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RECENT CHANGES IN THE SIZE OF SOUTHERN FOREST ENTERPRISES: A SURVIVOR ANALYSIS

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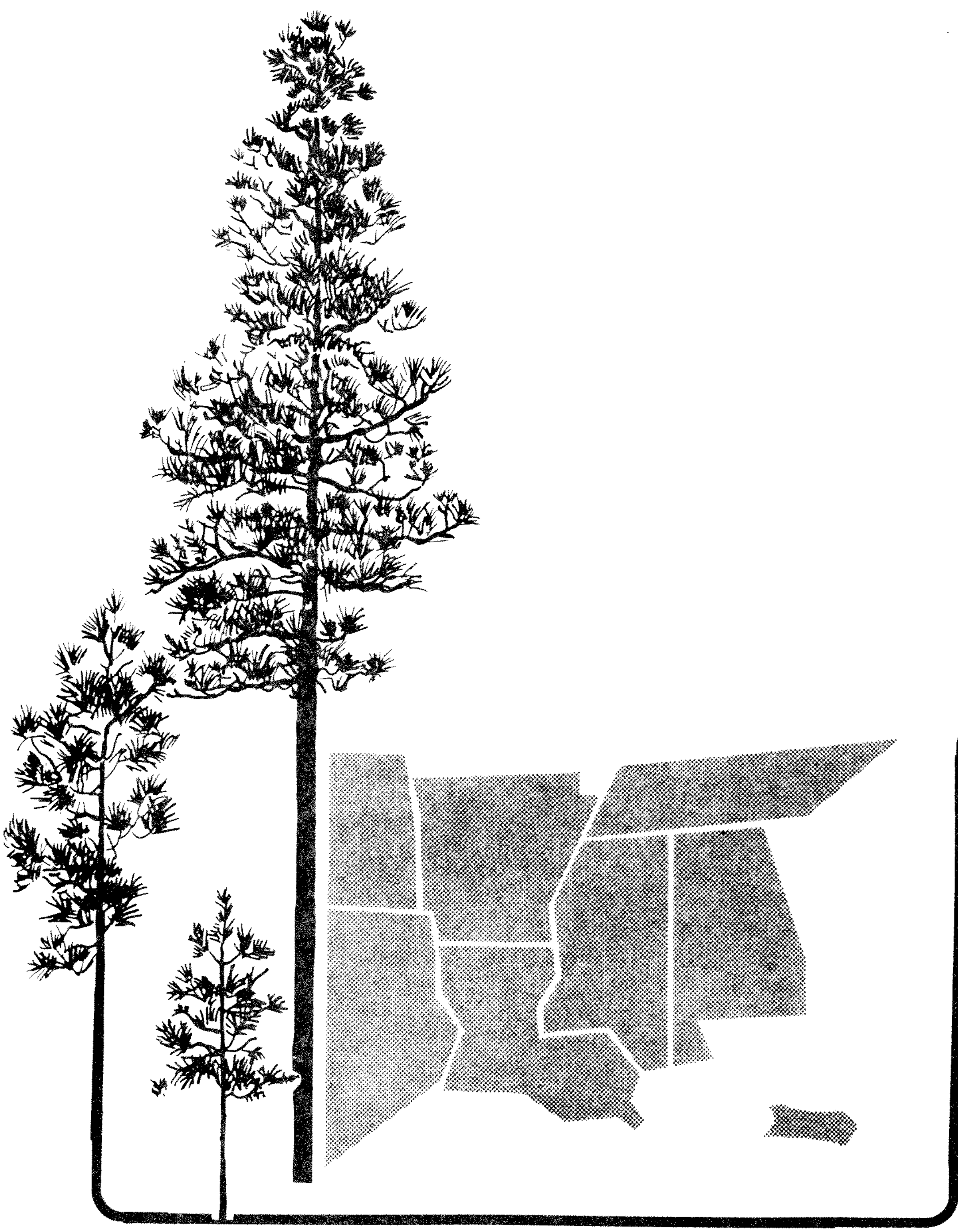

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RECENT CHANGES IN THE SIZE OF SOUTHERN FOREST ENTERPRISES: A SURVIVOR ANALYSIS

James E. Granskog[1/]

ABSTRACT

Over the decade from 1976 to 1986, the trend among southern enterprises that process softwood timber has been to build larger operations to reduce unit costs. Minimum efficient plant size, as determined by survivor analysis, has increased from 1,000 to 1,500 tons per day for pulpmills, 100 to 250 million square feet per year for softwood plywood plants, and 20 to 50 million board feet per year for pine sawmills.

INTRODUCTION

Many new forces have influenced the development of southern forest industries over the past decade. A severe recession and new competition from imports and products such as waferboard and oriented strandboard have forced firms to reduce costs and become more efficient. Consequently, a substantial amount of industry restructuring has occurred.

Change in the scale of operations can be an important factor affecting competitiveness. Over the past decade, average pulpmill capacity in the South has risen 30 percent, average softwood plywood plant capacity has climbed 62 percent, and average sawmill output has jumped 76 percent. These increases suggest strong measures have been taken to realize economies of scale.

To determine what sizes or range of sizes appear to be the most efficient for processing southern timber, this study, an update of a study conducted in the late 1970's (Granskog 1978), uses the survivor analysis technique to measure efficient plant sizes for southern pulpmills, softwood plywood plants, and sawmills. For each sector, the findings from the previous study are noted; then changes that have occurred over the 1976-86 period are analyzed.

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SCALE ECONOMIES AND EFFICIENT PLANT SIZE

Economies of scale refers to the reduction in unit costs as output increases. Technically, it is more accurate to say economies of size, because scale effects are measured in terms of changes in output relative to proportionate increases in all inputs, which is rarely the case. However, economies of scale remains the more popular terminology.

Enlarging the scale of operation is one way to increase output efficiency. As size increases at the plant level, for example, economies can result from division and specialization of labor, increased utilization of more efficient machines and advanced technology, and lower administrative costs per unit of output. Diseconomies occur if plant size is expanded to the point where unit costs increase, resulting from management problems in controlling and combining inputs in the production process.

The measurement of scale economies and efficient plant size in an industry is usually accomplished by comparing production costs for plants of different sizes. How much unit costs are reduced as plant size increases indicates the extent to which economies are achieved. Efficient plant sizes are identified as those having the lowest costs over the range of sizes examined. A major problem, however, is that accurate cost information is difficult to obtain and is seldom up-to-date. The effort necessary to acquire satisfactory information of this sort is probably not justifiable unless one is actually planning to construct a plant.

An alternative approach for estimating size efficiency is to study changes in the size distribution in an industry over time (Stigler 1958). Called the survivor technique, this approach is based on the premise that efficient plant sizes will survive over time, and inefficient ones will tend to disappear. With this method, plants in an industry are classified by size, and the share of industry capacity or output accounted for by each size category is calculated for two or more time periods. Those categories that increase their relative share over time are considered the most efficient. The smallest group showing an increase is identified as the minimum efficient size.

PULPMILLS

Previous study of the size distributions of southern pulpmills for 1956 and 1976 revealed that mills in size categories above 1,000 tons per day (tpd) increased their relative share of total capacity over the 20-year period, while the shares for mills in smaller categories declined. According to the precepts of survivor analysis, 1,000 tpd was the minimum efficient size for a southern pulpmill, and the efficient range extended to the largest mill with a capacity of 3,000 tpd.

From 1976 to 1986, southern pulping capacity increased from 98,000 to almost 120,000 tpd (table 1). However, the number of pulpmills decreased from 112 to 105. Actually, 10 new mills opened and 17 were closed--15 of which were below 1,000 tpd. Several of the closures were roofing felt mills, due to a trend toward glass fiber roofing products in place of woodpulp (Pulp and Paper 1982). In terms of change in capacity share, only those categories above 1,750 tpd showed gains. However, there was little or no change in the number of mills in the four categories that cover the range from 750 to 1,750 tpd.

Table 1.--Distribution of pulping capacity in the South for 1966, 1976, and 1986.[1/]

Mill Capacity[2/]	1966 No. Mills	1966 Capacity Total	1966 Capacity Percent	1976 No. Mills	1976 Capacity Total	1976 Capacity Percent	1986 No. Mills	1986 Capacity Total	1986 Capacity Percent
<250	19	2,541	3.9	16	2,153	2.2	9	1,330	1.1
250-499	15	5,680	8.9	17	6,382	6.5	10	3,510	2.9
500-749	12	7,738	12.0	20	11,430	11.6	13	7,640	6.4
750-999	16	13,718	21.2	12	10,295	10.5	12	10,272	8.6
1,000-1,249	9	9,500	14.7	16	17,604	18.0	16	17,870	14.9
1,250-1,499	9	12,215	18.9	11	15,295	15.6	13	17,825	14.9
1,500-1,749	4	6,325	9.8	16	25,810	26.3	16	25,788	21.5
1,750-1,999	1	1,879	2.9	1	1,950	2.0	5	9,420	7.9
2,000-2,249	1	2,130	3.3	2	4,155	4.2	6	12,600	10.5
≥2250	1	3,000	4.6	1	3,000	3.1	5	13,570	11.3
Total	87	64,726	100.0	112	98,074	100.0	105	119,825	100.0

[1/] Sources: Van Hooser and Christopher (1967), Bertelson (1977), and May (1988).
[2/] Tons per day

As found in the previous study, a 20-year time period presents a clearer picture of size efficiency for pulpmills. Table 2 shows that there were strong gains in capacity shares for mills at 1,500 tpd and above from 1966 to 1986. The slight gain in the 1,000 to 1,250 tpd category probably reflects the fact that this is the range of most new greenfield mills when they begin operating. Because of the large investment involved, a new mill may not initially reflect its planned capacity. For instance, the Union Camp mill in Eastover, South Carolina, came on-line at 600 tpd in 1984, but currently is being expanded to 1,700 tpd. Three new mills now under construction will begin operation with capacities ranging from 1,000 to 1,200 tpd.

The mill capacity data used in this analysis include all processes at a site and do not recognize the variation in products or proportions of pine and hardwood pulpwood consumed. It would be more accurate to make a comparative analysis based on the markets in which mills compete. Nevertheless, the results likely indicate the range in pulpmill sizes, from 1,500 to 3,400 tpd, required for efficient production of commodity grades of paper.

In addition, the results of the analysis have other useful applications, such as projecting the future number of pulpmills. Given the rate at which regional pulping capacity has been growing the past two decades, a total of 150,000 tpd would not be out of line by the year 2000. If we assume that average capacity for all mills in the year 2000 will equal the current minimum efficient size of 1,500 tpd, the number of mills necessary to meet tonnage requirements would be 100. Alternatively, if we divide the future tonnage by the average size in the efficient range (1,918 tpd), the number of mills would be 78. These computations suggest that the recent trend of a net decrease in the number of mills will continue in the coming years.

Of course, restructuring in the industry to achieve greater efficiency has not been limited to change in the size of mills. Product-line specialization has been occurring as well, such as Stone Container and Jefferson Smurfit in linerboard and Federal Paperboard in bleached board (Smith 1985). The economies that may result from such strategies are not identified in the above analysis.

Table 2.--Change in the percentage share of southern pulping capacity, by mill size category, from 1966 to 1986.

Mill Capacity[1/]	Change
<250	- 2.8
250 - 499	- 6.0
500 - 749	- 5.6
750 - 999	-12.6
1,000 - 1,249	+ 0.2
1,250 - 1,499	- 4.0
1,500 - 1,749	+11.7
1,750 - 1,999	+ 5.0
2,000 - 2,249	+ 7.2
≥2,250	+ 6.7

[1/] Tons per day

PLYWOOD PLANTS

The estimation of relative size efficiency for softwood plywood plants in the earlier analysis was limited by this industry's relatively brief history in the South, which began in 1964, and its record of rapid growth. As one writer, in discussing the application of the survivor technique, stated: "A period of rapid growth accompanied by high or increasing levels of profitability should be avoided, because all but the completely inept would survive and prosper" (Mead 1966).

Still, a comparison of size distributions, both in terms of capacity share and number of mills, from 1969--a point midway in the industry's regional development--to 1976, gave some indication of probable efficient size. All of the growth had occurred in size categories above 100 million square feet, as plants below this level increased their capacity and new, larger ones came on stream. All size classes below 100 million square feet registered declines, both in number of plants and relative share of total capacity. Therefore, plants in the range of 100 to 225 million square feet--the largest in 1976--appeared to be the most efficient for producing sheathing grades of plywood, the only product line produced in southern plants at that time.

Since 1976, however, southern plywood plants have been subjected to severe competition as waferboard and oriented strandboard have penetrated the sheathing market. A total of 15 new plants continued to open between 1976 and 1981, but 14 plants also closed over the 10-year period through 1986 (table 3). Still, total annual capacity grew from 7 to 12 million square feet as the remaining plants continued to expand.

Table 3.--Distribution of softwood plywood capacity in the South for 1976 and 1986.[1]

Plant Capacity[2]	1976			1986			Change in Capacity Share
	No. Plants	Capacity Total	Capacity Percent	No. Plants	Capacity Total	Capacity Percent	
<50	1	48	0.7	-	-	-	-0.7
50-99	15	1,081	15.3	5	411	3.5	-11.8
100-149	22	2,478	35.1	9	1,090	9.3	-25.8
150-199	12	1,997	28.3	13	2,174	18.6	- 9.7
200-249	7	1,463	20.7	9	1,971	16.9	- 3.8
250-299	-	-	-	19	5,113	43.8	+43.8
≥300	-	-	-	3	925	7.9	+ 7.9
Total	57	7,067	100.0	58	11,684	100.0	

[1] Sources: Forest Industries (1977a, 1987a)
[2] Million square feet per year (3/8-inch basis)

A comparison of the size distributions shows mixed results. Only plant sizes above 250 million square feet gained capacity share, but a small increase in the number of mills also occurred in the two categories between 150 and 250 million square feet. One interpretation of these results is that smaller plants may have survived and increased in number by diversifying or pursuing a "value-added" strategy, including exporting. Sheathing is no longer the only product line manufactured by southern plants. Sanded and specialty grades made up 20 percent of production in 1986. For those plants that continue to emphasize sheathing, however, it appears an annual capacity of 250 million square feet has become the minimum efficient size.

As noted earlier, there are other potential applications for the results of survivor analysis. Managers can use the results to evaluate the size of their operations and the suitability of existing plants to various product strategies. For instance, in 1986 Georgia-Pacific's 16 southern softwood plywood plants had an average capacity of 265 million square feet. Because this is above the minimum efficient size of 250 million square feet, the firm's plants appear to be well-positioned to compete in commodity markets.

On the other hand, Weyerhaeuser has announced its intention to switch from 80-percent commodity sales in its wood products division to 80-percent differentiated products by the mid 1990's (Weyerhaeuser 1988). This strategy appears to be suitable for its seven southern plywood plants, which had an average capacity of 118 million square feet in 1986.

SAWMILLS

One sector where survival-ability appears to be an especially valid measure of efficiency is in sawmilling. From almost 24,000 sawmills in 1947, less than 10 percent of that number operate today. And only 10 percent of the current number--about 200--account for about three-quarters of total southern lumber production.

Most closures have been among the smallest mills, with less than 10 million board feet of annual output. From 1966 to 1976, the share of lumber production accounted for by mills with less than 10 million board feet dropped from 70 to 32 percent. For softwood production, 20 million board feet per year on a one-shift basis appeared to be the minimum efficient size operation.

Over the latest 10-year period, however, only sawmills with an annual production of over 50 million feet have been gaining in percentage shares of total output (table 4). The increase in minimum efficient size from 20 to 50 million board feet reflects both larger mills and longer production runs. Economies can be realized through longer production runs as well as larger mills. To a large extent, the additional capital investment required to adopt scanning technology and other innovations now requires two-shift operations at a majority of mills. Also, the minimum efficient size is for sawing pine dimension lumber, which accounts for about 80 percent of the softwood output.

The size distributions presented in table 4 are based on combined data for both softwood and hardwood mills. Because softwood mills dominate the categories above 20 million board feet, the changes in the production shares for the largest size classes are valid for softwood sawmills. Hardwood lumber is a more heterogeneous product than softwood; therefore, it would be necessary to have mill production data by major species sawn and markets served to get meaningful estimates of minimum efficient size.

Table 4.--Percentage distribution of lumber production in the South, by mill size class, for 1976 and 1986.[1/]

Sawmill size[2/]	Percentage of Lumber Production 1976	1986	Change in Production Share
<10	32.4	12.9	-19.5
10-19.9	16.5	14.4	- 2.1
20-29.9	12.9	8.6	- 4.3
30-39.9	11.0	7.9	- 3.1
40-49.9	8.2	5.9	- 2.3
50-59.9	7.9	9.6	+ 1.7
60-69.9	4.2	8.9	+ 4.7
≥70	6.9	31.7	+24.8
Total	100.0	100.0	

[1/]Sources: Forest Industries (1977b, 1987a, 1987b)
[2/]Million board feet per year

CONCLUSIONS

The pattern of change has been essentially the same in all three sectors examined. Overall, there has been an increase in average size resulting from additions to capacity at existing mills, the larger size of new plants, and the closing of smaller facilities.

Thus, the trend has been toward achieving economies of scale, that is, to build larger operations to reduce unit costs--at least for the commodity grade products. Over the past 10 years, minimum efficient size has increased from 1,000 to 1,500 tpd for pulpmills, 100 to 250 square feet per year for softwood plywood plants, and 20 to 50 million board feet per year for softwood sawmills.

This does not mean that all small producing units will disappear, however. There will always be some operations that continue to exist by providing specialized products and services. This is a viable strategy, especially for smaller firms, where the minimum plant size for efficient commodity production may constitute a barrier to entry. Indeed, specialization has become an often-quoted strategy even for some larger firms, which we hear expressed through terms such as value-added, specialty products, flexibility, quality, and marketing. In essence, such firms are attempting to survive by emphasizing revenue enhancement rather than cost efficiency.

Because the survivor technique reflects trends and adaptive processes in industries, and not just costs internal to a plant, some limitations in regard to studying scale economies should be noted. For example, it does not identify the optimum plant size in an industry. Also, it doesn't indicate the extent to which economies exist, nor does it identify the factors that contribute to greater efficiency. And, as applied here, it doesn't address the question of efficient firm size.

For the purpose of identifying the relative efficiency of different plant sizes in an industry, however, the survivor technique has several appealing features. It is simple and straightforward. The data required is readily available in industry reports and directories. It does not require difficult-to-obtain cost information. And finally, the results have many useful applications.

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