of firms in each size class as a percentage of the possible mobility under perfect mobility may be computed using the relative frequency distribution of volume by size class or weights. The results of computation of the index for both survivors and all firms are given in Table 33. Again survivors accounted only for deaths since the index is defined for initial distributions. Births could have been subtracted from the 1960 and equilibrium calculations but not for the 1954 distribution so uniformity of procedure was retained in this manner. These values indicate survivors are much less mobile than all firms and have become even less mobile since 1954. No significant declines have occurred for all firms. Thus the present high level of extants from the grain industry has accounted for the present level of firm mobility. A subsequent analysis of mergers will reveal the causes for firm deaths.

The previous mobility discussion emphasized relative volume changes of firms. Another measurement method was employed that focuses on firms' changing industry rank (20). This method studies the rank-shift pattern of firms by identifying changes in each firm's rank in the time interval. The procedure involved classifying the top 100 firms into 20 classes, each class width being 5. The top 100 had combined volumes of 87% of the industry. A transition matrix was set up to observe firm movement to different rank classes. Complete rigidity would be indicated by a single

Table 33. Percent of firm mobility relative to the perfectly mobile industry

	1954	1960	Equilibrium
Survivors	29.97	21.56	19.10
All Firms	44.66	44.63	44.05

diagonal of fives. A summary of rank changes is presented in Table 34.

The transition matrix indicated a slight majority of rank falls occurred between the ranking of 11 and 55. A majority of rises occurred between the ranking of 56 and 95. Table 34 indicates that 75% of all falls were less than 2 classes in magnitude while 67% of all rises were greater than 3 classes. To quantify the variation from the diagonal, a correlation coefficient was computed to be .77. This value understates industry fluidity for three reasons: (1) firm deaths could not be incorporated into computations, (2) the movement of firms below rank 100 were not included, and (3) the variation did not account for intra-class movement.

A comparison of the average percentage volume change necessary to move a firm to one higher class was made with the aggregate percentage volume change of the top 100. This comparison was necessary to insure that minor differences in growth rates did not produce wide jumps in rankings. The top 100 increased total volume by 25% while the average percentage increase in volume necessary to move up one class was 52%. Thus we can be assured that the observed rank changes required growth rates of much greater magnitude than the average rate of growth. Although no norm

Table 34. Extent of change in rank-group position between 1954 and 1960

Amount of Change (number of classes)	Number of firms that Rose	Fell	Same	Total
0	--	--	15	15
1	7	15	--	22
2	2	10	--	12
3	4	1	--	5
4	2	0	--	2
5	3	0	--	3
6	3	1	--	4
7	0	1	--	1
8	2	1	--	3
9	1	1	--	2
10	1	1	--	2
11	1	0	--	1
12	0	2	--	2
13	0	0	--	0
14	0	0	--	0
15	1	0	--	1
Total[a]	27	33	15	75

[a]Four firms fell below class 20, and 21 firms left the industry.

exists by which to interpret the correlation coefficient, its value and the supplementary reasons for understatement of industry fluidity lead to the conclusion that industry structure is much less than completely rigid, especially when births and deaths are included.

Dynamic analysis of growth processes

Attention is now directed to a discussion that logically follows the mobility analysis. That is, given the present level of firm growth, what are the primary growth processes? The previous analysis of diversification tendencies among firm sub-groups will be supplemented with an

aggregate regional analysis. Further, the Markov model will be employed to determine the rate of diversification changes as equilibrium is attained.

Analysis of the stochastic transition matrices of specialization ratios for all survivors, Table 36, and all firms, Table 37, reveals the predominate specialization or diversification tendencies within the distribution. Table 35 gives the specialization class limits employed in these matrices. The survivor matrix, Table 36, confirms an initial hypothesis that diversification and specialization are not mutually exclusive growth characteristics for the aggregate distribution.

Table 36 for survivors suggests that firms in the B specialization class in 1954 had net predominant effects of specialization movements. The results in this matrix are solely in terms of number of firms, the firm size factor being unaccounted for. The most diversified firms in 1954 tended to increase specialization a great deal more than the most specialized tended to diversify. In an attempt to relate size to diversification tendencies, both the top 50 and 2nd largest 50 survivors' specialization ratios were traced (Tables 38, 39). For the top 50 firms, the most highly specialized firms tended to stay specialized. Those firms in the second highest class displayed predominant diversification tendencies while firms in the other classes tended to increase specialization.

To test the adequacy of the arbitrary class limits, new limits were set up employing equal class intervals for the top 50. The results are not shown, but they were quite similar to those previously assessed. The second top 50 firms analysis, Table 39, employing both limit schemes led to similar results as the top 50, as well as indicating that the class

Table 35. Class limits for transition matrices in terms of specialization ratios

Class	Limits
A	.97 - 1.00
B	.85 - .96
C	.60 - .84
D	.40 - .59

Table 36. Survivors' matrix of specialization ratios

	A	B	C	D
A	.86	.06	.04	.04
B	.48	.17	.30	.05
C	.17	.12	.54	.17
D	.13	.04	.54	.29

Table 37. All firms' matrix of specialization ratios

	0	A	B	C	D
0	0	.75	.07	.09	.09
A	.40	.51	.04	.02	.03
B	.28	.34	.13	.22	.03
C	.28	.12	.09	.39	.02
D	.29	.09	.03	.38	.29

Table 38. Top 50 survivors' matrix of specialization ratios

	A	B	C	D
A	.90	.05	0	.05
B	.33	.17	.50	0
C	.15	.23	.54	.08
D	0	0	.46	.54

Table 39. Second top 50 survivors' matrix of specialization ratios

	A	B	C	D
A	.87	.08	.03	.02
B	.63	.13	.24	0
C	.33	.33	.33	0
D	.50	.50	0	0

limits were adequate. Diversification tendencies for the top 50 appear to be similar to those of smaller firms with one exception. The larger firms not highly specialized do not increase specialization at as high a rate as do smaller firms.

The hypothesis to be tested is that increases in specialty operations will predominate through time for those firms not initially in the highest specialty class while most of those initially highly specialized will tend to diversify. To test this hypothesis the relative frequency

distributions were calculated for various groups of firms for 1954, 1960 and equilibrium. The relative frequency distributions for survivors are given in table 40. Classes B and D illustrate a depletion of frequency with compensatory increases in classes A and C. Table 41 includes births and deaths, and in all classes but A, a tendency toward depletion of frequency existed. Table 42 is for the top 100 survivors and illustrates similar results to all firms.

Table 42 is very important for formulating conclusions since the results in Tables 40 and 41 are heavily biased toward characteristic changes of small firms due to the large number of small, highly specialized firms represented in the latter matrices. If the results for the top 100 had been different than for all firms, the conclusions developed from survivors and all firms would have been less interesting since the top 100 controls about 87 percent of industry volume. Thus the hypothesis is not rejected. Increases in specialty operations will predominate under existing growth processes. Many firms are continually moving from the highest specialty class to more diversified classes, but since more firms are becoming or remaining highly specialized, the predominancy, in terms of number of firms is toward greater specialization. The tendency, in terms of total firms, and weighed by firm volume, is toward increasing importance of diversification. The latter conclusions were developed previously in this study.

Another relationship that was tested was due to Gort (14). Gort has inferred that diversification is related to concentration in that diversification would be more likely to occur if the primary activity were

Table 40. Frequency distributions for survivors

	1954	1960	Equilibrium
A	59.4	60.8	61.9
B	10.6	8.3	8.2
C	18.9	21.7	21.0
D	11.1	9.2	8.9

Table 41. Frequency distributions for all firms

	1954	1960	Equilibrium
A	63.7	64.8	67.5
B	9.4	8.0	7.8
C	16.8	18.2	15.9
D	10.1	9.0	8.8

Table 42. Frequency distributions for the top 100

	1954	1960	Equilibrium
A	57.0	61.0	68.7
B	14.0	11.0	10.5
C	16.0	19.0	14.7
D	13.0	9.0	6.1

in a relatively highly concentrated industry. Frequency distributions were set up relating the extent of firm diversification (change in product mix) and the level of concentration within the primary product industry. The level consisted of ranking the 8 industries by level of concentration. There was a distinct correlation between specialization and level of concentration. That is, specialization tended to occur in those industries of relatively lower concentration. Firms whose primary activity was in a relatively higher concentrated industry displayed only a slightly greater tendency to diversify than did other firms.

Gort has indicated (14, p. 66) that diversification being a form of investment and therefore contributing to total firm size and the ability of large firms to raise investment funds contributes to the positive relation between size and diversification. However, there was no observable relationship between diversification tendencies (defined as change in product mix) and the size of the firm. There was, however, an observable relationship between the size of firm and diversification tendencies when diversification was defined to be an increase in the heterogeneity of markets served.

The relationship between diversification tendencies and firm rate of growth was tested in the belief that "a rapidly growing, and hence more successful company is under some circumstances likely to diversify more" (14, p. 75). The hypothesized positive relation between growth and diversification was tested by multiple regression according to the following model:

$$Y = \alpha + \beta_1 x_1 + \beta_2 x_2 \qquad (20)$$

where:

Y = The change in rank between 1954 and 1960.

X_1 = The change in average plant volume.

X_2 = The change in specialization ratio.

The coefficients were computed for various size classes of firms. The results are shown in Table 43. All equations yielded significant F tests at the .01 level. The X_1 variable was utilized in a prior analysis. The coefficients for the X_2 variable show the observed relationship between changes in rank and changes in specialization. The regression coefficients and partial correlations provide a good summary of diversification tendencies. The largest firms showed a small positive relationship between rank change and specialization. A substantial volume increase was necessary in all cases to increase firm rank. Diversification was the tendency for the next 74 firms while the smallest 64 firms predominantly specialized when increasing rank. Thus as previously indicated there is no apparent relationship between size and diversification tendencies. Processors tended to specialize while merchandisers tended to diversify when increasing rank. Computation of average rank changes for firms in the various 1960 size categories permitted observing the relationship between rate of growth and diversification tendencies. Again, no apparent relationship existed. One must not be misled by the growth measure, change in rank. The negative averages were associated with average volume increases. Further, these calculations are for the 1960 size group. Since these are not 1954 size groups, the averages cannot be interpreted as growth characteristics of various size firms. It would be necessary to

Table 43. Calculated multiple regression statistics for NCR grain industry firms

Group of surviving firms[a]	α	β_1	β_2	Partial Correlations	Ave. Rank Change
Largest 50 in 1960	- .64	-.001[b]	.03	.019	- .44
Rank 51-125 in 1960	-1.45	-.026[b]	-.15	-.044	- .99
Rank 126-190 in 1960	-3.09	-.079[b]	.28[b]	.217	-1.42
Largest 20 1960 processors	- .03	-.001[b]	.21[b]	.437	
Grain merchandisers, 1960	-2.07	-.001[b]	-.03	-.010	
Grain processors, 1960	-1.34	-.009[b]	.34[b]	.125	

[a]No births or deaths included.

[b]Significantly different from zero at .01 level.

calculate these averages for the 1954 group before conclusions were formed. In fact, previously in this thesis it has been shown that smaller firms have grown relative to large firms.

To ascertain the effects of another growth process, mergers, on the relative inequality of the firm distribution, it was necessary to have data on the identity of all participants of the merger process for both time periods. This analysis helps explain the decline in relative inequality, and thus overall concentration, as was indicated in Table 28. The overall effects on the 1954 and 1960 distributions due to merger activity were determined by two factors: (1) the variance changes of all firms engaged in mergers, and (2) the effects on the parent distribution

Table 44. Calculated statistics of firms involved in 1954-1960 mergers

	Before Mergers[a] (1954)		After Mergers (1960)
	Acquired Firms	Total	Total
Number	46	75	29
Mean[b]	2.28	3.44	5.38
Variance[b]	5.66	6.25	4.03

[a]Acquiring firms were not all in operation in 1954, due to a complete reorganization of 2 or more firms into a new 1960 firm, in certain cases.

[b]In units of Log to the base 2, from working mean of 453,600 bu.

due to merger activity. Table 44 gives the statistics of firms directly involved in the merger process. The rate of merger activity was 22% of total 1954 firms. A significant decline in the variance was recorded as well as an increase in the average size firm. The effects of mergers on the relative inequality of the size distributions over time is given in Table 45. The overall merger effects were broken into the effects of the acquired firms on the 1954 distribution and the effects of the acquiring firms on the 1960 distribution. The latter effects were somewhat different than the former since 6 acquiring firms were entrants to the industry and the remaining 23 were industry survivors. To determine the merger effects on the 1960 distribution due to acquirers, it was necessary to remove the acquired firms 1960 volume from the 1960 acquirers' volume. The variance increase, row 4 minus row 3, due to mergers developed by the merging of very large firms with those near the mean size. Still, relative inequality

Table 45. Effects of 1954-1960 mergers on the variances of firm sizes

1954 Total	6.88[a]
1954 Total, Subtracting acquired	7.32
1960 Total, Subtracting Acquirings' 1960 Acquired Volume	6.31
1960 Total	6.56

[a]In units of Log to the base 2, from working mean of 453,000 bu.

declined because firms not involved in mergers regressed toward the mean size and had a greater compensatory declining effect on the variance. These effects were similar to those observed in the concentration ratio analysis though not identical. The reason for this was that variance analysis considers a different aspect of structural change, although they are substituted for each other for formulating general conclusions. Changes in the variance were caused by changes in firm volume while changes in concentration ratios are caused by changes in firm volume relative to other firms. The latter deals with changes in proportions while the former, merely volume changes.

SUMMARY, CONCLUSIONS, AND SUGGESTIONS FOR FURTHER STUDY

Summary and Conclusions

Dominance characteristics were evaluated for buyers of grain, both merchandisers and processors, and indicate decreasing buyer concentration for the largest firms controlling 79% of 1954 volume. However, this deconcentration developed primarily because the largest firm had a substantial volume decrease. The effects of this change, as well as minor changes by other large firms, were reflected by cummulative statistical measurements through the largest 25% of firms to indicate the decreasing concentration. A decrease in the relative inequality of the entire size distribution indicated decreasing concentration for the industry. Industry deconcentration tendencies were comprised of unique changes by different size firms.

The above tendencies of the largest 25% of firms were associated with:

1. A high degree of size stability,
2. tendencies to specialize, and
3. mergers with small firms that, in itself, caused an increase in average size and concentration.

The smallest 75 % of industry firms increasing concentration was associated with:

1. higher rates of size mobility relative to large firms and very similar to those in the defined perfectly mobile industry,
2. tendencies to grow relative to the largest 25%,

3. a high percentage of firm entrants and extants,

4. a net tendency to increase rank, and

5. tendencies for the smallest firms to specialize while the 51-125 ranking firms tended to diversify.

In total NCR grain firms tended to:

1. have quite high but non-changing size mobility including births and deaths, although survivors became much less mobile,

2. increase the importance of multi-plant operations,

3. increase the importance of cooperative form of ownership,

4. specialize to a slight extent,

5. decrease concentration slightly, and

6. increase relative inequality by mergers, although merger effects were not sufficient to prevent the slight decline in concentration.

Analysis of seller concentration indicated:

1. Grain processors, in total, decreased concentration although four industries increased.

2. In total, processors tended to specialize although the bulk of processing volume is being controlled by more diversified firms.

3. Grain merchandisers deconcentrated.

4. In total, grain merchandisers tended to diversify.

Suggestions for Further Study

Limitations on the present study suggest several areas for possible further investigation. Briefly, these areas are thought to be:

1. Expansion of the scope of study to include all phases of grain marketing is necessary to more completely analyze structural aspects of the grain industry.

2. Norms for structural analysis need to be defined more completely.

3. More complete conduct and performance analysis of highly concentrated industries is necessary to supplement structural analysis implications.

4. More refined mathematical models are necessary to realistically evaluate structural changes and projections.

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APPENDIX

1. Distribution of grain for flour milling (.02) 1954-60

		00	01	02	03	04	07	12	13
4 largest	1954	27.6	7.7	48.0	14.5	2.3	--	--	--
	1960	43.0	2.0	40.1	12.3	2.6	--	--	--
8 largest	1954	25.1	5.9	56.0	11.2	1.8	--	--	--
	1960	42.1	1.7	45.8	8.4	1.7	--	--	--
20 largest	1954	28.2	4.8	55.9	8.3	2.8	--	--	--
	1960	37.5	1.6	51.0	8.2	1.5	--	--	--

2. Distribution of grain for oilseed processing (.03) 1954-60

		00	01	02	03	04	07	Ø2	13
4 largest	1954	54.9	2.3	8.5	29.6	0.01	--	4.7	--
	1960	52.9	7.1	---	38.7	1.2	--	--	--
8 largest	1954	41.2	8.3	12.9	32.5	1.8	--	3.3	--
	1960	47.7	4.6	4.7	38.5	1.0	--	3.5	--
20 largest	1954	38.9	7.9	13.4	34.7	2.4	--	2.7	--
	1960	39.1	4.6	9.5	40.9	3.3	--	2.6	--

3. Distribution of grain for feed manufacturers (01) 1954-60

		00	01	02	03	04	07	12	13
4 largest	1954	8.5	31.9	21.3	15.8	22.5	--	--	--
	1960	13.0	52.1	---	10.6	4.2	--	--	--
8 largest	1954	12.2	33.7	18.9	15.9	17.6	--	--	--
	1960	52.1	21.3	0.3	23.8	1.4	--	--	--
20 largest	1954	43.9	18.3	12.1	18.1	7.0	--	--	0.7
	1960	42.7	16.4	14.6	17.5	7.0	--	1.2	--

4. Distribution of grain for wet corn milling (12) 1954-60

		00	01	02	03	04	07	12	13
4 largest	1954	0.4	--	--	19.5	--	--	80.1	--
	1960	1.8	0.5	--	14.3	0.2	--	77.2	
8 largest	1954	0.3	--	--	15.6	--	--	80.8	3.2
	1960	1.4	0.4	--	11.2	0.2	--	80.8	6.1
20 largest	1954	0.3	--	--	15.3	--	--	81.3	3.1
	1960	1.6	1.1	--	10.9	0.2	--	80.6	5.7

5. Distribution of grain for dry milling and cereal mfg. (04) 1954-60

		00	01	02	03	04	07	12	13
4 largest	1954	5.0	11.8	4.7	8.0	70.5	--	--	--
	1960	3.0	4.1	--	15.8	77.2	--	--	--
8 largest	1954	5.6	16.2	25.1	7.8	45.4	--	--	--
	1960	7.9	13.0	14.1	25.8	39.2	--	--	--
20 largest	1954	9.1	18.7	22.7	13.8	35.6	--	--	--
	1960	13.7	10.0	14.5	26.2	28.0	--	5.1	2.4

6. Distribution of grain for malting and brewing (13) 1954-60

		00	01	02	03	04	07	12	13
4 largest	1954	11.9	--	--	--	--	--	15.2	73.0
	1960	7.7	--	--	--	.5	--	32.0	59.7
8 largest	1954	8.5	12.2	--	--	--	--	9.9	69.4
	1960	7.5	--	--	--	.4	--	32.9	59.2
20 largest	1954	16.8	9.5	9.9	--	--	--	7.0	56.9
	1960	6.9	--	--	--	.3	--	30.2	62.5

7. Distribution of grain for distilling and alcohol mfg. (07) 1954-60

		00	01	02	03	04	07	12	13
4 largest	1954	52.6	--	--	--	--	47.4	--	--
	1960	44.8	--	--	--	--	55.2	--	--
8 largest	1954	43.2	--	--	--	--	56.8	--	--
	1960	40.6	--	--	--	--	57.3	--	--
20 largest	1954	43.2	--	--	--	--	56.8	--	--
	1960	Only 6 firms in 1960							

8. Transition matrix for NCR grain industry survivors

		1954 Size Class																
Upper Limit	Classes	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Total
10	A																	
20	B									1								1
40	C	1		1	1	1												4
80	D			1	2	1		1										5
160	E				1	1	1	1	1	2								7
320	F				1		7	1		1	1							11
640	G					2		14	8	6					1			31
1,280	H					1	4	4	14	6	3	1						33
2.560	I						1	3	9	12	8	6						39
5,120	J							1		2	14	12	3	1				33
10,240	K										3	6	8	2	1			20
20,480	L								2		1		11	4				18
40,960	M								1					3	1			5
81,920	N														8	1		9
163,840	O															1		1
327,680	P																1 1	1
	Total	1	0	2	5	6	13	25	35	30	30	25	22	11	10	2	1	218