GIBRAT'S LAW AND GROWTH OF AGRICULTURAL MARKETING COOPERATIVES

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Gibrat's law is that growth rate and size are independent. Various empirical tests of the validity of Gibrat's law for regional marketing cooperatives in the United States are presented. The empirical tests do not support Gibrat's law and support the hypothesis of minimum efficient size among marketing cooperatives.

Key words: Growth rates, regional marketing cooperatives, Gibrat's law, market structure.

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Gibrat's law states that firm size and growth rate are independent. For agricultural cooperatives, the independence of growth rates and size would imply that small cooperatives operate at neither an advantage or disadvantage relative to large cooperatives. If Gibrat's law is valid for agricultural cooperatives, it would have specific implication for the future structural configuration of cooperatives. The rapidity of changes in concentration within an industry obviously is influenced by the relationship between firm size and growth rate.

The purpose of this paper is to statistically test Gibrat's law as it applies to agricultural marketing cooperatives. There are four primary implications of Gibrat's law. Each implication is empirically tested for a fixed population of U.S. agricultural marketing cooperatives. The results of these tests are then compared to available empirical results for proprietary firms. Finally, some economic implications are given in concluding remarks.

Empirical evidence reported in previous research suggests that Gibrat's law generally held prior to 1950 but not since for proprietary firms. Samuels cites several studies which support this conclusion for British and American proprietary firms. A recent study by Keating for Australian proprietary firms concludes that Gibrat's law cannot be accepted.

Among the sparse evidence available for cooperatives is by Biere and Trapp for producer grain cooperatives in Kansas. They regressed business volume in 1955 on business volume in 1965 which led to their not accepting Gibrat's law. Similar results for grain processing firms were obtained by Fletcher and Kramer.

A prior one could argue that Gibrat's law might hold for producer cooperatives even though it does not for proprietary firms. Conventional wisdom is that substantial differences exist in operation and control of cooperatives relative to proprietary firms. Cooperatives operate at cost, limit returns to capital and are subject to democratic membership control. None of these factors lend variant impetus for the rate of growth by size of cooperatives. However, an opposite argument is that substantial economies of size exist, particularly in marketing cooperatives compared to supply cooperatives. Assuming some minimum efficient size exists, economies of size would suggest that small cooperatives must grow at a more rapid rate than large cooperatives so as to achieve this minimum size.

The Data

Fiscal year sales data for all regional marketing cooperatives were obtained from the United States Department of Agriculture for 1960-61 through 1973-74. Included are all regional cooperatives with marketing sales during this period (thus, some cooperatives included are primarily supply cooperatives but with some marketing sales). Sales were recorded by major commodity category for each cooperative and deflated by appropriate farm prices received indices (e.g. grain prices received index was utilized for the grain category).[1/] For each cooperative, categories were aggregated to obtain annual marketing sales in constant dollars (1967 = 100).

In this analysis, $S_{i,t}$ is defined as marketing sales for cooperative i valued in constant prices in year t. Growth rate in year t is then defined as:[2/]

(1) $GR_t = S_{i,t} / S_{i,t-1}$

All data were converted to natural logarithms.

Because the second version of Gibrat's law is adopted in this analysis, the universe is composed only of regional marketing cooperatives that were

in business during the entire time period, 1960-61 through 1973-74. Of the 625 regional marketing cooperatives in 1960-61, only 285 or about 46 percent, remained throughout the 14 year period. Thus, the fixed population for this analysis is composed of these 285 regional marketing cooperatives.

A Weak Aggregate Test of Gibrat's Law

A weak aggregate test of Gibrat's law is possible which involves examining temporal growth for all regional marketing cooperatives. The base data period, 1960-61 through 1973-74, is split in two equal subparts. The slope coefficient of a log linear regression of one data set on the other is tested for unity. If the slope coefficient is not significantly different from unity, Gibrat's law is accepted.

The specific model used was:

$$(2)\quad \bar{S}_{i,\ 67\text{-}73} = \varepsilon \bar{S}^{b}_{i,\ 60\text{-}66}$$

where $\bar{S}_{i,67\text{-}73}$ is average size for cooperative i during the fiscal years 1967 through 1973, $\bar{S}_{i,60\text{-}66}$ is defined similarly, and ε is a random disturbance term. The estimated b coefficient is significantly greater than unity at the 95 percent probability level (1.027) with standard error of 0.003 (R^2 = 0.997, D.W. = 1.751). This weak aggregate test fails to support Gibrat's law for U.S. agricultural marketing cooperatives. It also supports findings from the Biere and Trapp study of producer grain cooperatives in Kansas.

Growth Rate by Size

A contingency table chi-square tests the independence of growth rate and size suggested by Gibrat's law. The test involves classification of all regional marketing cooperatives on the basis of average growth rates for the entire data period. Size categories of cooperatives were small (less than $5 million), medium ($5 - $25 million), and large (over $25 million) in constant dollar

annual sales for 1967-68 - the midpoint of the data period.

Results of the chi-square test, reported in Table 1, suggest that size and growth rate are not independent (α = 0.05). Another interesting observation from the contingency table is that 20 percent of all small cooperatives experienced negative growth rates compared to only 4 percent of all large cooperatives for the same period. However, 33 percent of all small cooperatives experienced average annual growth rates in excess of 10 percent compared to 32 percent of all large cooperatives.

To further examine growth rates by size, simple correlations were estimated between average annual growth rate and midpoint size (1967-68). For all cooperatives this correlation was 0.18 and significantly different from zero (at the 5 percent probability level). The same simple correlation by size category was: small + 0.22, medium + 0.20, and large + 0.03. Only the correlation for the small category is significantly different from zero. These correlations suggest that the significance of the chi-square arises only from the small cooperative category. Furthermore, among small cooperatives, the correlation indicates that the larger ones had relatively higher growth rates. No such association existed for the medium or large categories, however.

The chi-square test fails to support Gibrat's law. Similar results for Australian proprietary firms were obtained by Keating.

The Implications of Gibrat's Law

Various versions of Gibrat's law are possible depending on how exits are treated and the comprehensiveness claimed for the law. Mansfield (p. 1031) identified three versions. One is that the law holds for all firms, even those which exit during a specified period. A second is that the law holds for all firms except those which exit. A third is that the law holds only for firms larger than a minimum efficient size. The preponderence of literature on

Table 1. Chi-square Test of Independence of Average Growth Rate by Size, All Marketing Cooperatives, 1960-61 through 1973-74, United States

Average Growth Rate, 1960-74 [a/]	Size (1967-68) [b/]			
	Small	Medium	Large	Total
<1.0	24	12	3	39
	(16.4) [c/]	(11.9)	(10.7)	
1.0 - 1.1	57	49	50	156
	(65.7)	(47.6)	(42.7)	
>1.1	39	26	25	90
	(37.9)	(27.5)	(24.6)	
TOTAL	120	87	78	285

χ^2_c = 11.57 probability = 0.021

[a/] Average growth rate for firm (i) $= \left(\sum_{t=1}^{13} \ln(S_{i,t+1}/S_{i,t})/13\right)$ where $S_{i,t}$ is (sales) for cooperative i at time t.

[b/] Constant dollar sales for 1967-68 were used to divide firms into small (<$5,000,000), medium ($5,000,000 - $25,000,000) and large (>$25,000,000) categories.

[c/] Expected frequences appear in parentheses.

proprietary firms has adopted the second version, as is done here.

Given that Gibrat's law holds for all firms except those which exit during some specified period, the implications are (Hart, p. 30):

1) the distribution of growth rates is lognormal,
2) the relative dispersion of the sizes of firms tends to increase over time,
3) small, medium, and large firms experience the same average growth, and
4) the variance of growth rates about this common mean is the same for small, medium, and large firms.

Each implication is treated below.

Empirical Test of Each Implication

Lognormality

One implication of Gibrat's law is that the logarithmic growth rates distribution will be normal. The average annual growth rate in constant dollar sales for all regional marketing cooperatives is 18.8 percent for the period 1960-61 through 1973-74, Table 2. A chi-square goodness of fit test for the annual growth rate distribution fails to support this implication for regional marketing cooperatives. To the authors' knowledge, no other study has empirically tested this implication but rather "eye-balled" data graphically. Thus, no comparable test for proprietary firms exists.

Arithmetic growth rates reveal a substantial variance around the mean of 18.8 percent, Table 2. Of the 3,705 annual growth rates (285 cooperatives times 13 annual rates), 93.6 percent were 0.5 percent or less. For regional marketing cooperatives remaining in business over this time period, the probability of any particular year's growth in constant dollar sales exceeding 0.5 percent was remarkably small.

Variance of Size

The second implication is that the variance of sizes of cooperatives tends to increase over time. This was tested by regressing the variances of annual size for each cooperative on time for the entire 14 year period, Table 3. The b parameter estimate is 0.387 (standard error of $\hat{b}$ = 0.042, r^2 = 0.87, D.W. = 0.58). Thus, the variance of size increased significantly over this time period. These results substantiate this implication of Gibrat's law and are contrary to results reported by Keating for Australian proprietary firms.

Average Growth Rates

Another implication of Gibrat's law is that average growth rates are the same for small, medium, and large cooperatives. The contingency table chi-square previously reported tested the association between growth rate and size. This implication suggests, however, that a common mean growth rate by size category exists.

Average growth rates by size for the entire data period were tested for significant difference using analysis of variance. The size categories utilized are the same as before. An F-test was employed to indicate significant differences among the three means while least significant differences (LSD) were employed to indicate pair-wise significant differences between means.

The F test reported in Table 4 is significant. This indicates that common means across all three size categories do not exist. LSD tests show significant differences in average growth rates between the small and medium category and the small and large category. Small cooperatives experienced annual sales growth in excess of 30 percent while medium and large cooperatives were in the neighborhood of 8 to 10 percent.

These results fail to support the implication that small, medium, and large cooperatives have common average growth rates. Keating and Samuels both

Table 2. Distribution of Annual Growth Rates, All Marketing Cooperatives, 1960-61 through 1973-74, United States, Natural Log and Arithmetic.

Log_e Growth Rate	Frequency	Arithmetic Growth Rate	Frequency
-5 to -4	0	0.0 to 0.5	63
-4 to -3	1	0.5 to 1.0	1510
-3 to -2	3	1.0 to 1.5	1894
-2 to -1	23	1.5 to 2.0	149
-1 to 0	1546	2.0 to 3.0	62
0 to 1	2099	3.0 to 4.0	13
1 to 2	28	4.0 to 5.0	7
2 to 3	2	5.0 to 6.0	1
3 to 4	2	6.0 to 7.0	1
4 to 5	0	7.0 to 8.0	1
5 to 6	1	8.0 +	4
Mean = 0.033	Total - 3705	Mean = 1.188	Total = 3705
Variance = 0.110		Variance = 32.64	

Table 3. Variance of Sales, All Marketing Cooperatives, 1960-61 through 1973-74, United States.

Year	Variance of Sales	Year	Variance of Sales
1960-61	3.125	1967-68	3.433
1961-62	2.998	1968-69	3.463
1962-63	2.984	1969-70	3.504
1963-64	3.020	1970-71	3.834
1964-65	3.103	1971-72	4.232
1965-66	3.249	1972-73	4.321
1966-67	3.367	1973-74	4.399

Table 4. Mean and Variance of Growth Rates by Size, All Marketing Cooperatives 1960-61 through 1973-74, United States.

Statistic	Size (1967-68)[a/] Small	Medium	Large	Significance
N	120	87	78	
$\bar{X}_{log}$	0.0110	0.0408	0.0576	b/
$\bar{X}$	1.3173	1.0843	1.1030	
σ_{log}	0.4134	0.2687	0.2426	c/

a/ Constant (1967 = 100) dollar sales for 1967-68 were used to divide firms into small (<$5,000,000), medium ($5,000,000 - $25,000,000) and large (>$25,000,000) categories.

b/ Significant difference (α = 0.05) between the mean growth rate of small and medium size cooperatives, and small and large cooperatives.

c/ Significantly different from one another (α = 0.05).

report similar results for proprietary firms since 1950.

Variance of Average Growth Rates

The final implication of Gibrat's law is that the dispersion of growth rates around a common mean are the same for small, medium, and large cooperatives. This implication was tested utilizing Bartlett's test. Significant differences in dispersion of means across size category existed for the entire period, Table 4.

These results fail to support this final implication of Gibrat's law. Keating reports significant differences among variances of average growth rates for Australian proprietary firms and also rejects this implication of Gibrat's law. However, Samuels fails to reject this implication in his study of British

proprietary firms.

Concluding Remarks

Neither the weak aggregate test, chi-square test, nor tests of the individual implications of Gibrat's law support the law for a fixed population of regional marketing cooperatives in the United States. Growth rate and size are not independent. Available evidence suggests that small cooperatives grow at a relatively faster annual rate than medium or large cooperatives (30 percent compared to 10). However, small cooperatives experience greater variability in growth rates (nearly twice) than medium or large cooperatives.

These findings lend some credence to the frequent argument that substantial economies of size exist in processing and distribution cooperatives (e.g. Helmberger, p. 1433). Rapid growth of relatively small marketing cooperatives suggests these cooperatives are attempting to attain some minimum efficient size. However, this implication is tempered somewhat since the second version of Gibrat's law was tested. Regional marketing cooperatives which exited during the data period were excluded. It may be that small cooperatives either grow rapidly or exit because of a minimum efficient size phenomenon in operation.

Significantly greater variability in average annual growth rates between small and large cooperatives may be partially explained by the impact of commodity prices in relation to commodity diversification of the cooperative. Previous research by the authors shows that large regional marketing cooperatives have a greater level of diversification than do small cooperatives (Sporleder and Skinner, p. 194). Temporally fluctuating commodity prices would cause greatest variability in annual sales growth, ceteris peribus, for cooperatives with the least commodity diversification. Thus, the impact of fluctuating commodity prices on variability of growth may simply be reflected through different levels of diversification across size categories of cooperatives.

A larger implication of these results is that they do not fortify the

hypothesis that large regional marketing cooperatives dominate smaller ones in terms of sales growth. Although large regionals may grow faster in absolute dollar sales, small cooperatives still have the opportunity for growth.

Footnotes

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1/ The definition of local and regional by Abrahamsen (p. 15) is used here: "The operations of local cooperatives are usually confined within a county area or less. Areas served by regional cooperatives range in scope from several counties within a state or within bordering states to regionalized groupings of states or to many states widely scattered throughout the United States."

2/ Assets rather than sales are sometimes used to define growth rates. However, an annual time series of assets is not available for all regional marketing cooperatives in the United States.

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