

**Cost and Productivity Analysis of Southeastern U.S.
Logging Contractors from 1996 to 1997**

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(ABSTRACT)

A group of 22 independent southeastern U.S. logging contractors provided 44 contractor-years of detailed cost and production information. Information was collected on demographics, operational characteristics, and business strategies for the participants.

Precipitation was statistically proven to not be a good predictor of production, accounting for 2% of the weekly variation. High production through periods of favorable harvesting did not occur. Loggers contracting for the same mill in the same general area had higher than average production in the winter months and lower than average production in the summer months.

Summary analyses for the entire population found that the cost of producing an additional ton dropped in 1997 by \$0.90, but fixed annual costs rose. Predicting costs on the basis of production for the population was misleading. A comparison of total costs for individual firms with the population average (regression equation) found that the equation underestimated costs by as much as \$408,000 and overestimated costs by as much as \$528,000.

Contracted services expenditures increased in 1997, as expenditures for equipment, consumables, and labor decreased. Over the study period, total costs per ton increased by 3.7%, but total production increased by 3.9%.

The relationship between key cost components revealed strong evidence to disprove previously held theories. A major portion of the population increased production but experienced increased costs per ton. Replacement purchases of equipment tended to be of similar capabilities and technology and did not reduce labor costs. Trends in supply and equipment costs per-unit were not found in the expected fashion.

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Chapter 1 INTRODUCTION

Independent logging contractors are professionals who operate complex businesses. They provide a valuable service to the community by providing raw material to the forest industry, providing landowners with financial returns on timber investments, performing silvicultural operations to improve forested land, salvaging damaged timber, and creating jobs (Walbridge and Shaffer 1990).

Independent logging contractors face a great challenge in maintaining efficient and profitable businesses in a constantly changing business environment. To survive and prosper, they must constantly adapt their businesses and strategies to short and long run changes. Loggers face a variety of factors that create variation that inhibits the performance and profitability of their business. These include technical, organizational, natural, administrative, and regulatory forces (Stuart et al. 1998).

Technical forces include machine productivity and reliability and are specific to a particular job and application (Stuart et al. 1998). Equipment capabilities, breakdowns, and performance are all technical factors.

Organizational forces relate to the business size, structure, and overall business philosophy a logger uses in running his operation. These factors are job-specific, as each firm chooses a business and operating structure to match the local wood supply system (Stuart et al. 1998). Payment methods for employees, single or multiple crews, the use of trucking services owned by the logger or contracted out, specializing by harvest type, equipment types used, and similar decisions or factors are organizational based.

Natural forces include weather patterns and how they affect the stand being harvested (e.g. soil characteristics), as well as roads to gain access to a tract, and equipment selection to reduce site impacts. They also include insect and disease outbreaks and other forces beyond the direct control of man. Natural forces are difficult to predict but can be buffered through specialized

equipment purchases, employee training, administrative support, and specialized harvesting techniques.

Administrative forces include external factors created by the individual organizations that loggers contract with and the wood supply system as a whole (Stuart et al. 1998). Production quotas, equipment needed for special product specifications, and truck turnaround times at the mills are all examples. Untimely movement between tracts and inadequate placement of contractors to certain tracts are also included (Stuart et al. 1998).

Regulatory forces arise from legislation and regulation. Department of Transportation inspections, highway laws, wage and hour laws, OSHA standards, and water quality laws all affect the performance and productivity of independent contractors.

Research on independent logging contractors has been an ongoing effort at Virginia Tech with support from the Industrial Forestry Operations (IFO) Research Cooperative. Cost, production, and business information have been collected in an extensive data set extending back 10 years. Researchers who have contributed to data collection at Virginia Tech include Altizer 1999, Shannon 1998, Walter 1997, LeBel 1996, LeBel 1993, and Loving 1991. The data set has been updated to include 1997 cost and production data for 19 contractors who had previously participated in the study; 1996 and 1997 data were added for three new contractors.

This research will use similar approaches as previous logging cost and production studies at Virginia Tech. The objectives of the study are as follows:

1. To maintain and expand the cost and productivity study data set for 1996 to 1997.
2. To document changes in the operation, physical, and business environment over the two-year period.
3. To evaluate the relative effect of commonly discussed influences (weather, equipment purchases, and capital substitution for labor) on logging costs.
4. To assess the relative influences of natural (seasonal) and administrative forces on productivity and costs.

New approaches will be applied to the updated data set to assess and document demographic, productivity, and economic efficiency analyses for a sample of southeastern U.S. logging contractors.

Chapter 2 LITERATURE REVIEW

Logging in the southeastern United States has experienced rapid technological changes. The technological changes paved the way for an era of mechanization (1965 to 1985) with rapid improvements in rubber-tired skidders, knuckleboom loaders and attachments, shear and then saw head feller-bunchers, and in-woods processes. The period from the mid-1980s to present has been one of organizational changes and restructuring of logging systems and businesses to accommodate the additional capital investments associated with mechanization. Meeting the needs of a more diversified forest industry and satisfying the requirements of a more discerning public for soil and water protection have also added to these changes.

Research dealing with technological changes was rather straightforward. Field studies were structured to collect information on alternate machine types, and simulation was used to compare physical and economic performance (Stuart 1980). Computer simulations to analyze harvesting systems included Tufts et al. (1985), Reisinger et al. (1988), and Wang et al. (1999).

The assumption in most cases was that the small logging businesses of the era were similar. The American Pulpwood Association initiated a series of producer surveys to document the demographic and physical nature of these operations (Munn et al. 1998, Watson et al. 1989, Stokes 1988, Weaver et al. 1982, Weaver et al. 1981, and Watson et al. 1977).

Tools developed by Matthews (1942) were adopted over time and used to measure cost control. Sundberg et al. (1987) measured operational efficiency in forestry. Few efforts were made to evaluate job performance as a business.

Past research on these harvesting systems has focused more on individual machines and processes within the system (Shannon 1998). As stated by Shannon (1998), results from past research may not be “appropriate to the modern industry because of changing business conditions and technology.” Developing production rates has been the focal point in previous research, followed by cost calculations for individual machines or systems (Cubbage 1988). Again, results from past research must be taken guardedly, as they may not measure what can be

achieved on a broad-scale basis (Cubbage 1988). Broader, holistic studies are needed, as the logging profession is not based in a static environment.

2.1 *Past Research*

Haggard (1981) analyzed the establishment of fair cut-and-haul contract rates for loggers by using a heuristic model for independent contractors in southern Ohio. Contract rates were examined using a gross systems approach to evaluate the overall performance of the harvesting system. Specialized harvesting systems (thinning and pre-logging) in the southeastern United States were analyzed to document system characteristics contributing to their success (Corwin 1987). Corwin (1987) described the success of these operations as a function of business characteristics, equipment spreads, residual stand damage, and landowner and timber buyer support.

Hoffman (1991) discussed mechanization as a means of realizing higher profits. Problems caused by labor and shortages of skilled workers were linked to the trend of increasing mechanization (Hoffman 1991). Greene (1998) discussed past research on timber harvesting as focusing on equipment, systems, and methods and “either ignored or only indirectly addressed worker issues.” Labor is probably the toughest aspect in running a business, as people can often be difficult to manage. Demographics, views on the logging profession, and experience with training programs were explored using a sample of loggers in Georgia (Greene 1998).

Loggers’ capacity utilization and the link between woodyard inventory practices were discussed by LeBel (1993), Loving (1991), and Laestadius (1990). In Finland, successful logging businesses were found to have a higher capacity utilization when compared to less successful ones (Mäkinen 1993, 1992).

2.2 *Previous Cost and Productivity Studies*

Logging costs were analyzed on an average-cost basis using survey data from southeastern U.S. loggers, but “more variation in average harvesting costs was left unexplained than was explained by the statistical analyses” (Cubbage 1988). Productivity and management of an individual firm were described as key components in determining average logging costs (Cubbage 1988). Loving (1991) analyzed southeastern U.S. logging businesses using a general systems approach to document the components of logging costs. Logging costs can be categorized into six common components: equipment, consumables, labor, contract services, insurance, and administrative overhead (Loving 1991). These cost components form the basis for this thesis. Loving (1991) found that “harvesting mechanization has reached a technological plateau,” adding that additional research to analyze and document variability forces in the logging business was needed.

LeBel (1993) analyzed production capacity utilization in the southern logging industry. The most frequent causes of lost production included adverse weather, quotas, and moving; rain was found to have the most impact on loggers (LeBel 1993).

Few applications of efficiency analysis have been made to analyze timber harvesting (Shannon 1998). Efficiency measurements of southern U.S. logging contractors include Carter and Cubbage (1995), LeBel (1996), and Shannon (1998). Carter and Cubbage (1995) focused on aggregate data rather than on individual observations, unlike LeBel (1996) and Shannon (1998). LeBel (1996) used nonparametric data envelopment analysis (DEA) to measure radial and non-radial efficiency for southeastern U.S. logging contractors; performance and efficiency were measured for a sample of contractors, where 60,000 to 80,000 tons per year was estimated as the most productive scale size. Shannon (1998) followed a similar approach using DEA to measure technical efficiency for logging contractors. Shannon (1998) found that “demographic information, including age, experience, and education, appeared to have only minimal impacts on contractor efficiency,” while other factors (business, operational, and environmental) were larger determinants. Marginal cost and revenue analyses were used to examine the relationship

between efficiency and profitability, as “the point of maximum efficiency is not always where efficiency is maximized” (Shannon 1998).

Walter (1998) analyzed productivity and efficiency relationships using demographic, business characteristics, production, and cost information. Using similar approaches employed by Loving (1991), LeBel (1993 and 1996), and Shannon (1998), Walter (1998) found that harvesting costs could not be generalized. Again, harvesting systems were tailored to match business environment and adapt accordingly to these changes. Walter (1998) also described annual production as a function of annual expenditures as showing “no obvious economies of scale in operation size.”

Other independent surveys include Stuart et al. (1998) and Stuart and Grace (1999), both of which measured improvements in production and economic efficiency of loggers over time. This research used a large sample across the central and eastern United States to document the differences in harvesting systems, wood supply systems, and contractor types over time. Southeastern United States loggers were incorporated in this thesis; similar analyses for the U.S. Appalachians (Altizer 1999) and for the central United States (Miller 1999) will parallel the study discussed by Stuart and Grace (1999).

Stuart and Grace (1999) note that “the same event generates distinctly different responses for loggers serving the same procurement organization.” Understanding and identifying these events are key to a “smooth operation of the wood supply system” (Stuart and Grace 1999).

Chapter 3 METHODS AND PROCEDURES

3.1 *Contractor Selection*

American Pulpwood Association member companies or members of logging associations recommended contractors for inclusion in this study. Nominees had to meet certain criteria for inclusion: good community and industry standings, adequate and accurate records for needed information, and being considered as part of the top 25% of the wood-producing force in terms of production for a wood consuming mill. A background of the IFO Cost and Productivity Study, information needed, how the information would be used, and confidentiality procedures to protect the participant were explained to all selected contractors. The duration of participation in the study, if accepted, was solely up to each individual contractor and was explicitly stressed. Interviews and data collection then proceeded for the study population.

3.2 *Demographic and Business Information*

An interview was conducted with each contractor either at the job site, office, or home. Interviews lasted anywhere from a couple of hours to an entire day. Information obtained included demographics, business starting dates, organizational styles, family involvement, stumpage acquisition, crew sizes, number of employees (in-woods, truck drivers, and support personnel), employee payment methods, fringe benefits offered, equipment spreads, equipment strategies, and harvesting methods. Other information obtained included contractor and employee training, crew turnover, markets, products and species harvested, relative haul distances, and other general business information. Most information was used for a comparison of all participating contractors; other information was obtained to simply get a better feel for each business.

3.3 *Production Information*

Daily, weekly, quarterly or yearly production information was collected for all participating contractors. Daily or weekly production information was preferred; however, it was not feasible for all contractors in which case quarterly or yearly data sufficed. Production data were either collected from the individual contractor or from the forest products companies they supply, by whichever method was the most accessible, detailed, and accurate. Total production was measured as the green tons delivered per time period: loads, cords, and thousand board feet (MBF) were converted to tons using local conversion factors.

3.4 *Cost Information*

The total cost, in dollars, required of each contractor to get wood from the stump to the market was obtained. Only costs directly related to the harvest and transportation of wood were collected. Revenues, profits, contract rates, stumpage purchases, and owner's actual salaries were not included. Quarterly cost information was collected in instances where such data were available; otherwise, yearly costs were gathered for all participants. Cost information was gathered from the contractors themselves, accountants, or bookkeepers and was taken either from tax forms or financial statements.

The costs were broken down into six major categories as adapted from Loving (1991): equipment, labor, consumables, administrative overhead, insurance, and contracted services (Table 3.1). The equipment category includes depreciation or note payments, in addition to interest, leases, rentals, warranty, and other taxes. Note payments were the preferred costing values for equipment (shows actual cash flow to principal) and were used whenever possible. Tax depreciation plus interest was accepted as a substitute.

A "contractor-year" was defined as the total cost and corresponding total production data for an individual contractor's business for either a calendar or fiscal year. This study added 44 contractor-years to the data set.

Table 3. 1 Components of Logging Costs (from Loving 1991).

1. <u>Equipment</u>	A. Equipment Value (Depreciation or Note Payments, Interest, Lease, Rental, Warranty) B. Taxes (Highway Use, Property Tax, License)
2. <u>Labor</u>	A. Wages and Salaries B. Payroll Taxes (FUTA, SUTA, FICA, Medicare) C. Workers Compensation Insurance (WCI) D. Benefits (Uniforms, Health Insurance, Bonuses)
3. <u>Consumables</u>	A. Fuel, Oil, Tires (Fuel tax) B. Repairs and Maintenance (Supplies, Parts, Chainsaws) C. Misc. (Truck/Equipment Washing, Wrecker Service, Gravel)
4. <u>Administrative Overhead</u>	A. Office Expenses (Secretary Wages, Bookkeeping, Supplies, Advertising, Debt, Bank Charges, Education, Franchise Tax, Freight, Other Taxes) B. Legal & Accounting C. Telephone (Cell phone, CB Radio) D. Utilities (Electricity, Water, etc.) E. Medical Expenses F. Fines G. Contributions H. Dues I. Travel J. Misc. (Commission, Other)
5. <u>Insurance</u> (Except WCI)	A. General Liability B. Equipment (Fire/Theft/Vandalism) C. Umbrella Policy
6. <u>Contracted Services</u> (Any expense incurred from services of a third party: contract trucking, equipment moving, etc.)	

Labor was the most difficult cost component to document. Workers' compensation insurance (WCI) was included with other fringe benefits even though it would seem to logically fall into category 5. WCI is required by law and is tied to wages and specific to the industrial classification. Exact owner's salaries were not requested because they are rightfully personal and proprietary. The amount owners' draw from their business may vary according to business profitability, personal needs, and stage of business maturity. To put each business on an even footing, a base salary of \$20,000 plus a production-based value was estimated: \$0.30 per

delivered ton. This approach was adapted from Walter (1998), as “higher production operations require more management skill and effort and involve greater risk.”

3.5 *Production Analysis*

Contractors were grouped into production quartiles by the annual tons each contractor delivered. Production information was analyzed on a weekly, quarterly, and annual basis. The data allowed trends over each period to be assessed by operation size.

Analyses of sources of production variation (Chapter 1) using weekly production and rainfall were performed for a sample of the population. Loggers serving the same market or from the same general operating area offered an opportunity for assessing the effects of underlying variability at work. The predictability of production by using rainfall measurements was also examined.

3.6 *Cost Analysis*

Annual and quarterly cost information was analyzed for the production quartiles and for the study population. Paired production and cost data were used to determine the relationship between dollars spent and tons of wood produced.

The allocation of costs between cost categories for the study period and the cost shifts between 1996 and 1997 were also explored. Changes in key cost components from 1996 were performed. The distribution of costs and the movement of costs between categories illustrate business decisions and coping strategies employed by the contractors.

Relationships between key cost components were analyzed on a per-unit basis. The “expected” outcomes of these relationships were described and compared to the “true” outcomes. Common theories behind these relationships (e.g. as production increases costs per ton should decrease) were used as the “expected” outcomes.

Chapter 4 CONTRACTOR AND BUSINESS ANALYSES

This chapter contains demographic and business information for the 21 contractors who agreed to participate in the study. Complete demographic, business, operational characteristics, production, and cost information will be analyzed for all contractors and was accurate through summer 1998. Detailed demographic, business, and operational characteristics will be presented for the 21 businesses. Complete information for one contractor, who runs four crews, was obtained for only one of the crews. Another contractor, with a separate chipping operation, was also included. Detailed cost and production information will be presented for 23 businesses, often containing multiple crews for which the data could not be separated.

4.1 Contractor Demographics

All contractors included in the study were owned and operated by white males. Ages ranged from 32 to 58, with a median age of 46. The middle 50% (the inter-quartile range) of the contractors was between 41 and 52 years old (Figure 4.1).

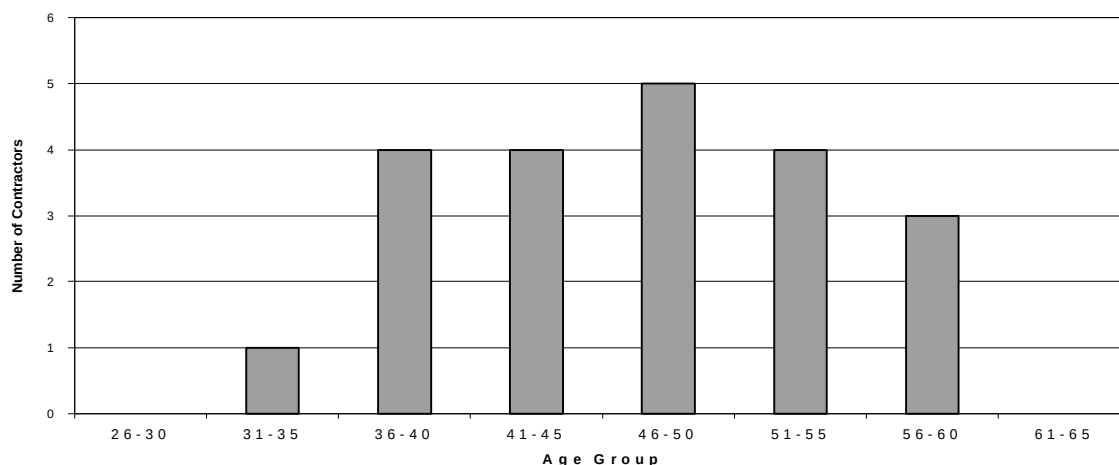


Figure 4. 1 Histogram of Contractor Ages.

Figure 4.2 illustrates the relationship between contractor age and education level. All contractors had at least some high school education, with three not finishing and 18 graduating. The contractors who did not finish high school were 46 years and older. All contractors under the

age of 40 were high school graduates and three had completed some college. Three contractors earned a two-year associate's degree. Four contractors received a bachelor's degree with two in forestry and two in business.

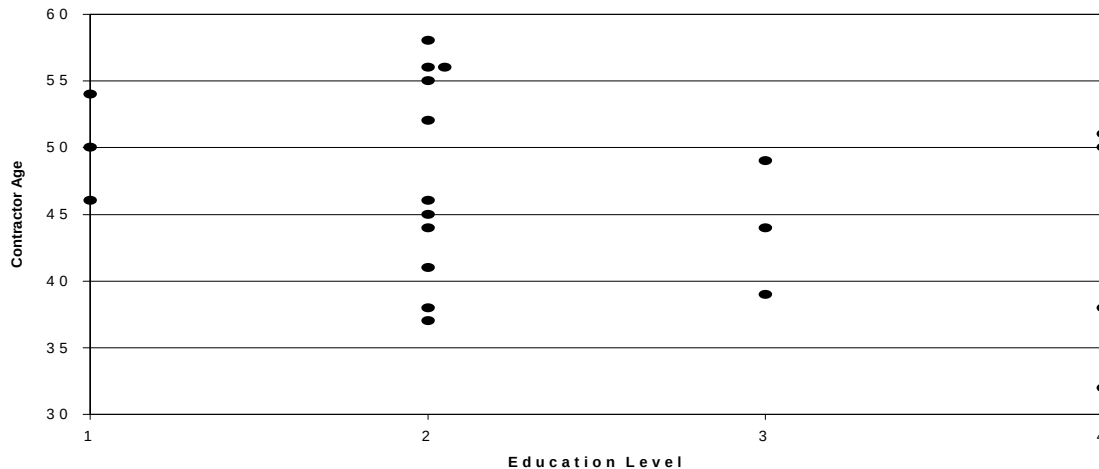


Figure 4. 2 Contractor Education Level vs. Age.

1 = did not finish high school	3 = 2 years of college
2 = finished high school	4 = 4 years of college

The experience level for each contractor was measured as the number of years the individual owned the business (Figure 4.3). Developmental years, reflecting time working under the family business or for another contractor, were not included. Experience levels ranged from 3 to 38 years, with a median of 20. The inter-quartile range was between 14.5 and 25 years of experience, indicating that the majority of the contractors had owned a harvesting operation for quite some time.

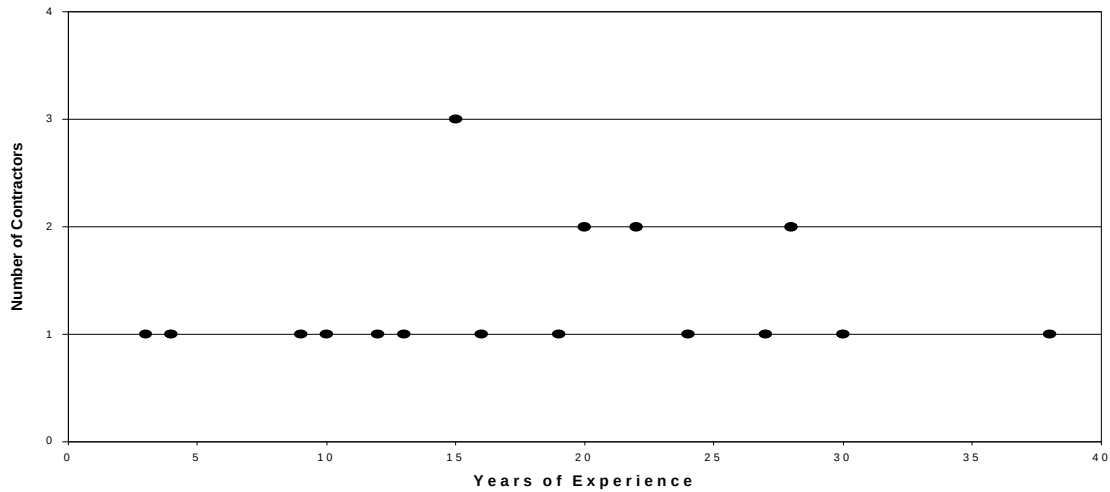


Figure 4. 3 Experience Level of Contractors.

All participating contractors operate within the southeastern United States across two principal physiographic regions (Figures 4.4 and 4.5). The region covered allows for differing harvesting operations and situations encountered. Five contractors in each state represent Georgia, South Carolina, and Virginia. Alabama had three contractors, followed by two in both Florida and North Carolina. Loggers were also grouped by physiographic region by their county of residence. Regions represented were evenly distributed between the piedmont and coastal plain.



Figure 4. 4 Geographic Location of Study Participants.

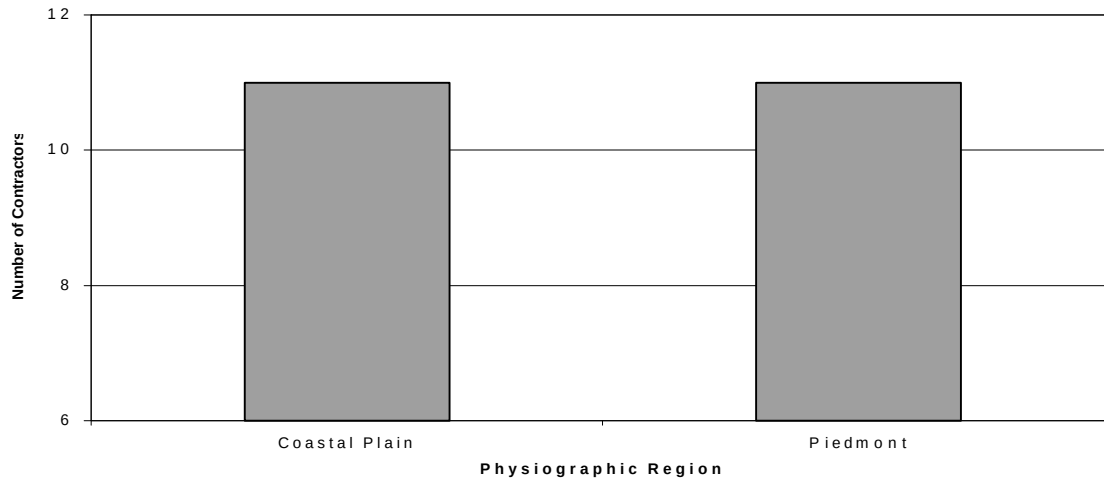


Figure 4. 5 Physiographic Region of Study Participants.

4.2 *Business Characteristics*

4.2.1 Logging and Chipping Business Organization

Three forms of business organizations were found (Figure 4.6). Only logging and chipping operations were included; contractor-owned trucking operations were excluded. The predominant organizational type was a corporation (91%) followed by 9% as sole proprietorships. Of the incorporated firms, 50% were “S” Corporations and 50% were Full C Corporations.

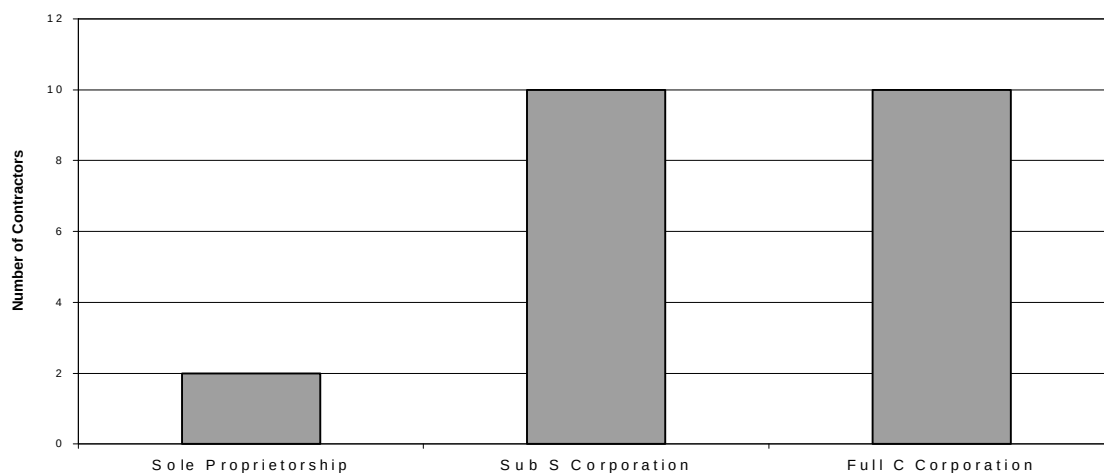


Figure 4. 6 Logging and Chipping Business Organization for Contractors.

4.2.2 Trucking Business Organization

The logging and chipping contractors used three trucking strategies:

1. Trucking operations (as a separate business) organized as a wholly owned corporation, with sole use of the trucks by the firm.
2. Trucking separate with the use of some contracted trucks owned by a second party.
3. Contract trucking as the sole means of transportation.

Contractors with logging or chipping operations who combined a trucking operation into a single business comprised 68% of the study population, while separate contractor-owned trucking businesses were found for 32% (Figure 4.7). None of the contractors who were interviewed relied solely on contract trucks.

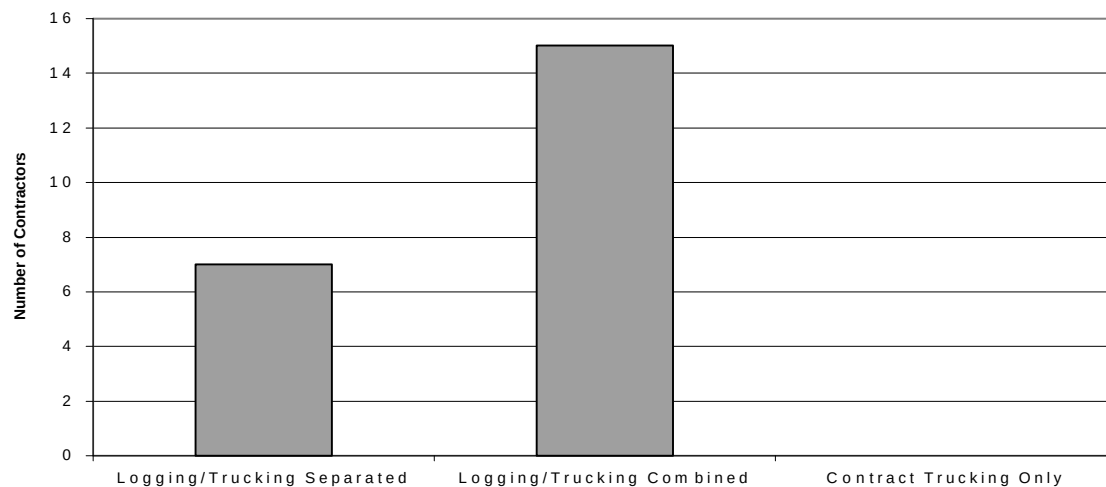


Figure 4. 7 Trucking Business Organization for Contractors.

Figure 4.8 shows the total number of logger-owned trucks and contracted trucks used by each logger on a regular basis. Even though none of the contractors relied solely on contract trucks, contract trucks still composed a large portion of the trucking fleet. A total of 126 trucks, either owned by the contractor or contracted out, were used on a regular basis; 37% were contracted trucks. Contract trucks per logger ranged from 0 to 9, with a median of 1 truck. The inter-quartile range was between 0 and 2 trucks. The majority of the contractors opted to run more of their own trucks than contracted ones; only two contractors (10%) relied more on contract

services for the trucking side. Contractors owned from 1 to 13 trucks, with a median of 4 trucks. The inter-quartile range was between 3 and 4 trucks.

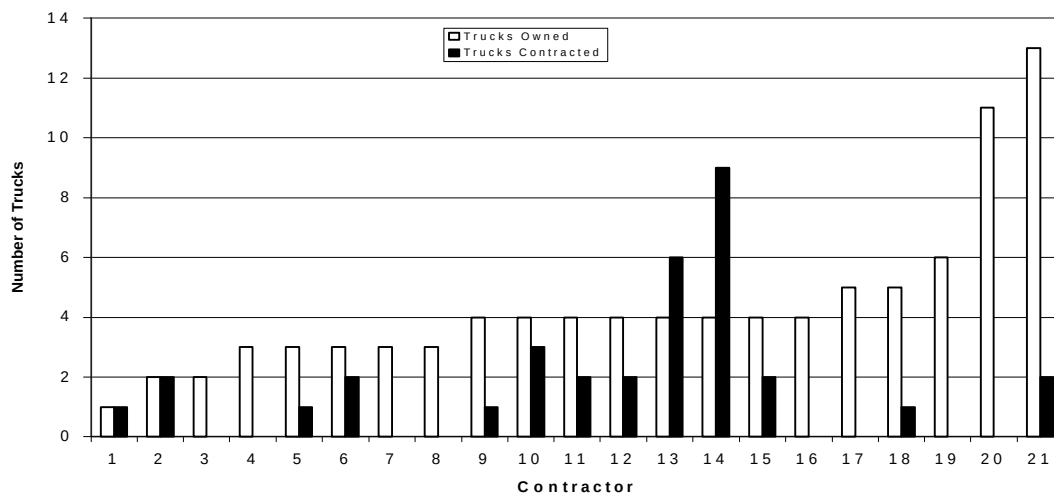


Figure 4. 8 Trucks Owned vs. Contracted Out for each Contractor.

4.2.3 Stumpage Acquisition

Contractors in the southeastern United States have three primary methods of obtaining raw material: from timber owned by a wood-consuming mill (either from timber deeds or company-owned fee lands), from stumpage purchased by a dealer, or from stumpage purchased by the logger himself. Stumpage acquisition for all 21 contractors was primarily through a mill or wood dealer system, accounting for at least 75% of the stumpage purchased for each contractor (Figure 4.9). Fifty percent of the contractors purchased some of their own stumpage; however, the percentage was very low (Figure 4.10).

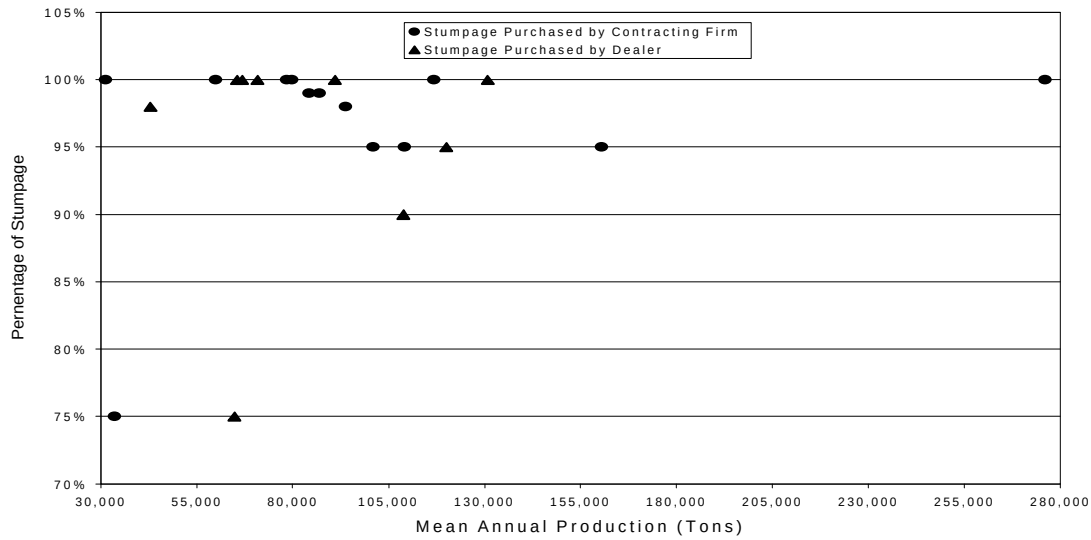


Figure 4. 9 Primary Sources of Stumpage Acquisition.

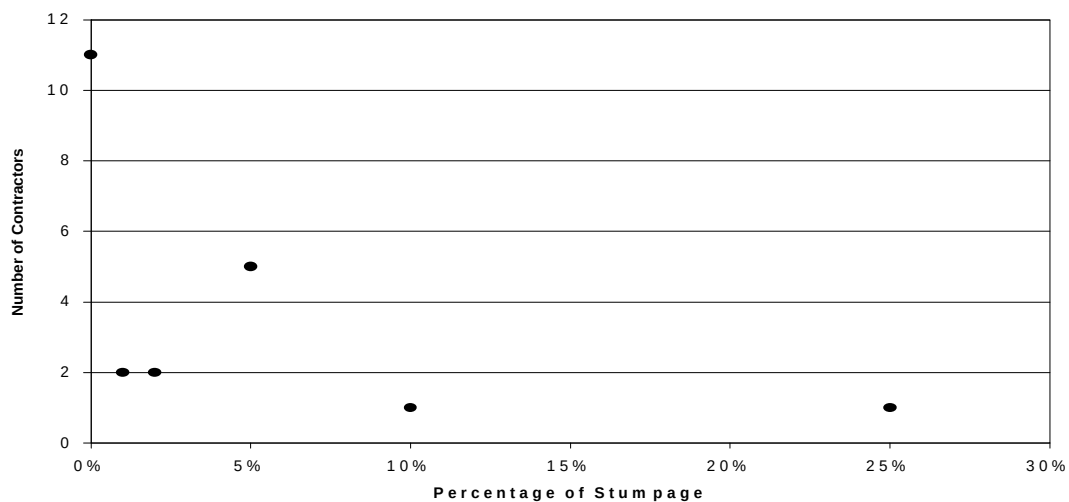


Figure 4. 10 Percentage of Contractor-Purchased Stumpage.

4.3 Production and Business Size

Twenty-nine percent of the participating contractors were running more than one crew at the time of the interviews (Figure 4.11). One-crew operations comprised 71% of the study population, followed by two-crew operations (19%) and four-crew operations (10%). The 21 contractors interviewed operated a total of 31 crews split as follows: clear-cutting (68%), thinning (22%), and chipping (10%). Several contractors had added or removed a crew prior to

the interview (within two years). Three contractors had added one crew, while two contractors had dropped a crew entirely from the business. Reasons for adding an additional crew stemmed from taking advantage of niche environments, such as starting chipping or thinning operations. Contractors that ran multiple crews stated that a good foreman was the key to maintaining an efficient and productive operation. Multiple factors were associated with the removal of a crew, including the difficulty in overseeing two or more operations and deteriorating mill relations.

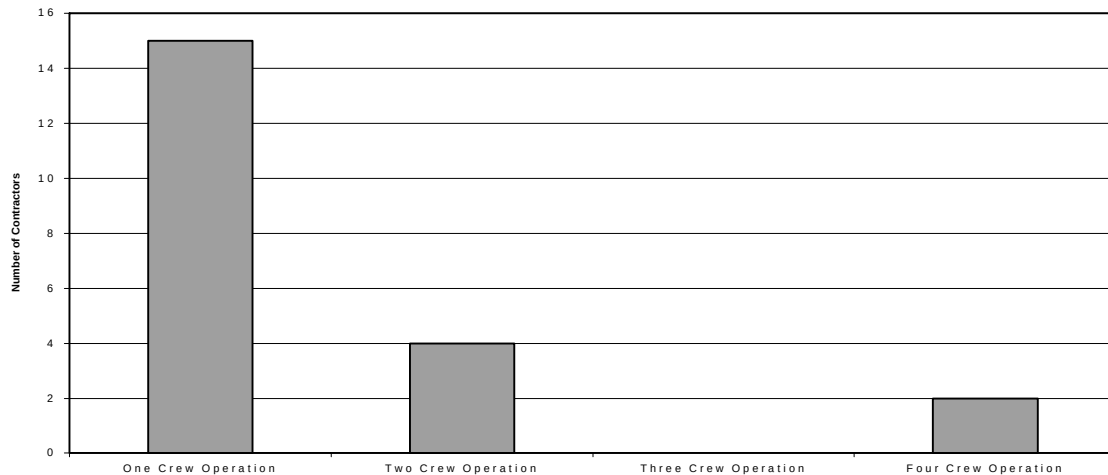


Figure 4. 11 Number of Crews per Contractor.

Annual production, along with mean annual production, for the 23 businesses for which production data were available is illustrated in Figure 4.12. Several of these ran multiple crews. Contractors with annual production less than 50,000 tons represent roughly 13% of the study population, 50,000 to 100,000 tons at 52%, and 35% with greater than 100,000 annual tons.

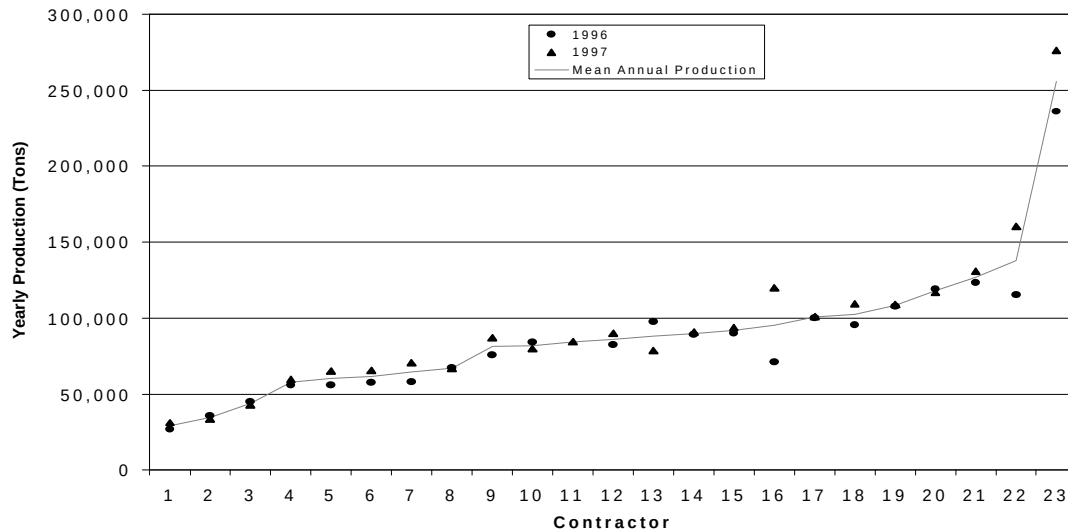


Figure 4. 12 Production Totals for each Contractor.

4.4 Labor

4.4.1 Number of Employees

Annual production for 22 contractors along with the total number of employees associated with each business is shown in Figure 4.13. Total employees include the owner, in-woods labor, truck drivers, and full-time support personnel (mechanics, secretaries, and bookkeepers). Truck drivers, whether employees of the business or contracted out, fluctuate over time due to market conditions; therefore, the number of drivers used on a regular basis by each contractor was estimated. Contract truckers, whose number was found to be directly proportional to production, were included even though they are not direct employees of the contractor's business. The total number of workers for all businesses was 317. Total employees in each business ranged from 6 to 44, with a median of 12 and an inter-quartile range between 10 and 15.

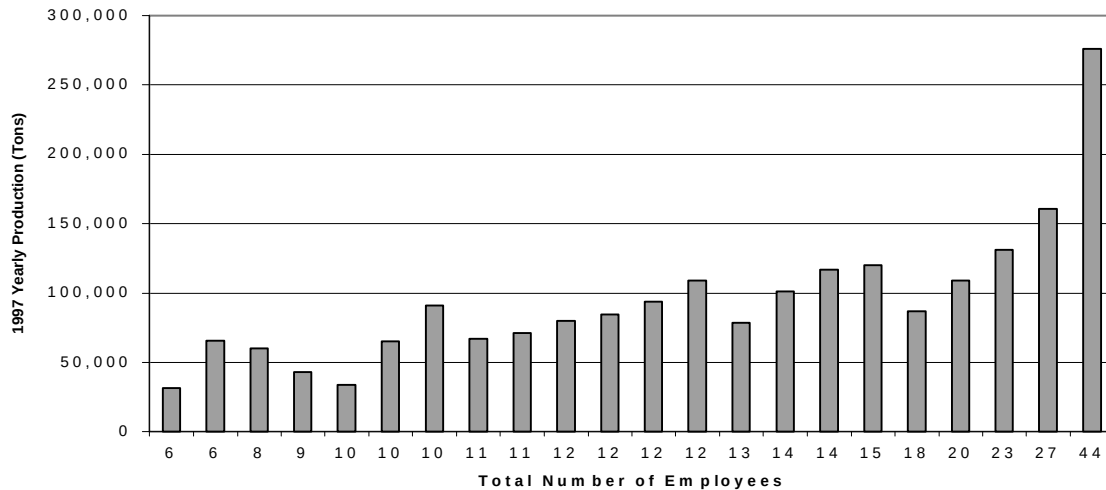


Figure 4. 13 Number of Employees vs. Production.

Figure 4.14 shows the number of in-woods personnel for 28 crews, including equipment operators, saw-hands, and the owner (if a regular working member of the crew). Some contractors opted for fewer crew members with additional equipment. Such equipment included pull-through delimiters, gate delimiters, and bucking saws, all of which were common with the participating contractors. Several contractors had structured their operations with additional crew members, eliminating the need for costly support equipment. The total number of in-woods personnel for all crews was 169 and ranged from 3 to 11 employees per crew. The inter-quartile range was between 5 and 7 employees, with a median of 6.

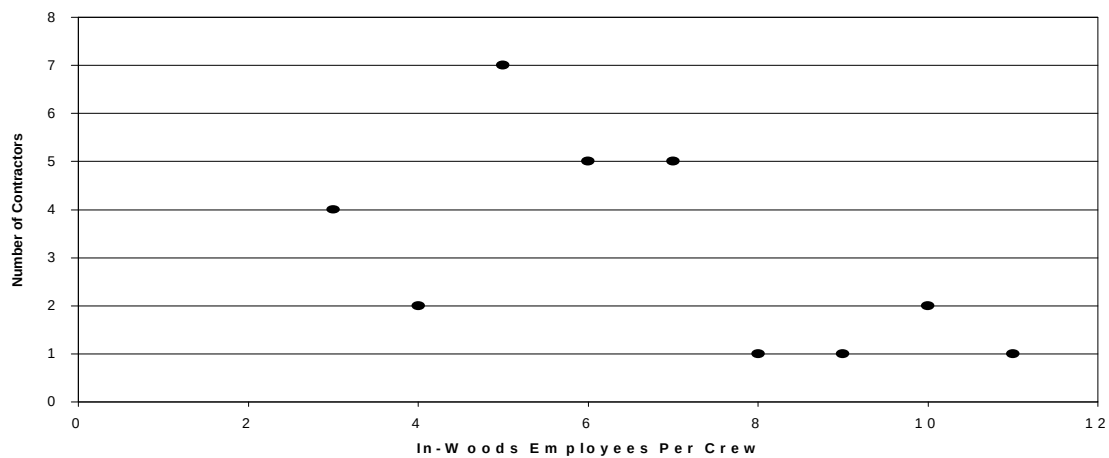


Figure 4. 14 In-Woods Personnel per Contractor.

4.4.2 Methods of Payment

Payment methods differed among the contractors (Figure 4.15). The majority (55%) chose to pay employees with one single method: hourly, daily, production-based, or salary. Others used combinations of these methods, usually where key employees (family members, foremen, and long-term employees) were compensated differently than other employees. Contractors expressed different views on payment methods. Several thought that paying on a production basis would offer an incentive to work harder and induce higher production levels. Others thought that paying on an hourly or daily basis creates a safer environment for the crew, eliminating the need to “hurry up” and get the extra loads associated with production-based payment. One contractor pays each of his crew members (including truck drivers) on an hourly basis to avoid liability. He commented that paying employees on a daily or production basis could interfere with fair labor laws, especially in the logging business where long hours are often worked during “good” weeks.

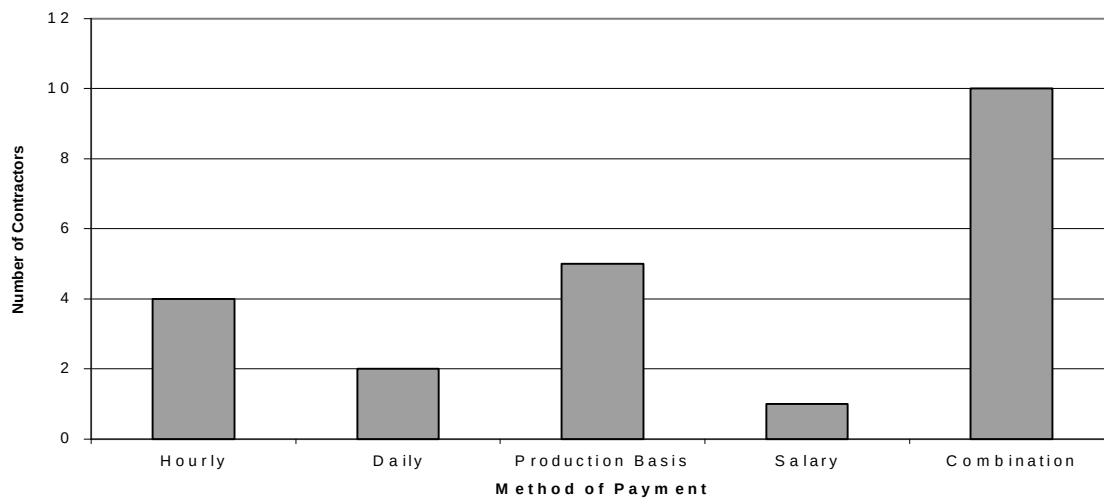


Figure 4. 15 Payment Methods Employed.

4.4.3 Fringe Benefits

All contractors offered some type of fringe benefits (Figure 4.16). Being paid for transportation (at least one-way) to the woods was provided by 90% of the contractors, followed by paid vacations (80%), Christmas bonuses (76%), employee loans or financing (71%), uniforms (52%), health insurance (43%), and retirement plans (19%). Several contractors expressed concern about keeping and finding good personnel. Many stated they simply could not afford benefits for their employees. Others mentioned they had experimented with programs to match dollar-to-dollar for health insurance and retirement plans, only to have employees withdraw from the offer once weekly paychecks were reduced.

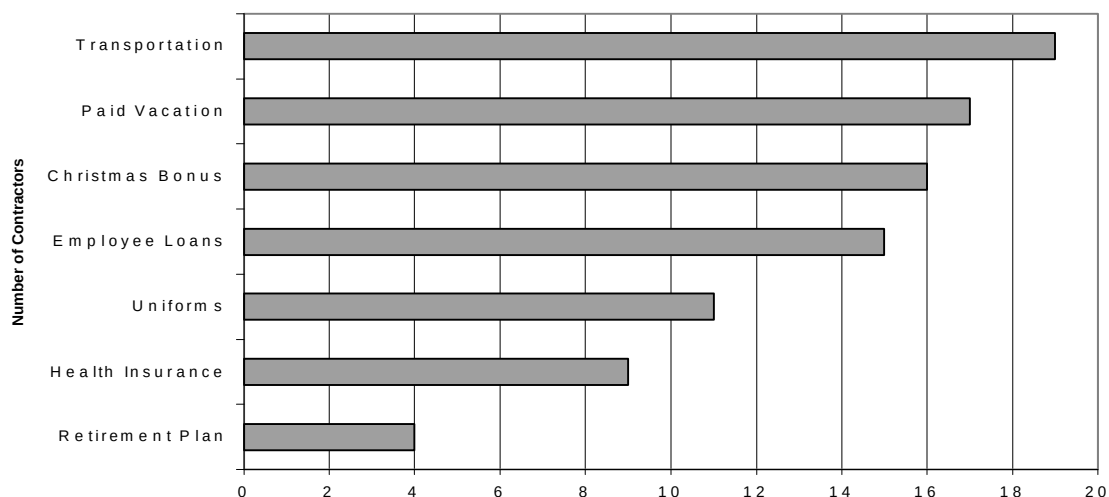


Figure 4. 16 Fringe Benefits Offered by the Contractors.

4.4.4 Family Involvement

Forty-one percent of the businesses had extended family involvement (Figure 4.17). Owners whose fathers or grandfathers had started the business and those with a large number of family members (fathers, brothers, sons, and in-laws) involved in the business were included. Smaller businesses (less than 60,000 mean annual tons in 1996 or 1997) tended to be family-run operations. Several contractors had family members working within the in-woods portion of the

business (Figure 4.18). Ten percent of the contractors had three family members working in-woods, 23% had two family members, 10% had one family member, and 57% had none.

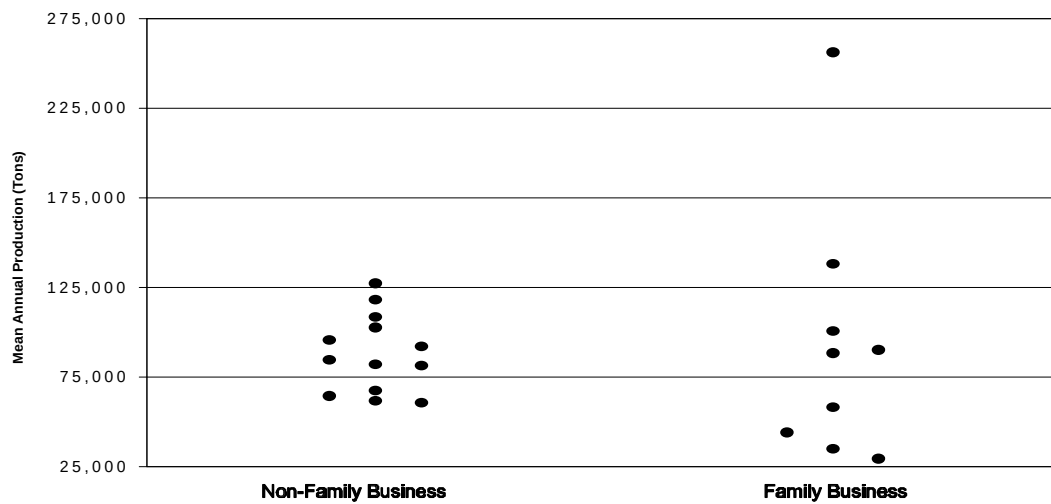


Figure 4. 17 Family and Non-Family Business vs. Production.

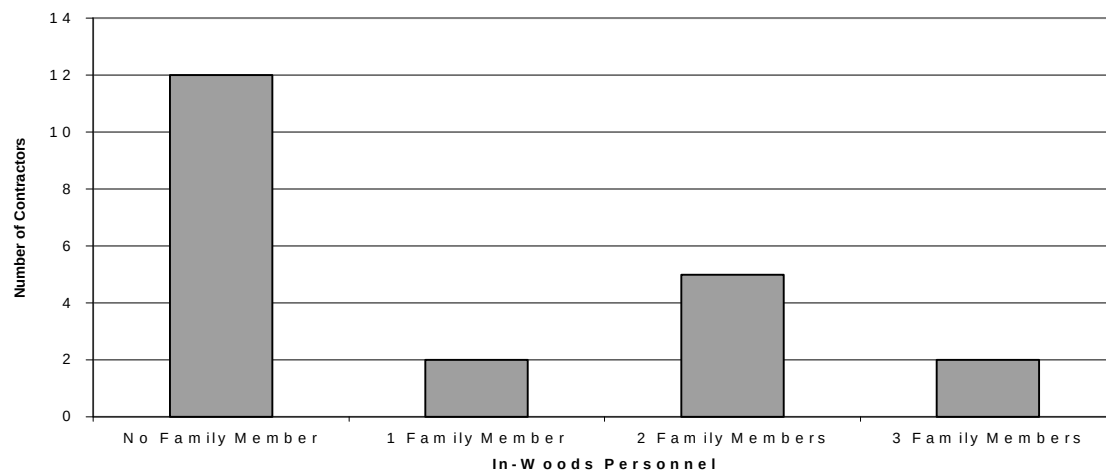


Figure 4. 18 In-Woods Family Members.

4.5 *Equipment and Processes*

4.5.1 Felling

All contractors used mechanical felling backed up by chainsaw felling in special situations. A total of 36 feller-bunchers were used for 28 crews, with 1 to 4 per crew. The majority (61%) of this equipment was sawheads. Thirty-two of the feller-bunchers were rubber-tired machines, while four were tracked-machines (all were sawheads). The model year for feller-bunchers ranged from 1987 to 1998, with a median year of 1996 (Figure 4.19). The inter-quartile range for model years was between 1995 and 1996. Of the 36 feller-bunchers, only 9 (25%) were 1997 or newer.

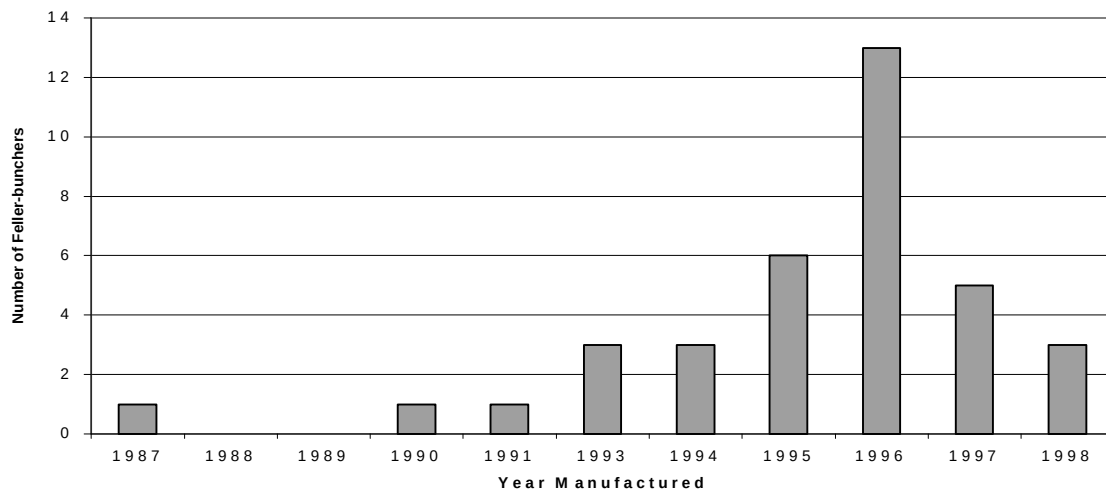


Figure 4. 19 Age Distribution of Feller-Bunchers.

4.5.2 Skidding

Grapple skidders were the sole type of skidding equipment. A total of 64 skidders were used, with 1 to 4 per crew. Contractors working during wet ground conditions often employed dual or wider tires for reduced ground disturbance. Skidder year models ranged from 1990 to 1998 (Figure 4.20). The inter-quartile range for year models was between 1994 and 1997, with a median year of 1995. Only 12 (19%) skidders were 1997 models or newer.

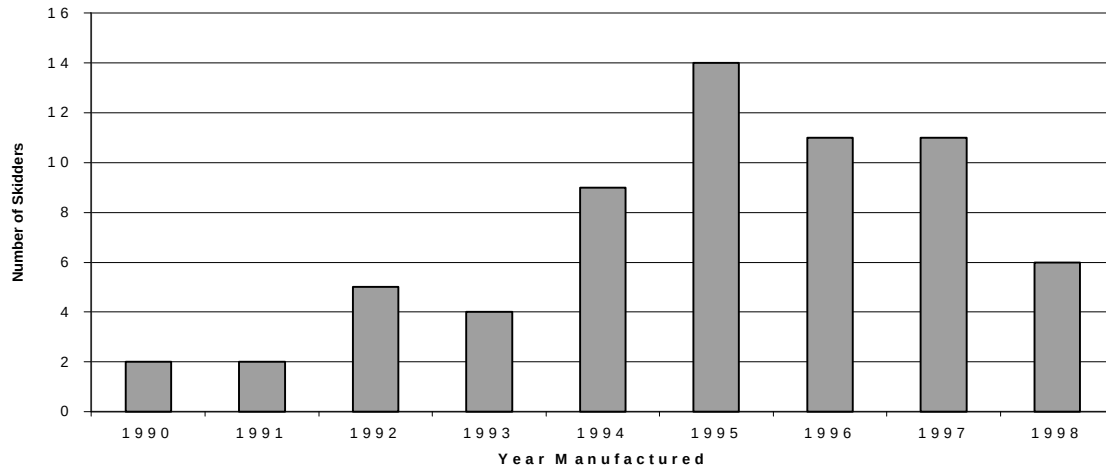


Figure 4. 20 Age Distribution of Skidders.

4.5.3 Loading

All loaders were knuckleboom; 97% were mounted on a trailer and 3% were track-based. Reasons for the use of tracked loaders included increased mobility around deck areas and decreased deck sizes. A total of 35 loaders were used for all crews, with 1 to 3 per crew. Year models ranged from 1990 to 1998, with a median of 1995 (Figure 4.21). The inter-quartile range was between 1994 and 1996, with 8 (23%) loaders 1997 or newer.

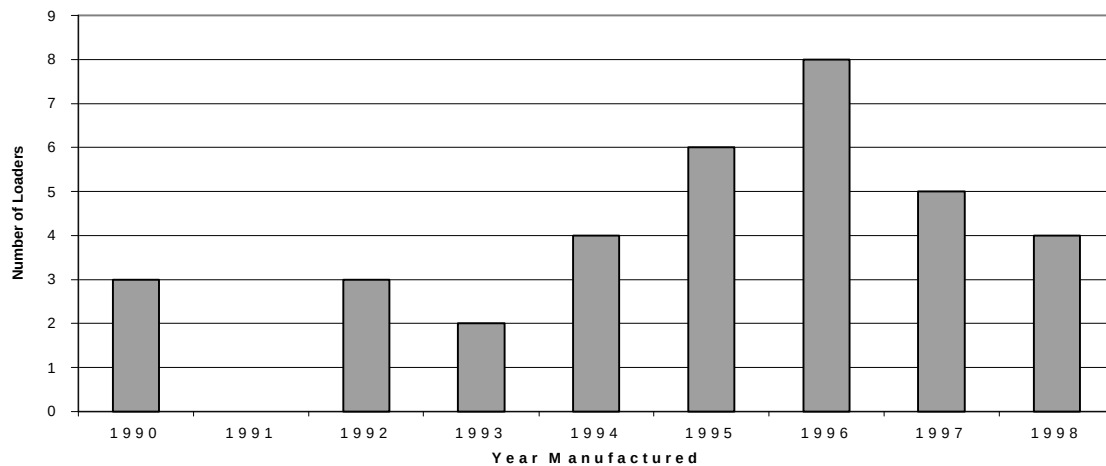


Figure 4. 21 Age Distribution of Loaders.

4.5.4 Other Equipment

Fifty-five percent of the contractors owned a bulldozer; 28% of the crews had one on site. Multiple-crew operations usually had only one dozer, moving it among crews as needed. Dozer year models ranged from 1964 to 1997 (Figure 4.22), with a median of 1991. The inter-quartile range was between 1985 and 1996, with 3 (19%) dozers 1997 or newer.

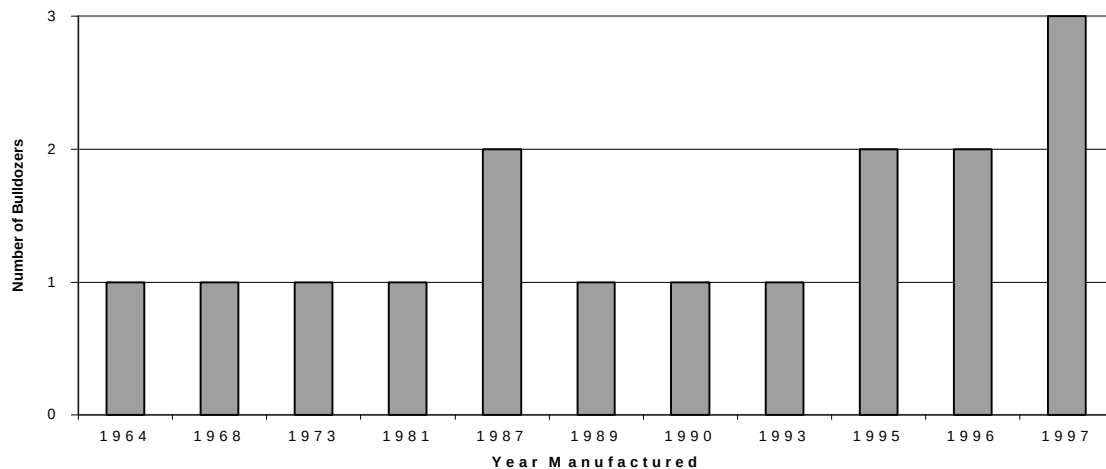


Figure 4. 22 Age Distribution of Bulldozers.

All contractors owned at least one service truck equipped to carry personnel or repair equipment. Two contractors owned graders for increased road maintenance.

Gate delimiters were found predominantly in coastal plain regions, although several were used in piedmont regions. Contractors employing at least one gate delimiter comprised 54% of the study population. Pull-through delimiters were used by 61% of the contractors, especially ones regularly working in stands with larger hardwood pulp mixtures. Relying solely on manual chainsaw delimbing was not as common but was often used in combination with other delimbing strategies. Slasher saws connected to loaders were used by 54% of the contractors for bucking long pulpwood and sawlogs. Some contractors also used bucking saws, the use dependent on timber types and market conditions.

4.6 *Processes Employed*

Equipment types and processes were similar across all operations, differing primarily by the delimbing and bucking method used. Felling, skidding, delimbing, bucking, sorting, loading, and trucking was the common flow.

Several contractors employed a shovel logging technique in swampy, coastal plain areas. Shovels are excavator-type machines with a grapple mounted on the end of the boom. Shovel logging, if employed correctly, can reduce site disturbance in extremely wet conditions and increase workable days per year. Variants of shoveling techniques were present, all of which filled a unique niche in the wood supply system. Primary attributes of shovel logging included increased workable days and reduced site impact; secondary attributes included steady paychecks for crew members, reduced crew turnover, quicker site regeneration, less inventory for mills during wet periods, and a constant and reliable fiber source for mills. Several key factors must be present to justify shovel systems. These include the ability of the contractor to make a large financial investment and increased mill support to sustain that investment. Others include proven shoveling techniques, no quotas, steady wood supply, consistent “good” quality timber, and roads capable of supporting wet-weather hauling.

Chapter 5 PRODUCTION ANALYSIS

This chapter provides an analysis of production information (as described in section 3.3) on an annual, quarterly, and weekly basis. Contractors were categorized by four production quartiles, adapted from Stuart and Grace (1999). These quartiles represent the tonnage produced and also reflect the contractors' business types and structuring.

5.1 *Production Quartiles*

Contractors producing less than 50,000 tons per year were included in the first quartile. Smaller family business and thinning operations adapted to privately owned tracts were also included. Owners were frequently working members of the crew as well as being responsible for supervision, repairs and maintenance, and acquiring stumpage. Trucking was normally done in-house. Family members usually performed bookkeeping and administrative tasks. These operations were all from the piedmont region.

The second quartile includes contractors with annual production between 50,000 and 75,000 tons, harvesting a mix of privately owned and industry timber. Again, these were often family-run businesses. Most of these businesses were cut-and-haul only, working primarily on dealer-acquired stumpage. The owner worked as a member of the crew when needed but spent more time supervising and performing repairs and maintenance. Owners and family members performed office tasks, but normally on a part-time basis. Most second quartile loggers also worked in the piedmont regions.

The third quartile contractors include those with annual production between 75,000 and 100,000 tons. Most of these were strictly cut-and-haul contractors. Some worked primarily on dealer-acquired stumpage; however, the majority relied on mill procurement for their stumpage. These harvesting operations were mainly large, single-crew systems, although some contractors ran an additional specialty crew. Management and supervision accounted for the owner's primary responsibility, but the owner would perform any crew function if necessary. Trucking was

included in the logging business for most of these operations, which were distributed evenly between the piedmont and coastal regions.

The fourth quartile included contractors with annual production in excess of 100,000 tons. This group included highly productive single-crew and multiple-crew businesses found mainly in coastal plain regions. Stumpage purchased by mills was the main source of wood for these loggers, with a few working through dealers. Fourth-quartile businesses often employed full-time office personnel and mechanics. Separate, contractor-owned trucking businesses performed a large portion of the transportation services.

The distribution of loggers by production quartile by year is shown in Table 5.1. First quartile contractors are slightly under-represented. The distribution across the other three quartiles is reasonably balanced.

Table 5. 1 Percentage of Contractors in each Production Quartile.

Year	Production Quartile				Number of Contractors
	1st <50,000 tons	2nd 50,000 to 75,000 tons	3rd 75,000 to 100,000 tons	4th >100,000 tons	
1996	13.6%	27.3%	31.8%	27.3%	22
1997	13.0%	21.7%	30.4%	34.8%	23
Mean	13.3%	24.5%	31.1%	31.1%	

5.2 *Annual Production*

Figure 5.1 shows the annual production for 1996 and 1997 for 23 contractors. The annual production of the 22 contractors included in the 1996 data set ranged from 26,995 tons to 235,970 tons. The inter-quartile range spanned from 57,591 tons to 99,563 tons, with a median of 83,101. Annual production in 1997 ranged from 31,291 tons to 276,055 tons for the 23 contractors in this data set. The inter-quartile range was between 66,223 tons to 108,988 tons, with a median of 86,957.

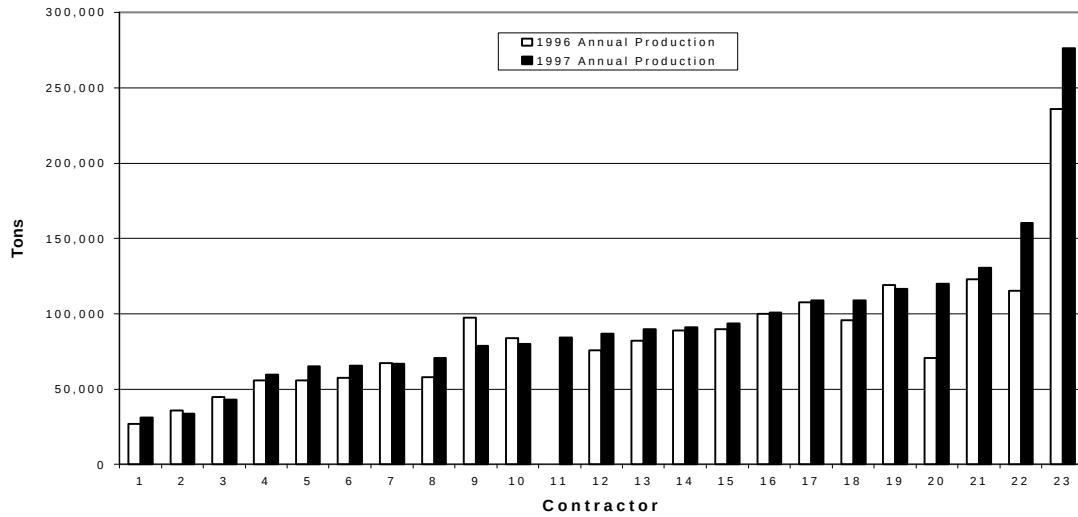


Figure 5. 1 Annual Production for Participating Contractors.

Total production for 22 1996 contractors was 1,888,278 tons, while 23 contractors produced 2,163,272 tons in 1997. Figure 5.2 shows the percentage of total production for each production quartile over the study period. The third and fourth quartile generated between 75% and 80% of the total production by all contractors.

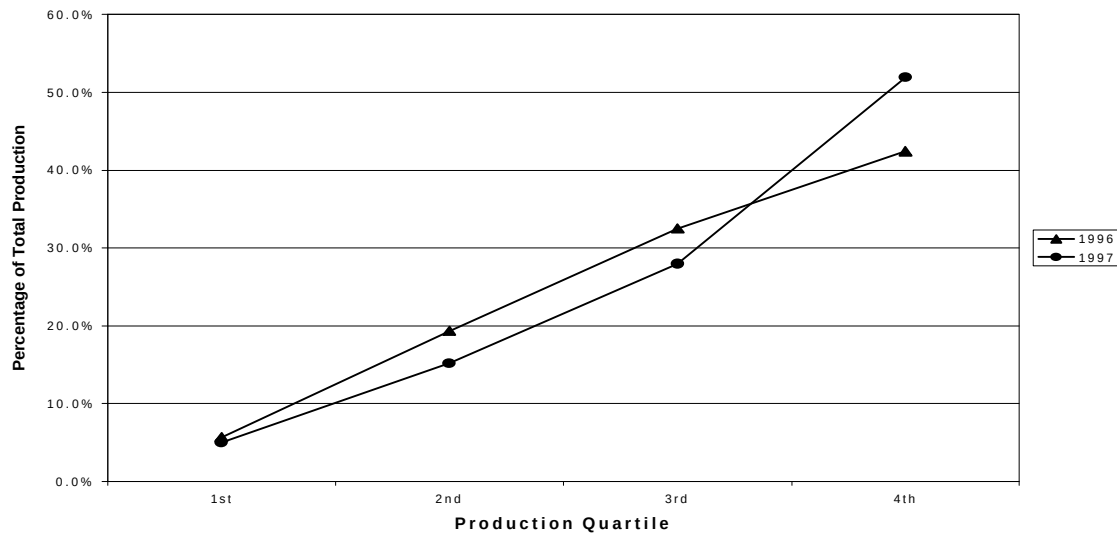


Figure 5. 2 Percentage of Total Production by Quartile for all Contractors.

5.3 Quarterly Production

Quarterly production information was analyzed for 16 contractors where complete data were available for at least one year. Thirteen contractors provided quarterly production for both 1996 and 1997 and were grouped by production quartile and state. The production quartiles reflect some important organizational, business, and location characteristics of the loggers and will be used to partition the data set for the quarterly analyses.

5.3.1 First Quartile Contractors

Only two first quartile loggers could provide quarterly production information, one provided both years (Figure 5.3). The Virginia contractor had constant production during the first two calendar quarters of both years, dropped in the third, and then rose again in the fourth. Production for the South Carolina logger was high in the first quarter, declined through the second and third, then rose considerably in the fourth.

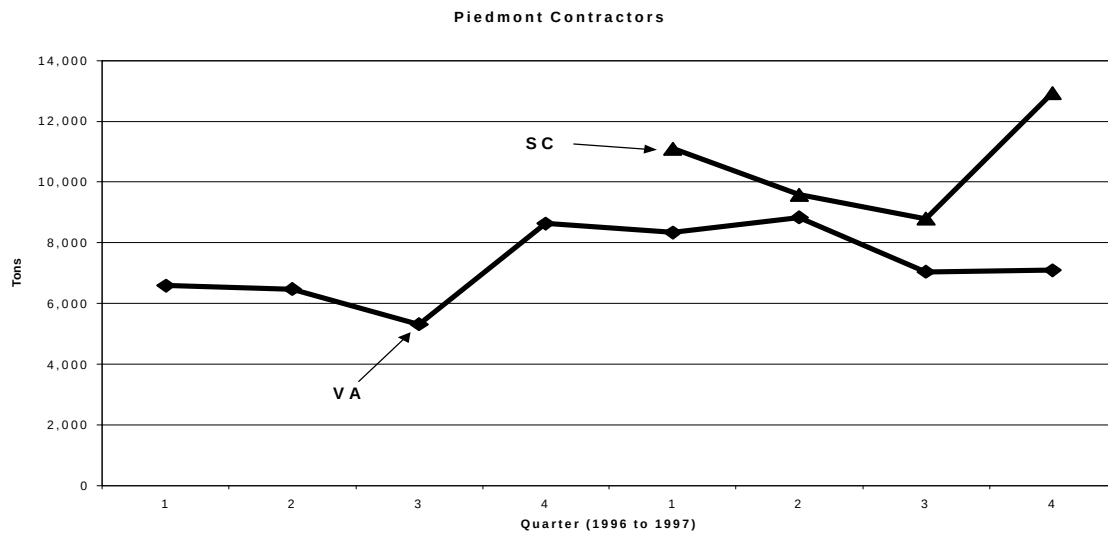


Figure 5. 3 First Quartile Total Production by Quarter.

5.3.2 Second Quartile Contractors

Complete quarterly information across both years was available for two contractors; either 1996 or 1997 production information was available for another two contractors (Figure 5.4). The Florida and Alabama (2) contractors produced at stable levels; the Georgia contractor dropped in the first and fourth quarters (1997), while remaining consistent in the second and third quarters (1997). The Alabama (1) contractor was stable through six quarters, then production proportionally increased in the last two quarters of 1997.

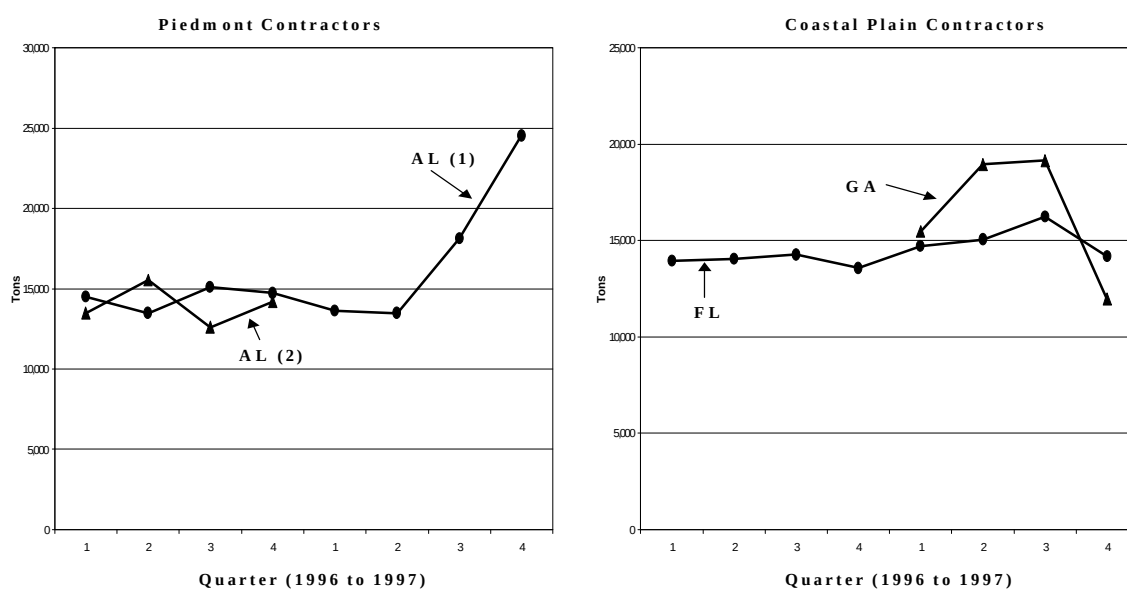


Figure 5. 4 Second Quartile Total Production by Quarter.

5.3.3 Third Quartile Contractors

Complete quarterly data is shown in Figure 5.5 for five third quartile loggers. The South Carolina contractor experienced five quarters with proportionally higher production than the other three. Production for the coastal plain loggers mirrored one another except for the second quarter 1996 and the second and third quarters 1997.

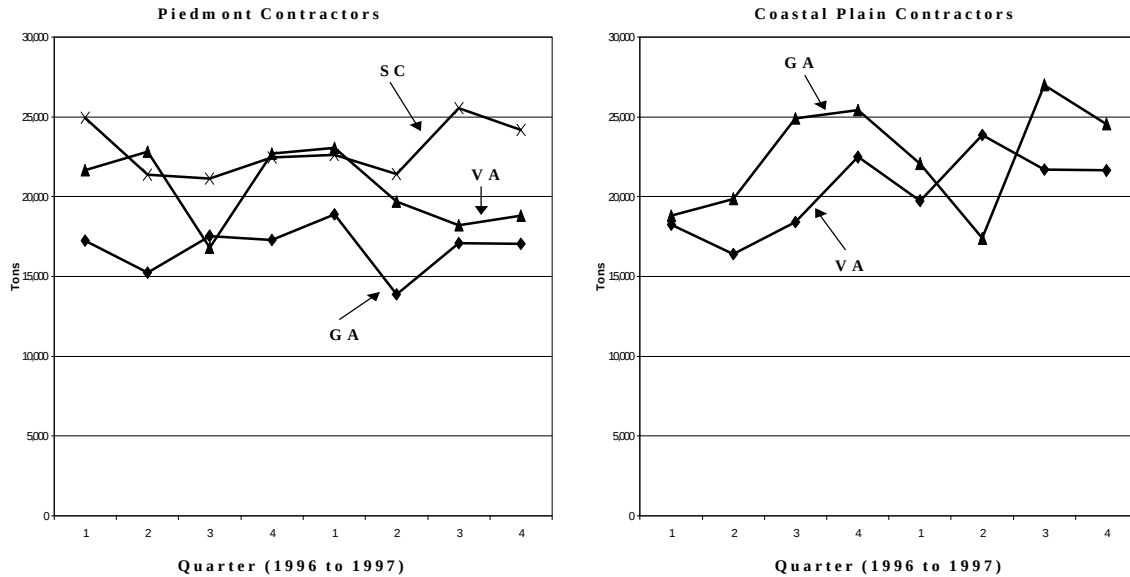


Figure 5. 5 Third Quartile Total Production by Quarter.

5.3.4 Fourth Quartile Contractors

High production-capacity loggers are represented in Figure 5.6. The Florida contractor experienced five straight quarters with increasing production. The Virginia (excluding first quarter 1996) and South Carolina (2) contractors had fairly stable quarter-to-quarter production. Two quarters with proportionally high production and one with proportionally low production characterize the Georgia contractor; other quarters were less variable. The South Carolina (1) contractor had drastically low production in the first quarter of 1996 as compared to other quarters.

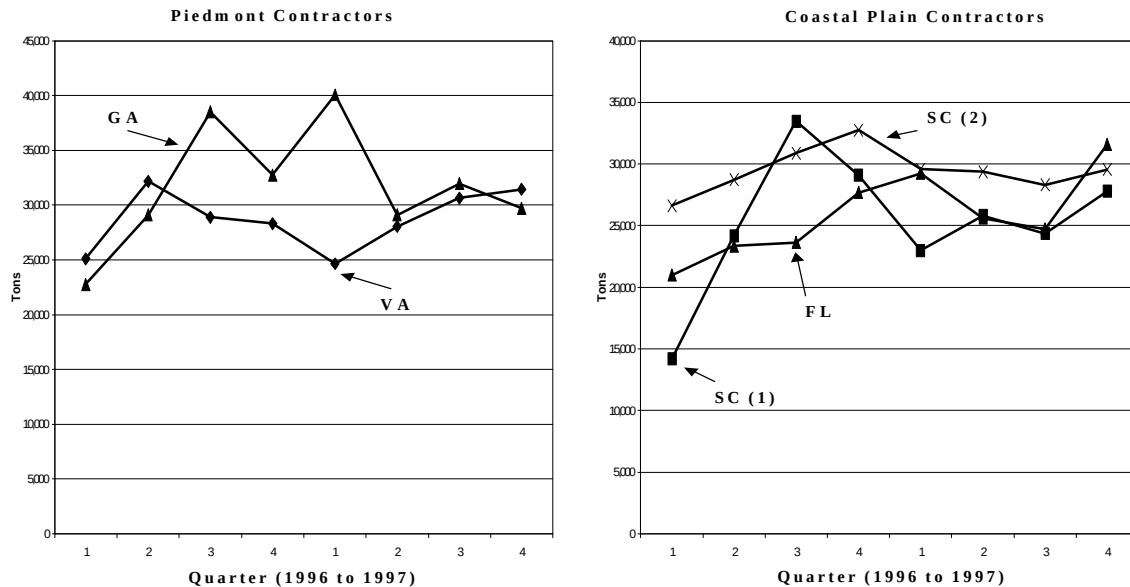


Figure 5.6 Fourth Quartile Total Production by Quarter.

5.4 Weekly Production

Complete weekly production (1996 to 1997) was collected for 13 contractors; partial data (either 1996 or 1997) were collected for an additional three contractors. Production for the 13 contractors ranged from 0 to 6,370 tons per week, with a median of 1,617. The inter-quartile range was between 1,168 and 2,115 tons (47 to 85 loads).

Run charts offer an easy way to assess the week-to-week variation associated with logging. Forces that influence production variability include technical, organizational, natural, administrative, and regulatory factors (Stuart et al. 1998). Variation is a part of the business, but planning and management must moderate the extent and effect of the fluctuation. Figure 5.7 illustrates weekly variation for contractor 002, the most consistent of the businesses in terms of weekly production variation included in the study. The inter-quartile range was roughly 100 tons, or four truckloads. Even with this degree of consistency, the effects of weather, holidays, and wood orders caused high and low swings.

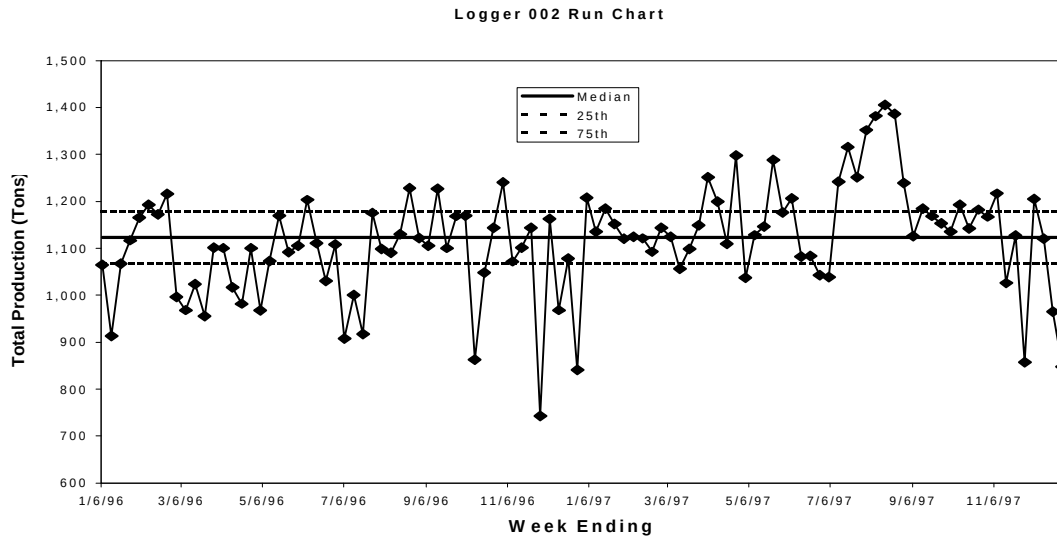


Figure 5. 7 Run Chart (Contractor 002).

The contractor with the largest inter-quartile range was 806 at roughly 900 tons (Figure 5.8). Again, a similar pattern emerged with several periods either at a high or low for extended weeks. Some of the downward swings were associated with holidays (Christmas, Thanksgiving, and July 4th), while high production was associated with inventory building or making up after a holiday.

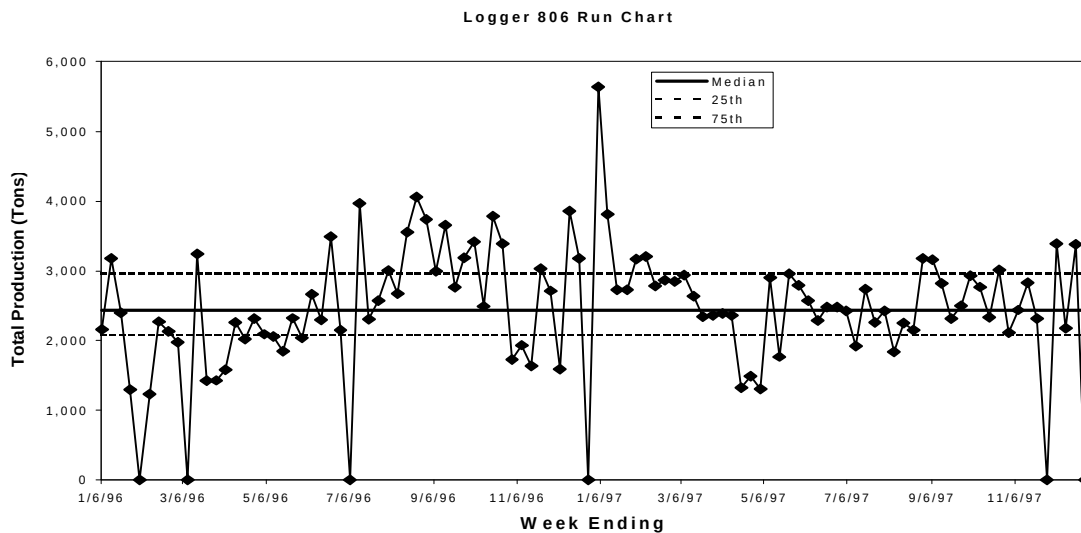


Figure 5. 8 Run-Chart (Contractor 806).

5.5 Productivity Trends

5.5.1 Yearly Productivity Trends

Yearly production ranged from 26,995 tons to 276,055 tons across contractors and years. The inter-quartile range was between 64,926 tons and 107,704 tons, with a median of 84,356. Yearly production levels increased from 1996 to 1997 (Figure 5.9). Both the 25th and 75th percentiles rose more quickly than the median, indicating wider fluctuations in production for some contractors. Although most contractors increased production from 1996 to 1997, 27% of the study population had reduced yearly production.

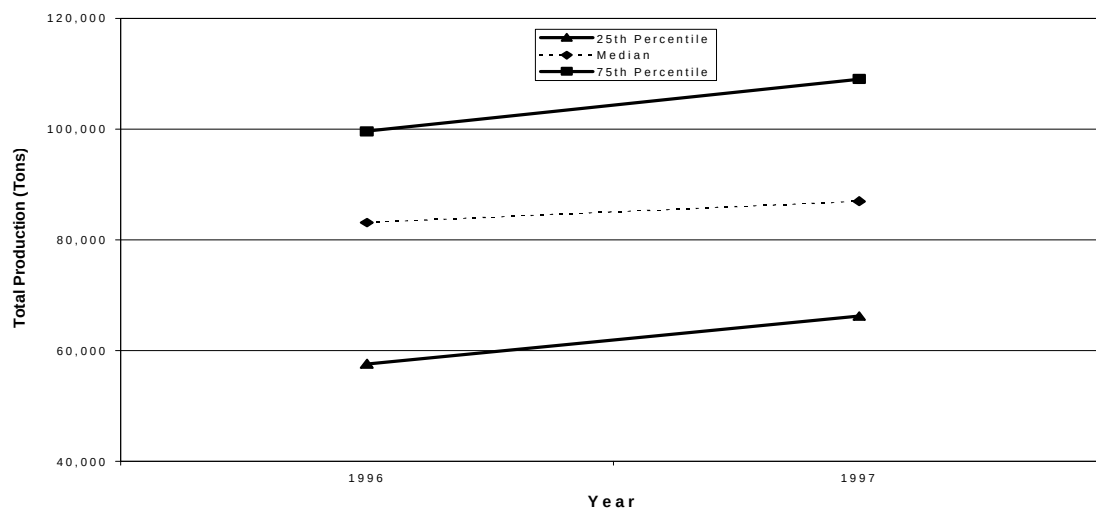


Figure 5.9 Median, 25th, and 75th Percentile Production Levels by Year.

5.5.2 Quarterly Productivity Trends

Quarterly production ranged from 5,308 to 40,058 tons, with an inter-quartile range between 14,971 to 25,665 tons, and a median of 21,401. Production increases for the population occurred in the second and fourth quarters of 1996 and the third and fourth quarters of 1997 (Figure 5.10). Interestingly, the level of the 25th percentile remained relatively constant, with a sharp increase only in the third quarter of 1997. The upper bound of the inter-quartile range (the 75th

percentile) was more volatile, rising when the median fell in the third quarter of 1996 and falling faster than the median during the fourth quarter of that year. The 75th percentile rose as the median fell in the first quarter of 1997 and then moved with the median for the rest of 1997. The changes in widths of the percentiles are indications that some force or combination of forces was introducing variability for some contractors.

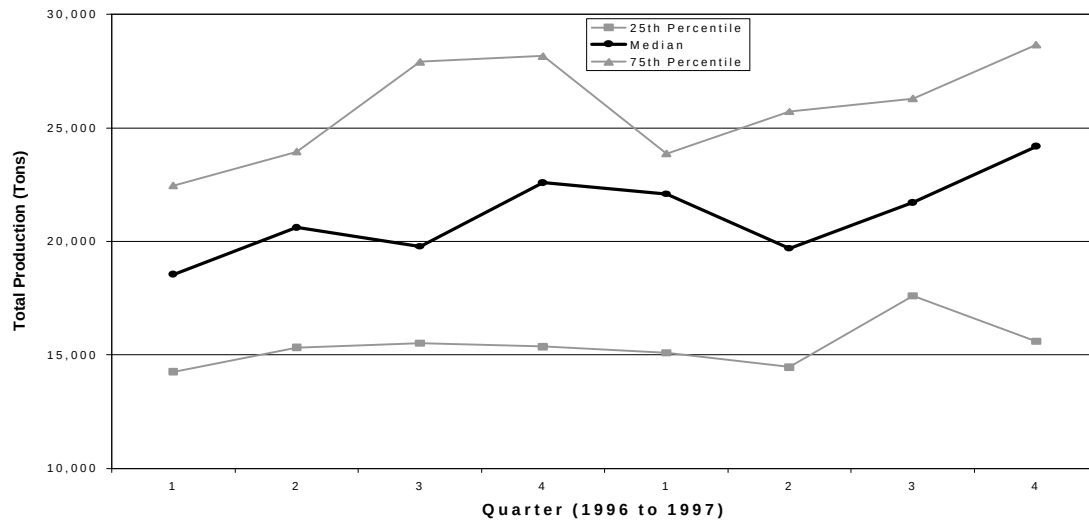


Figure 5. 10 Median, 25th, and 75th Percentile Production Levels by Quarter.

5.6 Analysis of Variability Forces

Attempting to identify and quantify all the various forces that could serve as predictors of production variation is beyond the scope of this thesis, but may become feasible as the data set is strengthened and expanded. Infinite factors contribute to production variation in the logging business. The nature of the data set allowed two key areas for variation analysis: non-weather and weather factors.

5.6.1 Non-Weather Factors (A)

5.6.1.A Analysis of Virginia Contractors

Figure 5.11 shows run charts for two Virginia loggers that contract with different mills but work within 50 miles of each other. If natural forces were a major determinant of production variation, their production histories should be similar. The effects of holidays (July 4th, Labor Day, Thanksgiving, and Christmas) can be seen; however, no common pattern was apparent for the two-year period. Both contractors experienced a significant drop in production the second week of January 1996, possibly weather-induced. The first week in March 1996 shows a large increase in production for contractor (1) and a large decrease for the other. Contractor (1) experienced a major increase in the last week of April 1997 and the other increased production slightly. August through October (1996 and 1997) indicate weeks of controlled wood orders (represented by the blocked regions in Figure 5.11). Production increases were often for multiple weeks but were more of a recovery response; production was at lower levels for extended weeks as compared to others periods.

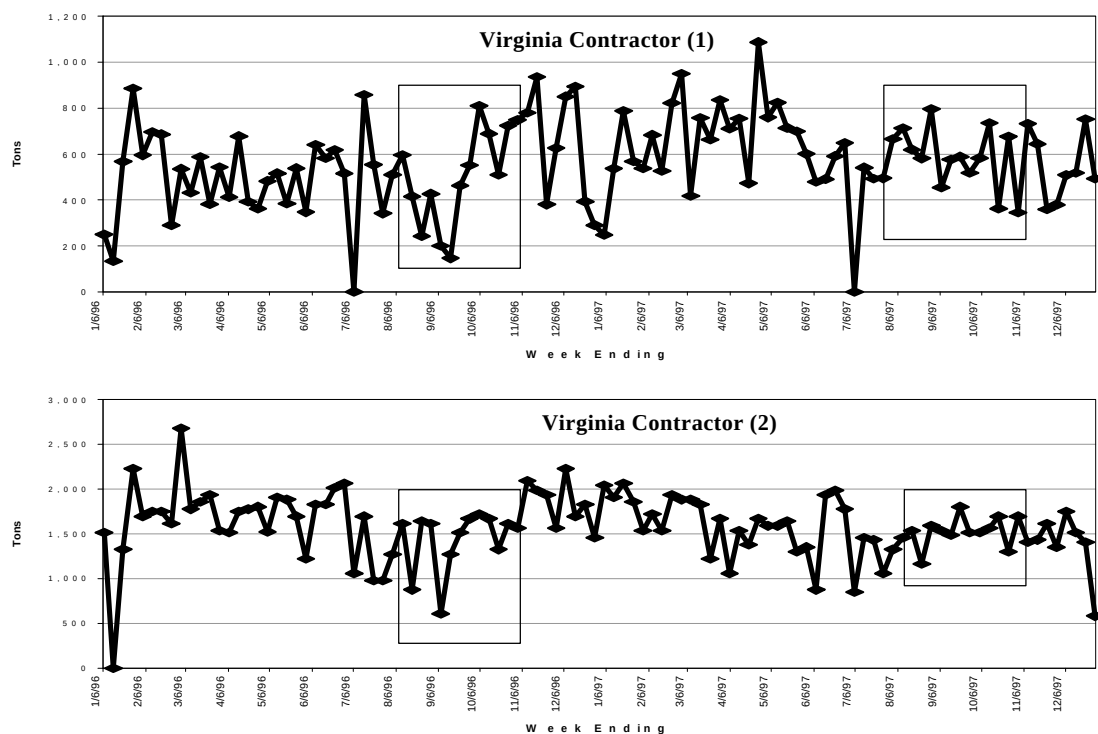


Figure 5. 11 Run Charts for Virginia Contractors (Total Production).

Table 5.2 shows the 13 high and 13 low production weeks for each contractor by year. The lowest and highest weeks indicate production levels that were outside the inter-quartile range (the range of production met 50% of the time). The blocked regions in Table 5.2 show runs of either high or low production for continuous weeks; four consecutive weeks were included as a run even if one interior week was missing (e.g. weeks 4, 6, 7).

Table 5. 2 Virginia Contractors: High and Low Production Weeks.

Low Contractor Weeks				High Contractor Weeks			
VA (1) 1996	VA (2) 1996	VA (1) 1997	VA (2) 1997	VA (1) 1996	VA (2) 1996	VA (1) 1997	VA (2) 1997
Week	Week	Week	Week	Week	Week	Week	Week
<u>1</u>	<u>1</u>	<u>1</u>	12	4	4	3	<u>1</u>
2	2	10	14	6	9	8	2
8	3	16	16	7	11	9	3
12	22	23	21	15	12	11	4
17	<u>27</u>	24	22	28	19	13	8
22	29	<u>27</u>	23	40	20	15	9
<u>27</u>	30	29	<u>27</u>	41	25	17	10
30	31	36	30	43	26	18	11
34	33	42	31	44	45	19	24
36	36	44	34	45	46	35	25
37	37	47	43	46	47	41	26
47	42	<u>48</u>	<u>48</u>	49	49	45	38
<u>52</u>	<u>52</u>	<u>52</u>	<u>52</u>	50	51	51	49

Note:

Week numbers in Bold represent common high or low weeks for each contractor for that corresponding year.

Week numbers Underlined represent holiday weeks (July 4th, Thanksgiving, Christmas, and New Year's).

Several weeks were commonly high or low for both contractors, though some of these were holiday weeks. Both contractors had low common runs in 1996: weeks 1 through 2 and weeks 36 through 37. In 1997, the contractors had low runs for weeks 23 through 24 (Contractor 1) and weeks 21 through 23 (Contractor 2). High runs were common for both contractors: weeks 40 through 46 for Contractor 1 and weeks 45 through 49 Contractor 2 (1996). In 1997, runs shared by the contractors were also found.

5.6.1.B Analysis of Florida and Georgia Contractors

Run charts are shown in Figure 5.12 for a Florida and a Georgia logger contracting for a different organization, again working in close proximity to one another. Rainfall data obtained from the National Oceanic and Atmospheric Administration (NOAA) weather station reports was also plotted. The contractors worked within 50 miles from where the rainfall data was taken. Production for the Georgia contractor dropped abruptly the second week of February 1996, while the Florida logger increased production slightly. Production increased proportionally the last week in August 1997 for the Georgia contractor, but dropped after a rather consistent four-week period for the Florida contractor. Region A in Figure 5.12 shows the effect of heavy rainfall with drops in production for both contractors. Region B shows little production variation for the Florida contractor and large variation for the Georgia contractor. Both contractors experienced weeks with proportionally higher production in region B.

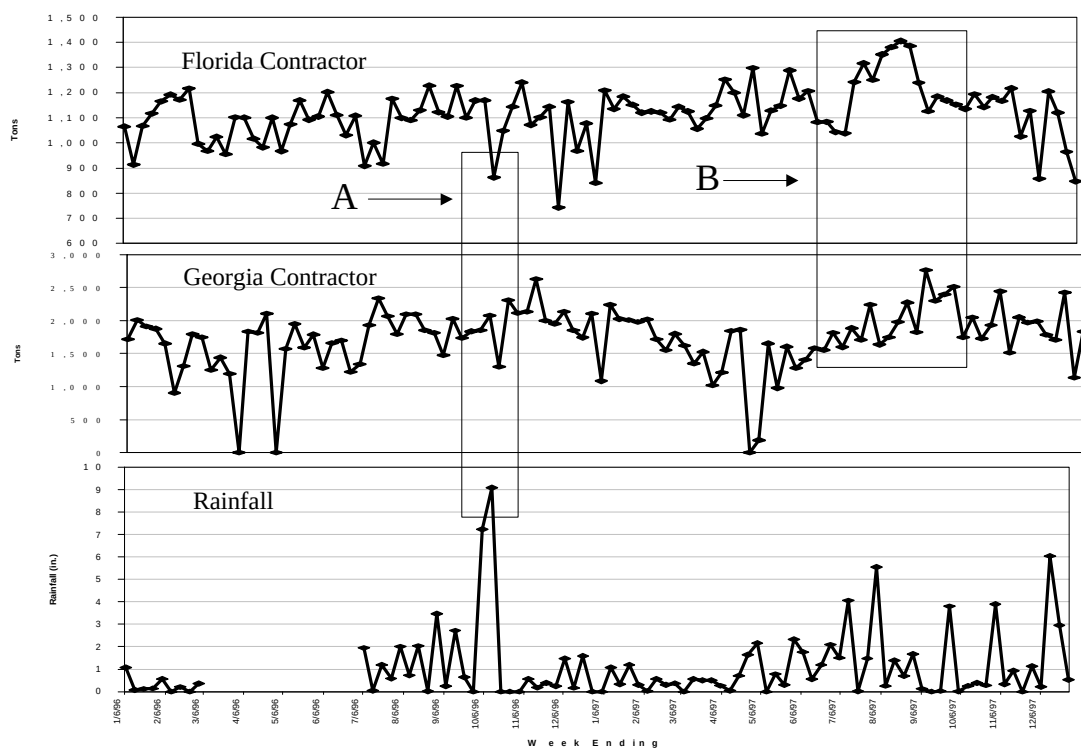


Figure 5. 12 Run Charts for Florida and Georgia Contractors (Total Production).

Table 5. 3 Florida and Georgia Contractors: High and Low Production Weeks.

Low Contractor Weeks				High Contractor Weeks			
Florida 1996	Georgia 1996	Florida 1997	Georgia 1997	Florida 1996	Georgia 1996	Florida 1997	Georgia 1997
Week 2	Week 6	Week 8	Week 7	Week 5	Week 16	Week <u>1</u>	Week <u>1</u>
9	7	11	10	6	28	14	2
10	10	12	11	7	29	17	5
12	11	16	12	8	31	21	29
16	12	18	13	20	32	28	33
18	13	24	16	23	36	29	35
<u>27</u>	17	25	17	30	40	30	36
28	22	26	19	34	42	31	37
29	25	<u>27</u>	21	37	43	32	38
41	26	46	22	39	44	33	40
<u>48</u>	35	<u>48</u>	24	40	45	34	43
50	41	51	44	44	<u>48</u>	35	45
52	52	<u>52</u>	51	49	51	45	50

Note:

Week numbers in Bold represent common high or low weeks for each contractor for that corresponding year.

Week numbers Underlined represent holiday weeks (July 4th, Thanksgiving, Christmas, and New Year's).

Several common weeks were either at a low or high for the contractors; holiday weeks accounted for some of these (Table 5.3). An interesting trend was found where the contractors experienced several high or low runs for the same period. The Florida contractor had low runs in 1996 for weeks 9 through 12; the Georgia contractor had low runs in weeks 10 through 13. In 1997 a similar pattern emerged: low runs for the Georgia contractor in weeks 11 through 12, and low runs for the Florida contractor in weeks 10 through 13.

High production runs were again similar for the contractors. In 1996, the Florida contractor had a high run in weeks 37 through 40; in weeks 40 through 45 the Georgia contractor experienced the same trend. The Florida contractor had an exceptionally long run in weeks 28 through 35 (1997), and the Georgia contractor had a high run in weeks 33 through 40 (1997).

5.6.1.C Analysis of Georgia and South Carolina Contractors

Figure 5.13 shows run charts for a Georgia logger and a South Carolina logger contracting with different organizations. Production patterns in June 1996 for both contractors mirrored one another: three weeks with increasing production followed by three decreasing weeks. The blocked area A shows a decreasing period in production for both contractors, possibly weather or quota related. Inventory building with increasing production for both contractors is shown in the blocked region B. Holiday effects with reduced production were apparent.

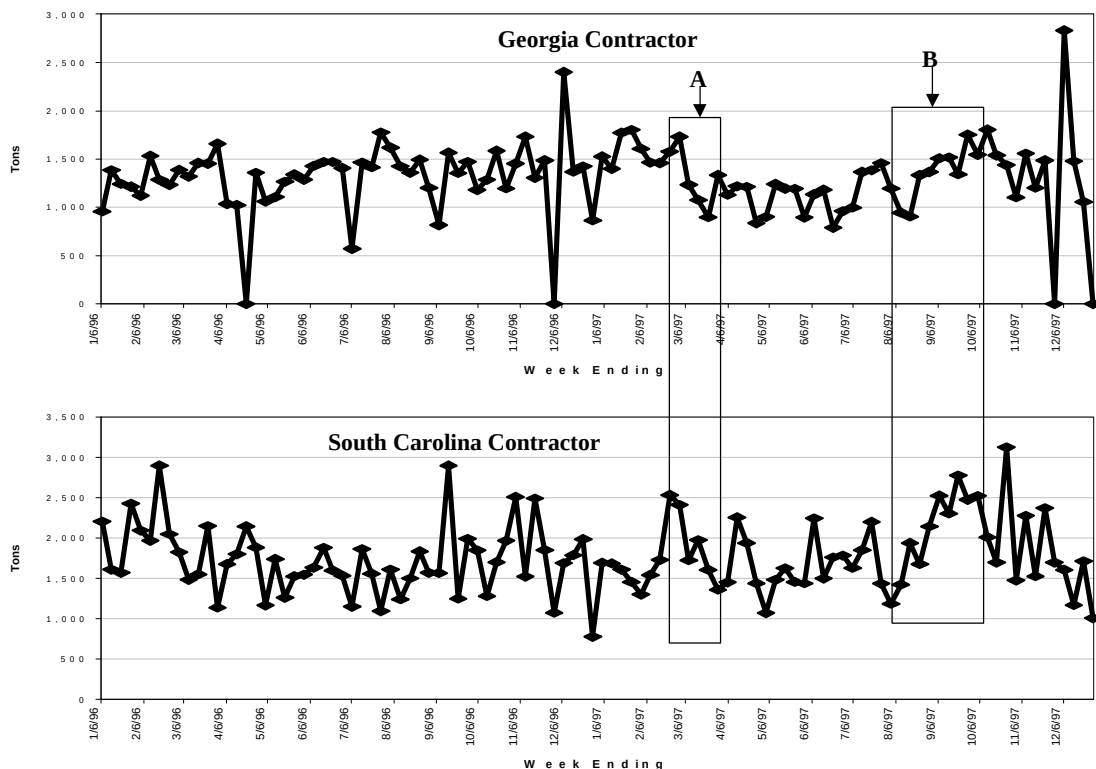


Figure 5. 13 Run Charts for Georgia and South Carolina Contractors (Total Production).

Table 5.4 shows the high and low production runs for the Georgia and South Carolina contractors. Again, common weeks at a low or high were found between the contractors. Low and high production runs were found in the same manner as described earlier.

Table 5. 4 Georgia and South Carolina Contractors: High and Low Production Weeks.

Low Contractor Weeks				High Contractor Weeks			
Georgia 1996	SC 1996	Georgia 1997	SC 1997	Georgia 1996	SC 1996	Georgia 1997	SC 1997
Week	Week	Week	Week	Week	Week	Week	Week
<u>1</u>	10	11	4	6	<u>1</u>	<u>1</u>	8
5	13	12	5	13	4	3	9
14	18	17	13	24	5	4	15
15	20	18	14	25	6	5	23
16	<u>27</u>	22	17	30	7	8	29
18	30	25	18	31	8	9	36
19	32	26	21	34	12	37	37
<u>27</u>	33	<u>27</u>	22	37	16	39	38
36	38	32	30	39	37	40	39
40	41	33	31	42	39	41	40
43	45	<u>48</u>	32	45	44	42	43
48	48	51	50	47	46	45	45
52	52	52	52	49	51	49	47

Note:

Week numbers in Bold represent common high or low weeks for each contractor for that corresponding year.

Week numbers Underlined represent holiday weeks (July 4th, Thanksgiving, Christmas, and New Year's).

5.6.1.D Summary

Weather patterns would not explain these trends. Adverse weather conditions come in spurts and are usually not persistent for periods of greater than four weeks. Exceptionally long high or low production runs and the same weeks shared by the contractors with high or low production give support to this claim: forces other than nature were the cause.

5.6.2 Non-Weather Factors (B)

Clusters of loggers within similar areas were used to ensure confidentiality for participating contractors. Often two or more contractors within these clusters contract with the same organization, whether with a wood dealer or wood consuming mill. Three clusters, each containing two contractors for which complete weekly 1996 to 1997 production data were obtained, were used.

In an effort to eliminate the effect of business sizes and structures, all weekly production was normalized to bring each individual business on an equal level where the average observation for all individual observations forms the base value. The normalized data are expressed as a percentage of the average through the following equation:

$$(\text{individual observation} - \text{average of all observations}) \div \text{average of all observations}$$

Cusum charts measure accumulated variation over time from a production goal. Average weekly production for the year was used as the goal, and cumulative variation is expressed as a percentage of that average. Beginning and ending time points are zero, a result of using the average value as the base. Weekly cusums were used to show where each contractor was behind or ahead of his average weekly production at any given time during that year.

A common assumption is one where loggers have high production levels in the summer or drier months and low production levels in the winter or wetter months. This did not seem to hold true for most of the participating contractors. Production tended to rise in the late third quarter then fell in the late first quarter of 1996 and 1997, respectively (Figures 5.14, 5.15, and 5.16). This pattern emerged for all three clusters of contractors. Strong factors (possibly other than weather-related) significantly either pulled the cusum lines up or forced them down.

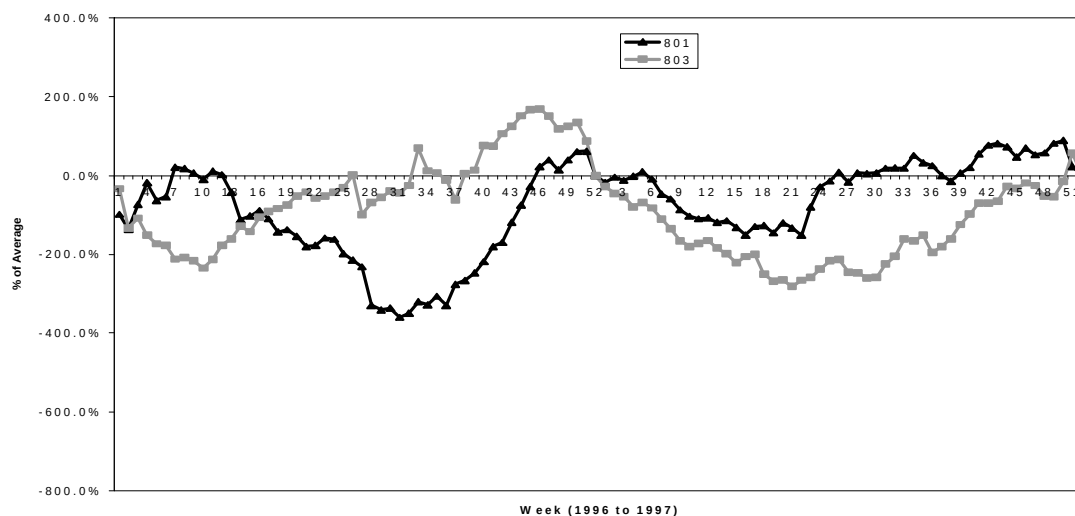


Figure 5. 14 Cusum for Contractors 801 and 803.

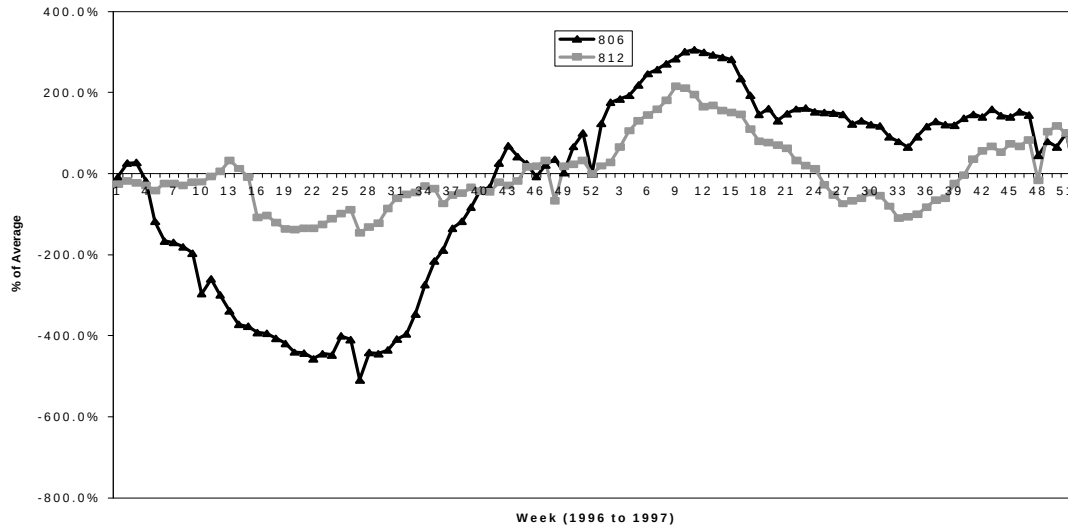


Figure 5. 15 Cusum for Contractors 806 and 812.

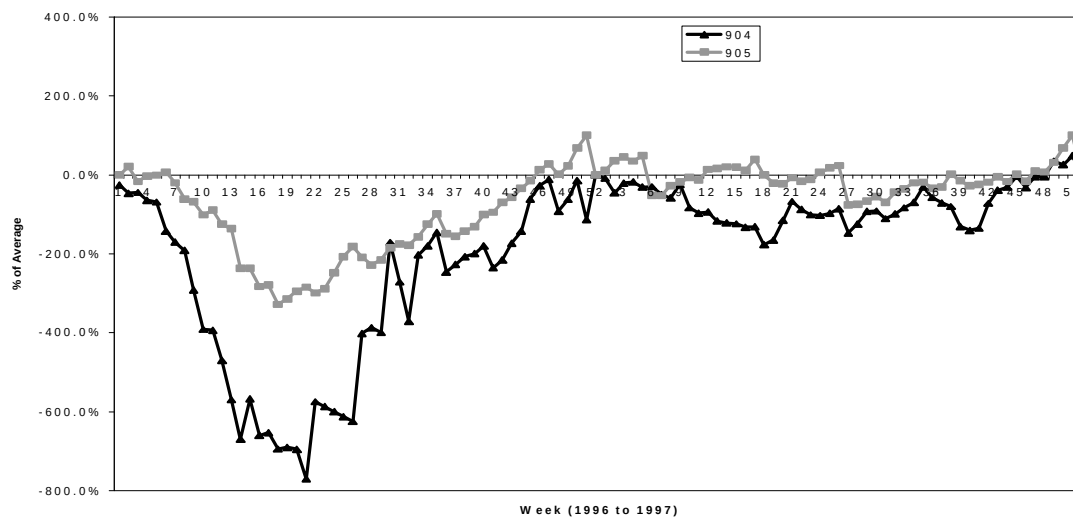


Figure 5. 16 Cusum for Contractors 904 and 905.

All contractors were behind their goal by mid-year (1996) with two behind the equivalent of four weeks production (400%) and 904 lagging by eight weeks. Only contractor 801 was on or near his goal by mid-year. Production rose during the third and fourth quarter of 1996 with five of the six contractors getting slightly ahead, then dropping back to zero once the holidays started.

The patterns for 1997 were similar, but the departures from the goal were less. Some contractors (801, 806, and 812) managed to stay ahead of their goal for major portions of the year. Periods that were remarkably good for one contractor (801), such as weeks 35 through 45 in 1996, may have led to the benefit to another similar contractor working in the same area (803). Possible inventory building by the mills in that area during the fall of 1996 led to an increased need for wood. Both contractors were in the top 25% of the wood-producing community, and given the opportunity to meet higher wood orders both contractors were able to capitalize on the opportunity and maintain higher production levels.

Variability forces do not seem to be the cause of the low summer and high winter production trends. Contractors delivering to different mills generated different responses at different times; however, loggers who contracted with the same organization experienced similar patterns. Significant production patterns indicate that administrative factors created wood flow surges during winter periods (steady increasing cusum above 0% line) and an oversupply during summer periods (steady decreases in the cusum).

5.6.3 Weather-based factors

Weekly precipitation was obtained for four major cities and was matched to weekly production for six contractors whose zip codes were within 50 miles of the major city. Complete 1996 to 1997 production and corresponding rainfall were obtained for three contractors, July 1996 to 1997 for two contractors, and one with 1997 data only. Both rain and production data were normalized to eliminate scale effects.

A common assumption is that as rain increases production decreases, and vice versa. This relationship is illustrated for four contractors, each in different areas (Figures 5.17, 5.18, 5.19, and 5.20). In several instances production decreased with heavy rainfall; however, no consistent pattern could be found. One would expect an inverse pattern with production falling dramatically during a week of heavy rainfall or the week immediately after a severe weather event; this did not occur in some instances such as week 24 in 1997 for contractor 905.

Production dropped slightly during an exceptionally heavy rainfall period (week 31, 1997), then increased the following week for the same contractor.

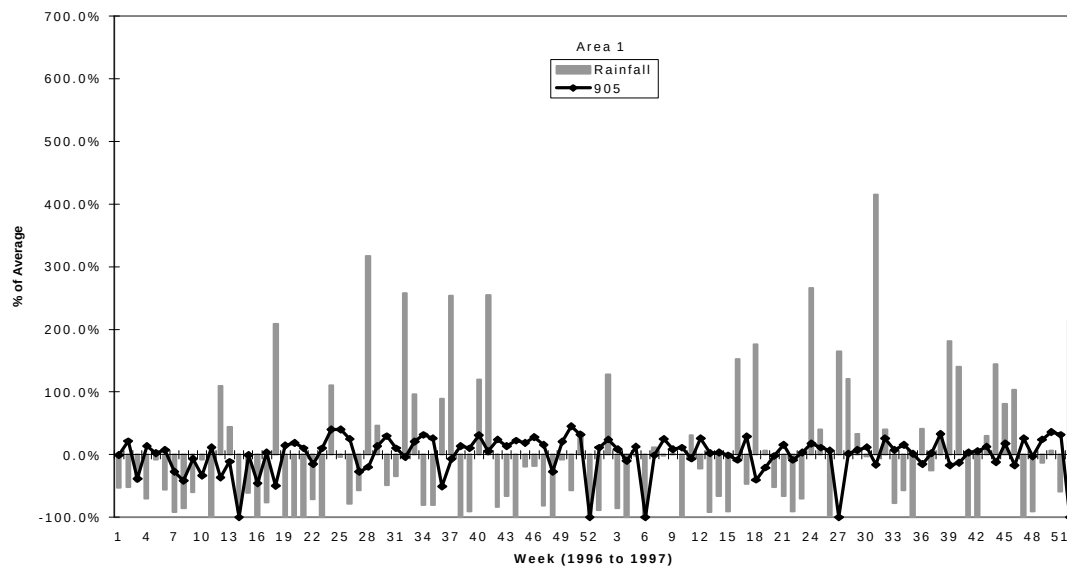


Figure 5. 17 Area 1: Rainfall vs. Production.

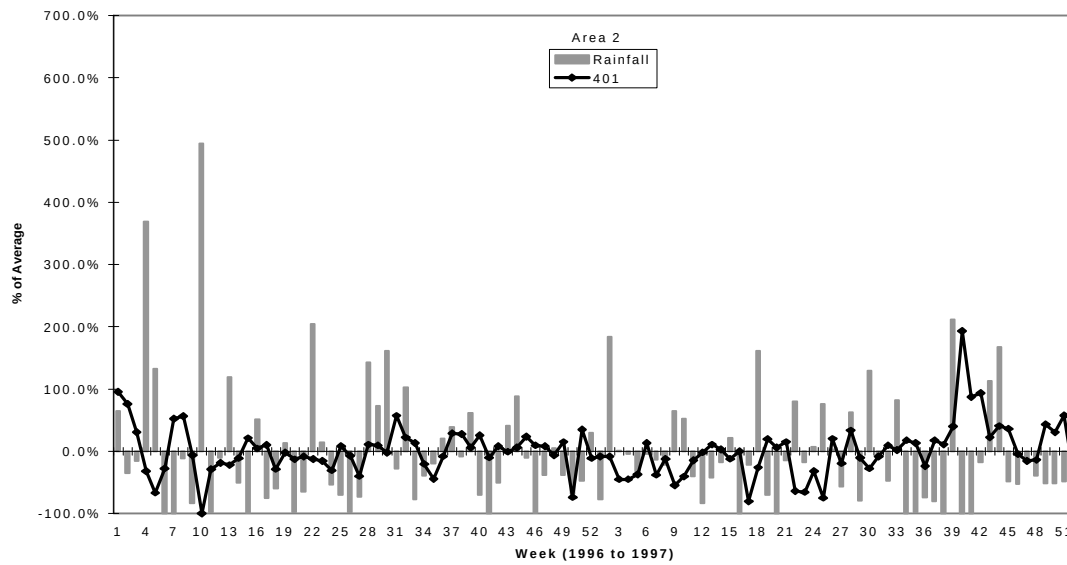


Figure 5. 18 Area 2: Rainfall vs. Production.

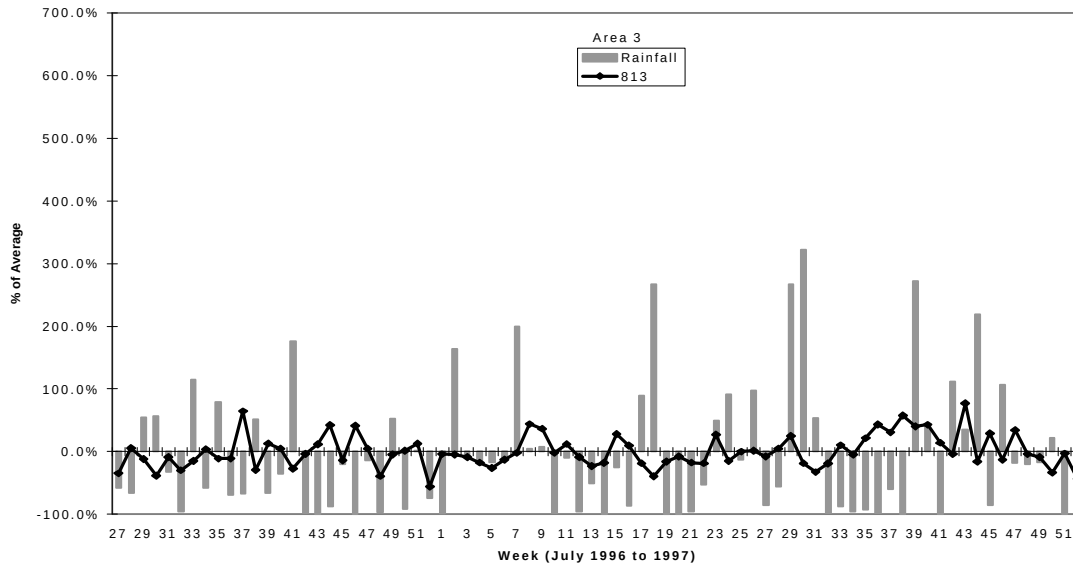


Figure 5. 19 Area 3: Rainfall vs. Production.

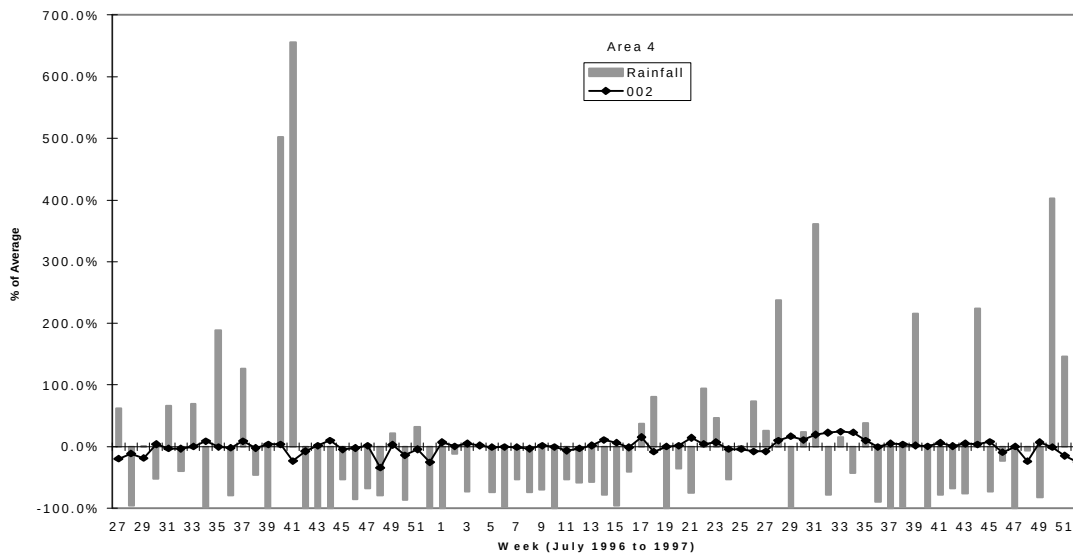


Figure 5. 20 Area 4: Rainfall vs. Production.

The data set was split further into two time periods to further test the relationship between rainfall and production. December through March was deemed as the non-quota period and June through September as the quota period. To eliminate holiday bias, three weeks for the Christmas and New Year's holidays, one week for July 4th, and one week for Labor Day were eliminated from the analysis. Contractors often shut down the operation for one or more of these holidays.

A simple linear regression was performed with paired rainfall and normalized production data. A total of 130 observations was available for the quota period and 161 observations for the non-quota period (Figures 5.21 and 5.22).

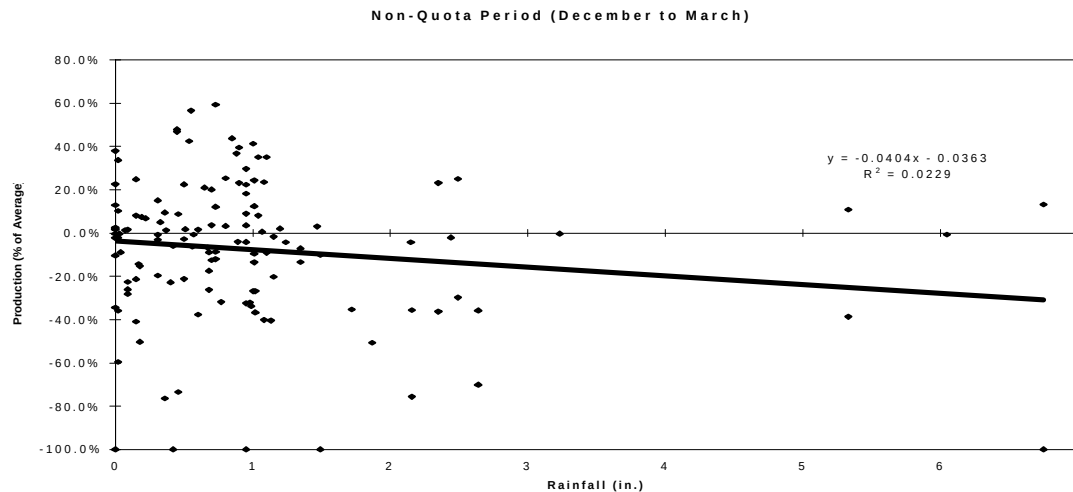


Figure 5. 21 Regression of Production Against Rainfall (Non-Quota Period).

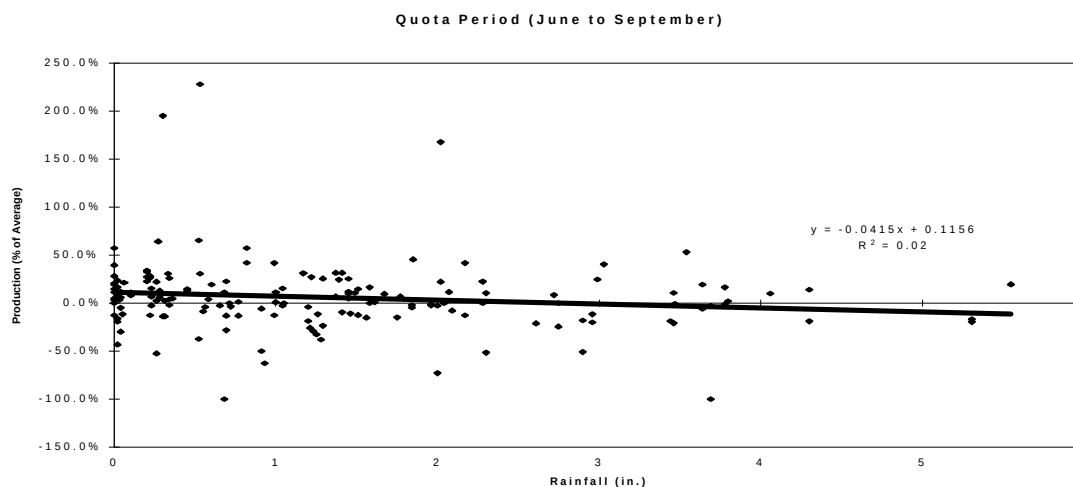


Figure 5. 22 Regression of Production Against Rainfall (Quota Period).

Results indicate that in both time periods production could not be predicted from rainfall with any degree of surety with 95% confidence (Table 5.2). The regressions are not significant and indicate a slope coefficient of zero. With this still in mind, only 2% to 2.3% of the variation in production can be explained by rainfall (Table 5.2). The correlation between rainfall and

production is negative, between -0.14 and -0.15 (Table 5.2). As rainfall increased, production tended to decrease and vice versa; however, the relationship was very weak.

Table 5. 5 Regression and Correlation Results

	P-value	R^2	Correlation
Non-Quota Period	0.0854	0.0229	-0.1514
Quota Period	0.0731	0.02	-0.1416

Chapter 6 COST ANALYSIS

This chapter provides an analysis of cost information (as described in Section 3.4) on an annual and quarterly basis. Total cost and individual cost components will be used to analyze trends and relate these trends to production. Shifts in cost categories are also explored to gain insight on the relationship between key cost centers.

6.1 Annual Cost Analysis

Total annual cost and production information was collected for 22 contractors. The cost of production decreased from 1996 to 1997, as illustrated in Figure 6.1 by the regressions of total yearly cost against yearly production. The cost of adding an additional ton (the slope of the lines) decreased from \$15.95 in 1996 to \$15.06 in 1997, a decrease of 5.6%. The intercepts increased from -\$260,491 in 1996 to -\$172,937 in 1997, showing an increase in fixed costs. Roughly 90% of the variation in annual costs was explained by production, remaining almost constant over the study period ($R^2 = 0.903$ for 1996 and 0.902 for 1997). Both 1996 and 1997 data were positive and highly correlated (correlation was roughly 0.95). Large values of production were associated with large values of costs; conversely, small values of production were associated with small values of costs.

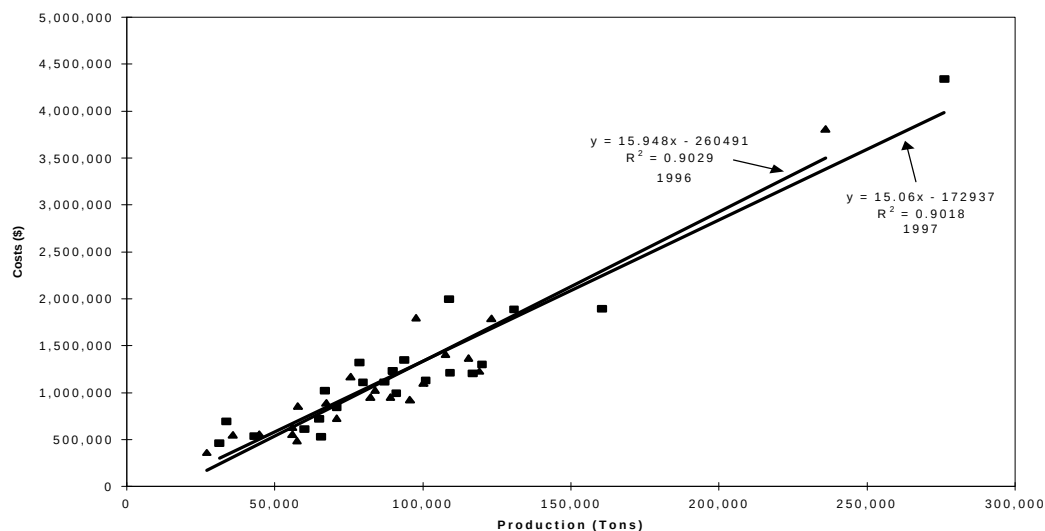


Figure 6. 1 Regression of Annual Cost Against Annual Production.

The regression equations for 1996 and 1997 were solved for and plotted by 10,000-ton increments from 30,000 tons per year (tpy) to 280,000 tpy. Expected values for average costs per ton were generated using the 1996 and 1997 regression equations to assess the effects of changes across operation sizes (Figure 6.2). The analysis shows that costs per ton rose for loggers producing less than 80,000 tpy, decreased for those producing more than 130,000 tpy, and remained relatively stable for those in the 80,000 to 130,000 tpy range. The population of contractors is not homogenous: different firms reacted to business environments in different ways. Figure 6.2 demonstrates two things: the situation changed in 1997 (both the slope and the intercept shifted) and the effect was different across size groups. A quartile analysis was used to gain a better understanding.

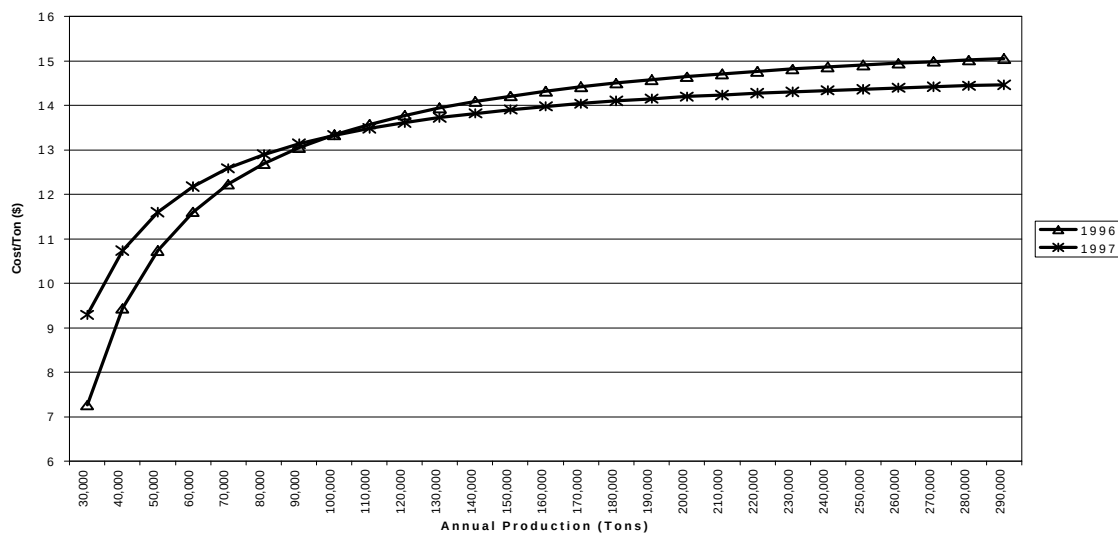


Figure 6. 2 Average Cost per Ton from the Regression Equations.

Residual annual costs were compiled for each logger and corresponding year by solving the regression for his predicted annual cost (as a function of his production) and then subtracting that from his actual cost. Regression is essentially a two-dimensional average, a line through a scatter of points that balances and minimizes the displacement of points above and below the line. The residuals from the regression equations are shown in Figure 6.3 by production quartile. The residuals are the difference between the actual total cost per ton and the predicted cost per ton at that given production level for each contractor. A \$200,000 residual cost means the logger's actual costs were that much higher than the predicted cost. Figure 6.3 shows that

predicting costs per unit on the basis of output for the population can be misleading. The difference between the predicted and actual cost per ton values ranged from roughly -\$408,000 to \$528,000, the smallest difference being within \$2,300. The cost per ton for the first and third quartiles was underestimated by the regressions for both years: most residual costs were greater than zero. Most second and fourth quartile observations fell below the predicted cost per ton level: residual costs were overestimated.

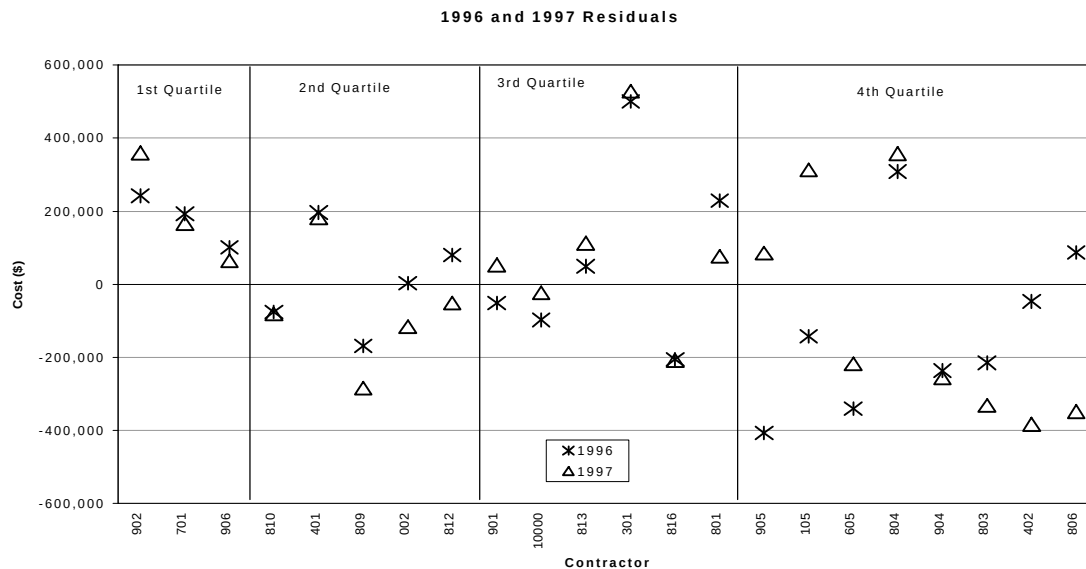


Figure 6. 3 Residuals from 1996 and 1997 Regressions by Production Quartile.

Median annual cost per ton increased \$0.37 over the study period, a change of 3% from 1996 (Table 6.1). The inter-quartile range increased from \$0.35 in 1996 to \$0.44 in 1997 (with a median of \$12.31 and \$12.68, respectively), an increase of 25.7%.

Table 6. 1 1996 to 1997 Annual Costs per Ton (Total Population).

	1996	1997	Change from 1996
25th Percentile	\$10.78	\$11.14	\$0.35
Median	\$12.31	\$12.68	\$0.37
75th Percentile	\$14.30	\$14.74	\$0.44
Inter-Quartile Range	\$3.52	\$3.61	\$0.09

Total cost per ton along with each contractor's median cost per ton for the study period is shown in Figure 6.4. Forty-one percent of the contractors were able to decrease their average cost per ton from 1996 levels. Thirty-six percent of the population had a significant increase (over \$1.00 per ton).

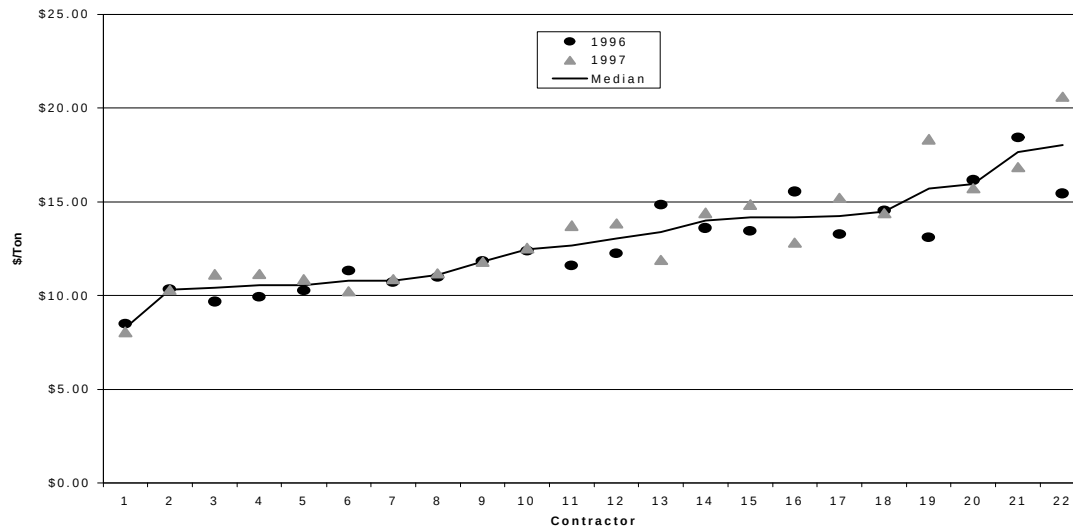


Figure 6. 4 Annual and Median Cost per Ton for all Contractors.

6.2 Quarterly Cost Analysis

Complete quarterly cost and production data were available for seven contractors. Median quarterly costs per ton and the corresponding inter-quartile range are shown in Table 6.2. Median cost per ton decreased by over a \$1.00 in the second quarter for both years; an increase of over a \$1.00 occurred in the last quarter of 1996. Increased production occurred in all but two periods: 4th quarter 1996 to 1st quarter 1997 and 1st quarter 1997 to 2nd quarter 1997. Production shifts in excess of 14,000 tons were in the 1st to 2nd quarter 1996, 2nd to 3rd quarter 1996, and 3rd to 4th quarter 1997: these periods resulted in negative or near zero median cost per ton shifts. The 3rd to 4th quarter 1996 had a median increase of \$1.80 per ton but experienced a minimal decrease in median production (541 tons)

Table 6. 2 1996 to 1997 Quarterly Costs per Ton (Seven Contractors).

Quarter	1996				1997			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th
25th Percentile	\$10.80	\$10.31	\$9.82	\$11.14	\$11.01	\$10.36	\$10.78	\$11.21
Median	\$12.39	\$10.84	\$10.04	\$11.84	\$12.29	\$10.99	\$11.73	\$11.78
75th Percentile	\$15.02	\$15.10	\$13.10	\$14.14	\$12.94	\$13.49	\$12.58	\$12.84
Inter-Quartile Range	\$4.22	\$4.79	\$3.29	\$3.00	\$1.93	\$3.13	\$1.79	\$1.63
Median Change from Previous Quarter		-\$1.54	-\$0.81	\$1.80	\$0.45	-\$1.30	\$0.74	\$0.05

Quarterly costs per ton along with the median are shown for seven contractors in Figure 6.5. Variation in quarter-to-quarter cost per ton was apparent for all contractors. On a quarter-to-quarter basis, 43% of the observations (24 out of 56 contractor quarters) experienced a median cost per ton increase; 23% of the quarter-to-quarter increases were over \$1.00 per ton.

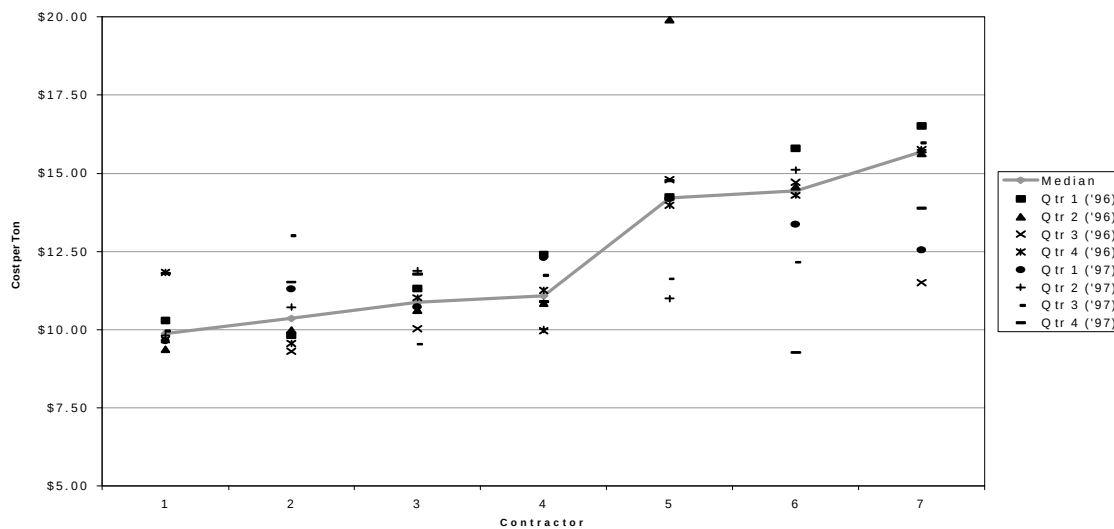


Figure 6. 5 Quarterly and Median Cost per Ton for Seven Contractors.

6.3 Cost Allocation

Contractors adapt differently to changes in the business environment and may allocate their costs differently among the categories to match these changes. Shifts in cost categories were broken down by production quartile to gain insight concerning these responses. The percentage of total cost by each cost component and shift from 1996 to 1997 are shown in Table 6.3 for each production quartile and the entire population (22 contractors).

Table 6. 3 Cost Allocation by Production Quartile.

	Year	Equipment	Consumables	Labor	Contract Services	Insurance	Administrative Overhead
1st Quartile	1996	22.91%	25.16%	42.02%	4.86%	3.36%	1.69%
	1997	18.42%	24.35%	37.51%	14.02%	3.78%	1.91%
	Change from '96	-4.49%	-0.81%	-4.51%	9.16%	0.42%	0.23%
2nd Quartile	1996	21.93%	22.62%	32.61%	15.67%	3.27%	3.91%
	1997	20.84%	20.45%	33.78%	17.23%	4.51%	3.19%
	Change from '96	-1.09%	-2.16%	1.17%	1.56%	1.24%	-0.72%
3rd Quartile	1996	18.29%	28.64%	32.16%	15.44%	3.96%	1.51%
	1997	17.39%	24.96%	33.47%	18.45%	3.71%	2.02%
	Change from '96	-0.90%	-3.68%	1.30%	3.01%	-0.25%	0.51%
4th Quartile	1996	17.34%	19.40%	33.65%	23.93%	3.92%	1.76%
	1997	17.62%	18.58%	32.54%	24.92%	3.27%	3.07%
	Change from '96	0.27%	-0.82%	-1.12%	0.99%	-0.65%	1.31%
Population	1996	18.60%	22.90%	33.57%	19.13%	3.81%	1.98%
	1997	17.83%	20.84%	32.93%	22.22%	3.54%	2.64%
	Change from '96	-0.77%	-2.06%	-0.64%	3.08%	-0.27%	0.66%

The percentage of total cost allocated to contract services increased for all quartiles in 1997. The population experienced an increase of 3% in contract services; the first quartile contractors had the largest increase at 9%, and fourth quartile loggers had the lowest increase at 1%. Relative expenditures for equipment, consumables, labor, and insurance were reduced in 1997 for the population as a result of using more contract services. Reduced expenditures in trucks, fuel, oil, labor, insurance, etc., occur when the trucking services shift to a separate business. Whether this shift was towards the use of trucks wholly owned by the logger, as a separate business, or trucks owned by a different second party is not known.

Stuart and Grace (1999) found similar results from a larger study population in the southeastern and southcentral U.S. from 1994 to 1997. Production quartiles were grouped by the same basis, where “outlays for contract services increased modestly for the first and second quartile, rose sharply for the third quartile, and remained relatively constant for the fourth quartile” (Stuart and Grace 1999). Increased dependence on contract services may reflect a disinvestment in the trucking side or a strategy of creating a separate trucking business to take advantage of lower WCI rates. Larger producers (e.g. fourth quartile loggers) may have already made the switch to increased contract services before 1996 and 1997. This analysis also shows that smaller producers may be in the process towards a similar cost reallocation.

Administrative overhead expenditures rose for the population by 0.6%, increasing in all but the second quartile. Fourth quartile loggers experienced the largest increase at 1.3%. Cellular phones, full-time secretaries, mechanics, and other support personnel usage increased over the study period for most of the businesses.

WCI (included in labor) expenditures were available for 20 contractors. The contractors experienced relatively low WCI rates, a probable result of the increased use of self-insured groups. WCI expenditures increased very little in 1997 (0.03%) and accounted for a low percentage of total cost (2.66% in 1996 and 2.69% in 1997).

6.4 Changes in Key Cost Components

6.4.1 Total Basis

The percent changes in total cost and production by cost category, on a total basis, from 1996 to 1997 is shown in Table 6.4. Production increased by roughly 3.9% for the population, with all quartiles experiencing an increase in 1997. Contractors within the second and fourth quartiles had the greatest production gains, 11.5% and 16%, respectively. Production remained relatively constant for the first and third quartile loggers.

Table 6. 4 Changes in Key Performance Indicators (Total Basis).

Percent Change from 1996 (Total Basis)								
	Production	Equipment	Consumables	Labor	Contract Services	Insurance	Administrative Overhead	Total Cost
1st Quartile	0.29%	-19.60%	-3.20%	-10.74%	12.49%	188.69%	13.47%	15.42%
2nd Quartile	11.48%	-4.96%	-9.56%	3.60%	37.84%	9.96%	-18.41%	8.78%
3rd Quartile	0.30%	-4.92%	-12.84%	4.05%	-6.30%	19.50%	33.99%	-0.16%
4th Quartile	16.01%	1.58%	-4.20%	-3.32%	-16.54%	4.15%	74.67%	20.81%
Population	3.91%	-4.16%	-8.99%	-1.92%	-7.04%	16.12%	33.28%	7.73%

The rate of change for total costs per year was 198% that of production for the study population. Cost increases outweighed production increases for the first quartile: a 15.4% increase in associated costs with a 0.3% increase in production. The fourth quartile was able to increase

production by 16%, but their costs rose by 21%. Only the second and third quartile loggers were able to increase production at a rate faster than the increase in costs.

Equipment, consumables, and labor expenditures as a percentage of total costs were reduced from 1996 to 1997 for the population. Contract services decreased for the population, mainly by cost reductions from the larger producers (third and fourth quartile). Insurance and overhead expenditures increased significantly for the population; insurance increased 188% for the first quartile and overhead increased 74% for the fourth quartile.

6.4.2 Per-Ton Basis

Percent changes in total costs per ton, and by cost category, are shown in Table 6.5. Equipment expenditures on per-ton basis decreased in 1997 for all but the fourth quartile contractors. This may indicate a lack of reinvestment in equipment, or the smaller businesses may have chosen to continue running older or used equipment. The investment in equipment may still be occurring, but by a separate firm with common ownership. Increased dependence on contracted services may also be an indication of this shift towards expensing capital costs (e.g. contract services) as opposed to capitalizing costs (reinvesting in new equipment).

Table 6. 5 Changes in Key Performance Indicators (Per-Ton Basis).

Percent Change from 1996 (Per Ton Basis)							
	Equipment per ton	Consumables per ton	Labor per ton	Contract Services per ton	Insurance per ton	Administrative Overhead per ton	Total Cost per ton
1st Quartile	-7.47%	11.40%	2.73%	232.25%	29.46%	30.59%	15.09%
2nd Quartile	-7.26%	-11.75%	1.09%	7.29%	34.50%	-20.39%	-2.42%
3rd Quartile	-5.35%	-13.24%	3.58%	18.96%	-6.72%	33.39%	-0.45%
4th Quartile	5.79%	-0.24%	0.69%	8.46%	-13.09%	81.89%	4.14%
Population	-0.63%	-5.64%	1.69%	20.39%	-3.62%	38.18%	3.68%

Consumable expenditures decreased on a per-ton basis for the second and third quartiles, rose for the first quartile, and remained stable for the fourth. Labor increased on a per-ton basis across job sizes at a rate between 0.6% and 3.5%. Across quartiles, labor and equipment costs per ton

appeared to have an inverse relationship: decreased equipment expenditures were linked with increases in labor.

Contracted service costs per ton increased significantly for the population. These services increased by 20% from 1996 for the population, with the largest increase in the first quartile (232%).

Insurance expenditures on a per-ton basis decreased by 3.6% for the population, with a considerable increase for the first and second quartiles, and a considerable decrease for the third and fourth quartiles. Administrative overhead costs per ton increased 38% for the population, with large jumps for all but the third quartile.

6.5 *Relationship Between Key Cost Components*

Conventional theory indicates a direct relationship between total costs per ton and production, labor costs per ton and equipment costs per ton, and consumable costs per ton and equipment costs per ton. Each relationship was tested using complete 1996 and 1997 annual cost and production information for 22 contractors. Seven contractors were included for a quarterly analysis. The change in each variable was calculated by subtracting the 1997 value from the 1996 value for each contractor. The result indicates the direction of change and is an ordinal measure. Each change is of interest but is directly affected by each contractor's operation, the operating environment for that year, and the reserve capacity the operation had at the start of study (Stuart and Grace 1999).

6.5.1 Production and Cost per Ton

Improving economic efficiency, the tons produced per dollar spent, is normally attributed to increasing production. Reduced total cost per ton occurs when fixed costs (equipment, insurance, and taxes) are distributed over a larger base by increasing production (Stuart and

Grace 1999). Certain conditions must be met to make this an effective approach (as adapted from Stuart and Grace 1999):

1. The increase in variable costs is less than the reduction from distributing fixed costs.
2. Few costs accrue on a per-unit basis.
3. There are sufficient reserves in the operation so that it is necessary to increase fixed costs when production is increased.
4. Other factors do not counter the move by increasing overall costs.

Annual production increased for 16 of the 22 loggers; cost per ton increased for 9 loggers (Figure 6.6). One would expect most observations to either fall in the upper-left quadrant or the lower-right quadrant: increased costs per ton as production decreased, or lower costs per ton with increased production. Only 50% of the observations matched the expectation. A significant pattern or trend was not apparent and no underlying cause for reality failing to match micro-economic theory could be formed in the data.

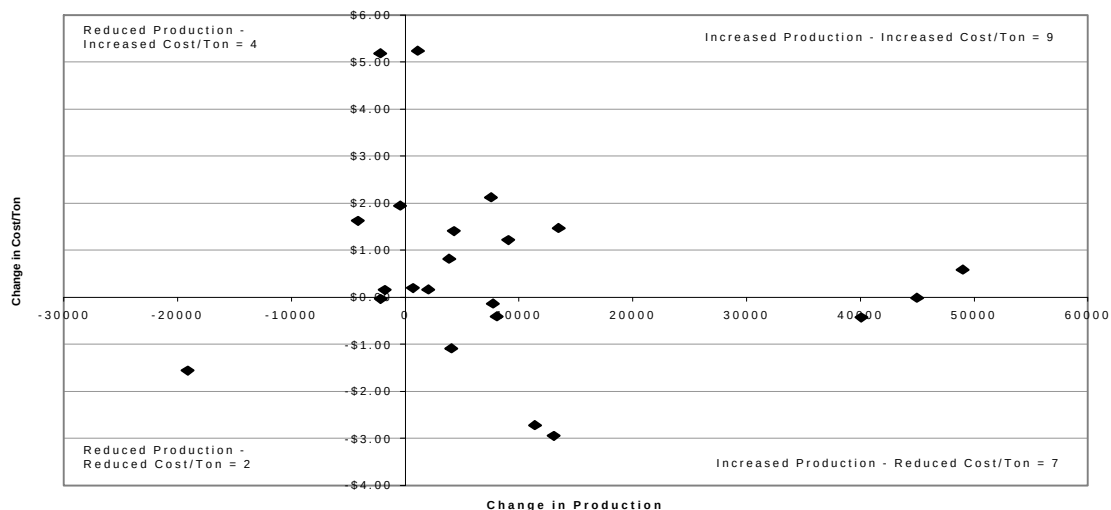


Figure 6. 6 Shifts in Cost per Ton vs. Production (Annual).

Quarterly production increased for 15 of the 28 observations; cost per ton increased for 5 of these observations (Figure 6.6). Two-thirds of the observations fell as expected, in either the upper-left quadrant or the lower-right quadrant. A significant pattern again was not apparent, although

a general tendency of the data points to align in a “northwest” to “southeast” pattern can be discerned.

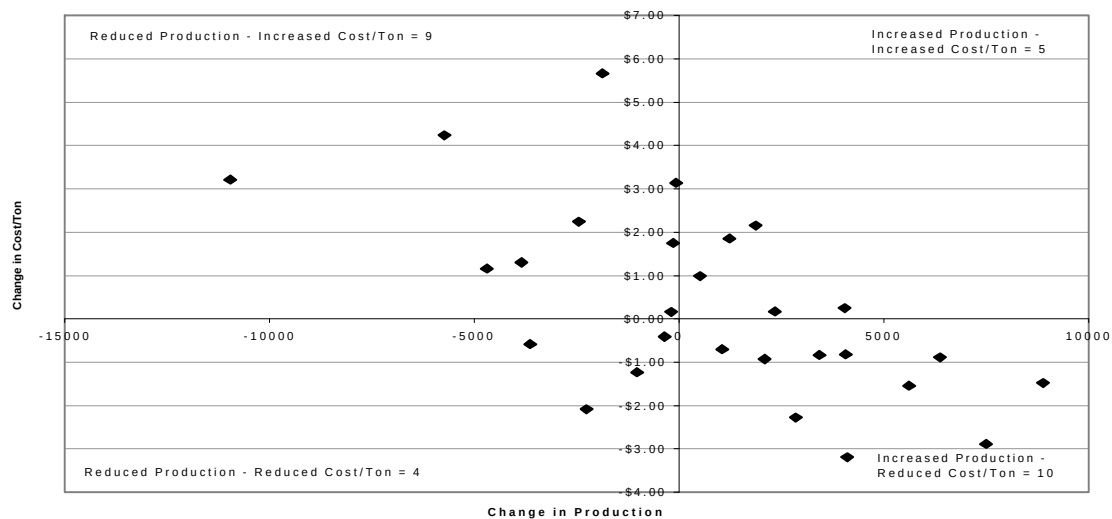


Figure 6. 7 Shifts in Cost per Ton vs. Production (Quarterly).

The match between theory and reality is tenacious. The quarterly analysis indicates that it may be better over shorter time frames. Cubbage et al. (1988) promoted the idea of reducing costs by increasing production. While this strategy may have been effective at one time, it seems to have lost its effectiveness. Reducing logging costs does not appear to be directly related to increased production, as extra capacity within logging operations appears to be non-existent for the study population.

Increased production may or may not lead to lower production costs. The annual shifts represent single, independent observations and are perhaps the better measure. Quarterly shifts are not truly independent. A downward shift one quarter must be accompanied by an upward shift in some future quarter if the job is to sustain its level of production. The fact that the data points are so poorly organized may indicate that, even at this time scale, the assumption is open to question.

6.5.2 Equipment Costs per Ton and Labor Costs per Ton

Contractors often opt for additional equipment (pull-through delimiters, gate delimiters, etc.) as a means of reducing payroll and WCI payments or simply as a means of reducing the dependence on manual labor. Equipment substitution for labor has been the rule in the southeastern U.S. logging business for quite some time. This strategy is effective as long as the cost increase per ton for equipment is less than the cost savings in labor cost per ton (Stuart and Grace 1999). One would expect reduced equipment costs per ton to be paired with increased labor costs per ton or increased equipment costs per ton paired with decreased labor costs per ton. This scenario would again lead observations to fall either in the upper-left quadrant or the lower-right quadrant. Again the data are ordinal, indicating the direction of shift from 1996 information.

On an annual basis, equipment costs per ton increased for 11 out of the 22 loggers; only 3 of these loggers had reduced labor costs per ton (Figure 6.8). Nine of the 22 observations fit the “expected” scenario. Thirteen loggers followed a counter pattern, where increased equipment expenditures were paired with increased labor costs and vice versa.

Several factors may be complicating the analysis. The increased equipment expenditures may simply be the result of replacing old equipment with newer machines with approximately the same technical ability. The substitution advantage may have been realized more on equipment rotation in the past. Increased equipment costs may be the result of technical improvements indirectly related to labor productivity: better operator protection, improved working conditions, improved machine reliability, etc.

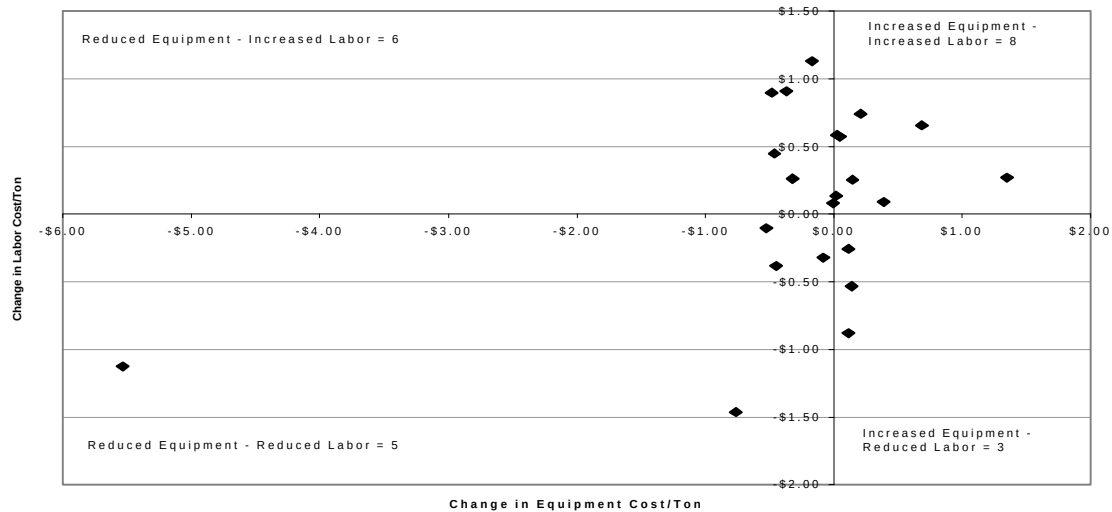


Figure 6. 8 Shifts in Equipment vs. Labor (Yearly).

Twelve of 28 observations had increased equipment costs per ton; only 2 of these observations were associated with reduced labor costs per unit (Figure 6.9). The general tendency in quarterly observations appeared to be opposite than expected: in 10 cases labor costs decreased with decreased equipment costs per ton, and increased labor with increased equipment costs in another 10. The relationship between equipment costs per ton and labor costs per ton resulted in patterns without apparent trends. Again, the quarterly shifts are not truly independent of each other, but the linkage between equipment and labor costs per ton is more complex than the volume cost per ton relationship described earlier.

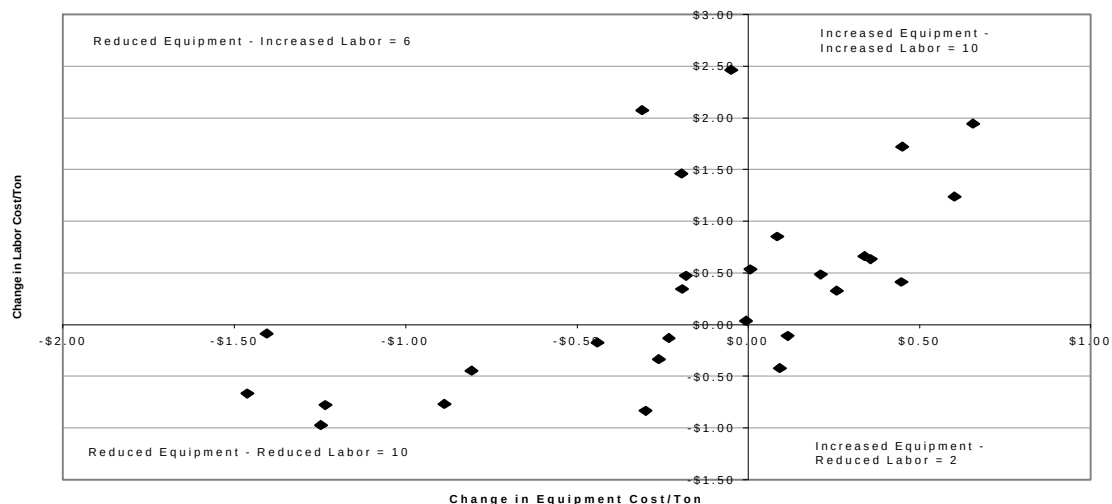


Figure 6. 9 Shifts in Equipment vs. Labor (Quarterly).

6.5.3 Equipment Costs per Ton and Consumable Costs per Ton

The relationship between equipment costs per ton and consumable costs per ton was explored. Newer equipment generally requires fewer consumables and less maintenance than older equipment. The increase in equipment costs per ton should be offset by a reduction in consumable costs per ton (Stuart and Grace 1999). This relationship was analyzed on both an annual and quarterly basis. The expected outcome should produce data falling either in the upper-left quadrant or the lower-left quadrant. Again, the data are an ordinal measure representing the direction of shift from 1996 information.

On an annual basis, equipment costs per ton increased for 14 of the 22 observations; a resulting decrease in consumable cost per ton occurred in 6 of the observations (Figure 6.10). “Expected” outcomes were apparent for 41% of the study population; however, a major trend was lacking for the majority of the population.

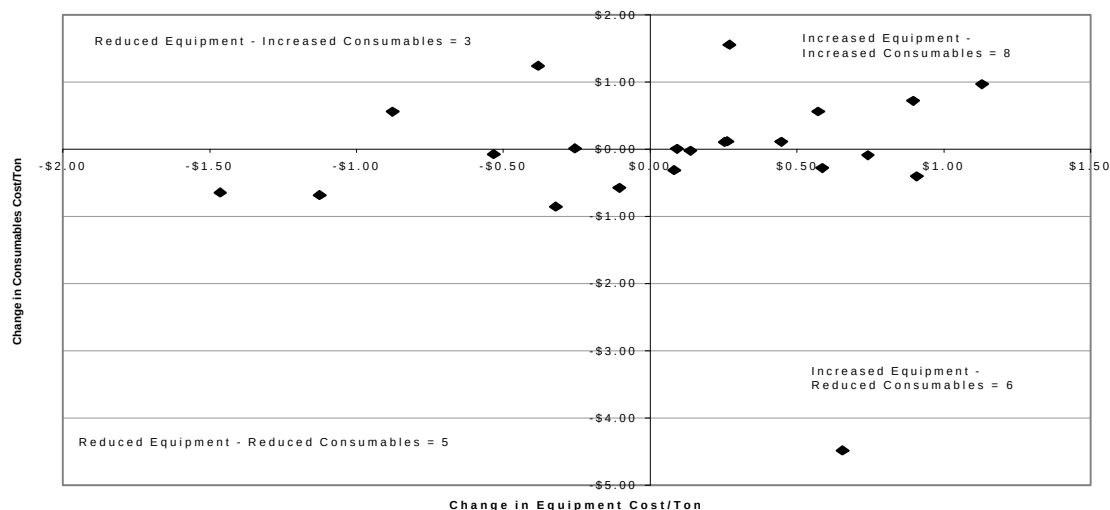


Figure 6. 10 Shifts in Equipment Cost/Ton vs. Consumable Cost/Ton (Yearly).

On a quarterly basis, observations with increased equipment costs per ton totaled 12 out of 28; reduced consumables appeared in 6 of these observations (Figure 6.11). Quarterly “expected” outcomes only reflected 43% of the observations. The relationship between equipment costs per ton and consumable costs per ton was not found in any suggestive pattern.

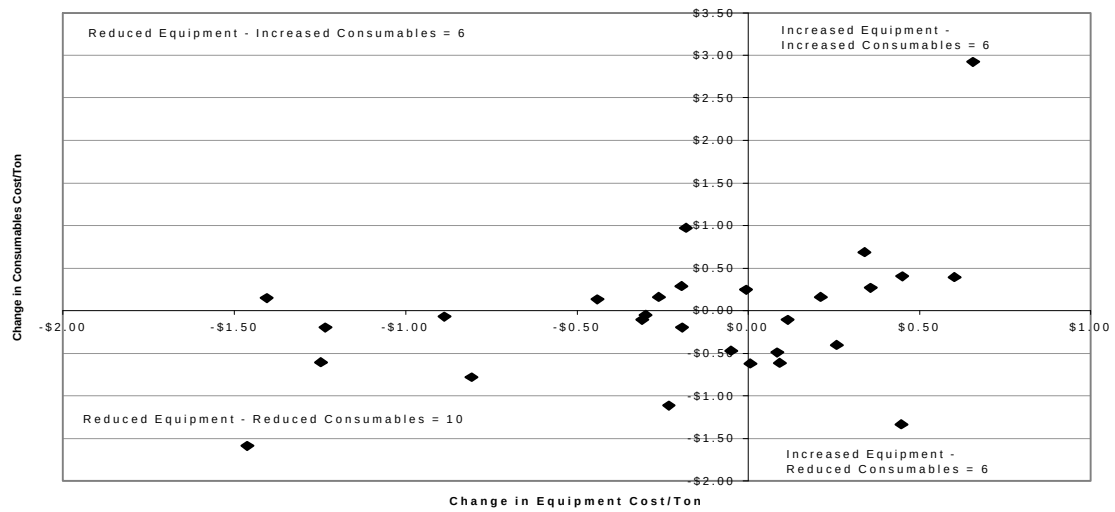


Figure 6. 11 Shifts in Equipment Cost/Ton vs. Consumable Cost/Ton (Quarterly).

Chapter 7 SUMMARY AND CONCLUSIONS

Data collection for 20+ contractors allowed an analysis of demographic, cost, and production information. This information was examined as indicators of the overall economic health of southeastern U.S. loggers. Trends and shifts were identified to explain cost allocation and shifts between cost components as well as the possible forces behind these phenomena.

7.1 Contractor and Business Analyses

Contractors were between 32 and 58 years old, with a median age of 46. Most contractors (86%) had finished high school and several had some college experience, although these contractors tended to be younger (less than 45 years old). Experience levels (number of years as business owners) for contractors ranged from 3 to 38 years, with a median of 20. Loggers with less experience usually had been a part of the business for a longer time but had not actually taken over the business until a previous owner had retired or died. All contractors worked in either the coastal plain or piedmont region, with a good distribution across six states.

Most businesses (91%) were incorporated; the remaining 9% were sole proprietorships. The incorporated firms were split evenly between Sub S and Full C corporations. Thirty-two percent of the loggers had a separate wholly owned trucking business; the others combined logging and trucking in a single entity. Only 10% of the loggers relied more on contracted trucks than on their own. A total of 126 trucks were used by the contractors, of which 37% were owned by contract haulers proving that this service constituted a large portion of the trucking fleet.

Stumpage was acquired primarily from wood-consuming mills or dealers. Most contractors stated that it was extremely difficult to compete for wood on the open market. Contractor-purchased stumpage was usually acquired through “word of mouth” and on the basis of the logger’s good reputation.

Most contractors ran only one crew, while the remaining (29%) had multiple crews. The total number of employees per business ranged from 6 to 44, with a median of 12. Very few contractors paid employees on a daily or salary basis; paying by the hour or production basis was more common. The majority used a combination of all four methods, where key employees were usually compensated differently than others.

Logging operations and technology were similar for most contractors. Delimbing and bucking techniques accounted for most of the differences in these operations. Feller-bunchers, skidders, and loaders were the basic equipment components for the majority of the harvesting systems; shoveling and chipping operations required other specialized machinery.

7.2 *Production and Productivity*

Loggers were grouped into production quartiles by the annual tons delivered. The larger producers, third and fourth quartile loggers, totaled from 59% to 65% (1996 and 1997, respectively) of the population and delivered from 75% to 80% (1996 and 1997, respectively) of the total tons produced. Total annual production increased in 1997 for the population; 73% of the 22 contractors increased production that year.

Quarterly and weekly production variation was apparent for all the contractors. Weekly production offered the best basis for analyzing the production variation and the true nature and extent of this variability. Some contractors were more consistent than others; however, the variability was still significant. Weekly inter-quartile production per contractor ranged from 50 to 450 tons (2 to 18 loads) for 13 contractors. One must keep in mind that a two-load weekly deviation for a first quartile contractor may have a significant effect on his profitability but would not affect a fourth quartile logger much at all.

The common assumption that loggers maintain high production through periods of favorable harvesting conditions did not hold. Weekly production for three sets of two loggers each contracting for the same organization was analyzed. All of the contractors experienced the same relative trend: increasing cumulative production in the winter months and decreasing cumulative

production in the summer months. Strong administrative forces seemed to be the root cause for this pattern.

Rainfall is assumed to be a good indicator of production. Weekly production and rainfall were negatively correlated, but the relationship was very weak. Two periods were used, one where quotas were common and one where they were not. In both periods, rainfall was statistically proven to not be a good predictor of production; roughly 2% of the variation in weekly production was explained by weekly precipitation.

7.3 *Cost and Productivity*

The average cost of producing an additional ton dropped in 1997 by almost \$0.90, a decrease of 5.6% from 1996, but the fixed annual cost rose. Total costs increased from 1996 to 1997 by 7.7%, and 36% of the population experienced an increase of over \$1.00 per ton. The median cost per ton increased \$0.37, a change of 3% from 1996. Roughly 90% of the variation in total cost was explained by production.

The study population experienced a reallocation of costs in 1997. Equipment, consumables, labor, and insurance expenditures decreased, with increases in contract services and insurance. The decrease in equipment, labor, and consumables was compensated for by the increased use of contract services.

Total costs per ton increased 3.7% from 1996, while production increased 3.9%. Administrative overhead expenditures experienced the most change, an increase of 33% from 1996. The use of cell phones, support personnel, office buildings, and other overhead expenses were attributed to the increase.

The relationship between key cost components revealed strong evidence to disprove previously held theories. A significant portion of the population increased production, but costs per ton increased; extra capacity within the logging systems may be gone. Increased mechanization to reduce per-unit labor costs has seemed to lose its effectiveness. Increased equipment costs per ton were often coupled with increased labor costs per ton. Adding an extra skidder, feller-

buncher, or loader to the operation was uncommon; replacement purchases usually occurred. Increasing equipment costs per ton should decrease consumable costs per ton: newer machines require fewer repairs, maintenance, and supplies. Trends in supply and equipment costs per-unit were not found to behave in the expected fashion.

7.4 *Implications*

- Predicting harvesting and transportation costs from intensive, machine-based studies are deceptive and fraught with risks because the approach focuses on one system, one business, one harvesting environment, and one stage in the wood supply cycle. A long-term, continuous study such as this, documenting changes in seasonal, weather and business cycle influences, provides better insight into the exogenous factors that drive costs. A modern system can compensate for much of the tract-related variation by rescheduling, restructuring, and redeployment, but it is unable to compensate for forces of regulatory changes, market cycles, or major business cycles.
- The southeastern United States wood supply system has undergone major technological change and in many ways is a mature industry. It no longer reacts to change in the same way it did 10, 20, or 30 years ago. As a result, many of the old operating maxims are no longer useful. Increased production does not necessarily lead to reduced costs but may, in fact, increase costs per ton. Weather does not have a significant effect on weekly production. Modern, well-equipped systems can respond quickly to short periods of lost production. Adverse weather was found, in some instances, to have a favorable effect for these operations by increasing their opportunity to work. The economic advantage of substituting capital for labor has virtually disappeared. New tools for assessment and evaluation must be developed.
- Administrative forces have replaced natural forces as the major source of variability in the wood supply system and are quite possibly the greatest barrier to overall efficiency. Micro-management keeps the system in a constant state of flux and encourages expenditures on counter strategies. The increased use of contracted services in fixing costs per-unit across wider ranges of output may be signaling a move to reduced investment in specialized harvesting equipment.

7.5 *Suggestions for Future Research*

1. The number of smaller businesses, loggers producing less than 50,000 tons per year, should be increased in the data set. Grouping contractors by similar business sizes (e.g. production quartiles) offers a good basis for understanding the key business decisions employed and should continue.
2. Additional contractors should be added to the data base in certain southeastern U.S. states. A more uniform distribution across the states would allow for a better state-by-state analysis of independent logging contractors.
3. Further research to study the effects of the five variability forces should continue, so as to pinpoint trends in the wood supply system and to provide detailed explanations behind these changes.

Literature Cited

- Altizer, C.B. 1999. Harvesting Costs and Productivity Analysis of Independent Contractors in the Appalachian Region: 1995-1997. M.S. Thesis. Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, VA. 94 p.
- Carter, R.C. and F.W. Cubbage. 1995. Stochastic Frontier Estimation and Sources of Technical Efficiency in Southern Timber Harvesting. *Forest Science* 41(3):576-593.
- Corwin, M.L. 1987. A Documentation and Analysis of the Physical, Operating, and Business Environments for Small-Tree Handling and Harvesting Systems. M.S. Thesis. Department of Forestry, Virginia Polytechnic Institute and State University. Blacksburg, VA. 197 p.
- Cubbage, F.W., P.A. Wojtkowski, T.G. Harris, and G.H. Weaver. 1988. Regional Analysis of Factors Affecting Southern Pulpwood Harvesting Costs. *Forest Products Journal* 38(11/12):25-31.
- Greene W.D., B.D. Jackson, and D.C. Woodruff. 1998. Characteristics of Logging Contractors and their Employees in Georgia. *Forest Products Journal* 48(1):47-53.
- Haggard, J.W. 1981. A Heuristic Model for Monitoring and Adjusting Cut and Haul Contract Rates for Independent Harvesting Contractors in Southern Ohio. M.S. Thesis. Department of Forestry, Virginia Polytechnic Institute and State University. Blacksburg, VA. 111 p.
- Hoffman, B.F. 1991. How to Improve Logging Profits. The Northeastern Loggers' Association, Inc. Old Forge, New York. 60 p.
- LeBel, L.G. 1993. Production Capacity Utilization in the Southern Logging Industry. M.S. Thesis. Department of Forestry, Virginia Polytechnic Institute and State University. Blacksburg, VA. 129 p.
- LeBel, L.G. 1996. Performance and Efficiency Evaluation of Logging Contractors Using Data Envelopment Analysis. Ph.D. Dissertation. Department of Forestry, Virginia Polytechnic Institute and State University. Blacksburg, VA. 201p.
- Loving, R.E. 1991. Components of Logging Costs. M.S. Thesis. Department of Forestry, Virginia Polytechnic Institute and State University. Blacksburg, VA. 205 p.
- Mäkinen, P. 1992. Puutavaran kuljetusyriitysten Menestymisen Strategiat [Strategies used by timber truck transport companies to ensure business success]. Acta Forestalia Fennica. The Society of Forestry in Finland/The Finnish Forest Research Institute. Report 238. In Finnish, English summary.

- Mäkinen, P. 1993. Metsäkoneyrittämisen Menestysyekiät [Success factors for forest machine contractors] Folia Forestalia. The Finnish Forest Research Institute. Report 818. In Finnish, English Summary.
- Matthews, D.W. 1942. Cost Control in the Logging Industry. McGraw-Hill Book Company. New York, NY. 374 p.
- Munn, I.A., J.B. Cutshall, and D.G. Hodges. 1998. 1993 Pulpwood Logging Contractor Survey. *Forest Products Journal* 48(7/8):47-53.
- Miller, L.R. 1999. M.S. Thesis – Draft. Department of Forestry, Mississippi State University, Mississippi State, MS.
- National Oceanic and Atmospheric Administration. 1999. Climate Visualization. Available: <http://www.ncdc.noaa.gov/onlineprod/drought/xmgr.html>.
- Resinger, T.W., W.D. Greene, and J.F. McNeel. 1988. Microcomputer-based Software for Analyzing Harvesting Systems. *Southern Journal of Applied Forestry* 12(1):37-41.
- Shannon, J.T. 1998. Productivity, Cost, and Technical Efficiency Evaluation for Southeastern U.S. Logging Contractors. M.S. Thesis. Department of Forestry, Virginia Polytechnic Institute and State University. Blacksburg, VA. 165 p.
- Stuart, W.B. 1980. A Simulation Approach to the Analysis of Harvesting Machines and Systems. Ph.D. Dissertation. Department of Forestry, Virginia Polytechnic Institute and State University, Blacksburg, VA. 202 p.
- Stuart, W.B., L.A. Grace, and L.G. LeBel . 1998. Wood Supplier Productivity and Cost Survey-Interim Report. American Pulpwood Association Inc. Technical Report 98-A-4. Rockville, MD. 19 p.
- Stuart, W.B. and L.A. Grace. 1999. Wood Supplier Productivity and Cost Survey-Draft Final Report. American Pulpwood Association Inc. Rockville, MD. Unpublished. 15 p.
- Sundberg, U. and C.R. Silversides. 1987. Operational Efficiency in Forestry. Kluwer Academic Publishers. Boston, MA. 219 p.
- Tufts, R.A., B.L. Lanford, W.D. Greene, and J.O. Burrows. 1985. Auburn Harvesting Analyzer. *Compiler* 3(2):15-15.
- Walbridge, T.A. and R.M. Shaffer. 1990. Harvesting Systems, Tree Processing, Skidding, Forwarding, and Yarding. In: R.A. Young and R.L. Geise (eds.). Introduction to Forest Science (second edition). John Wiley & Sons. New York, NY. pp. 340-348.

- Walter, M.J. 1998. Documentation of Productivity and Efficiency Relationships for a Group of Southern Logging Contractors. M.S. Thesis. Department of Forestry, Virginia Polytechnic Institute and State University. Blacksburg, VA. 131 p.
- Wang, J. and W.D. Greene. 1999. An Interactive Simulation System for Modeling Stands, Harvests, and Machines. *Journal of Forest Engineering*. 10(1):81-99.
- Watson, W.F., G.A. Day, J. Altman, T.J. Straka, D.W. Domenech, and R.K. Matthes. 1989. 1987 Pulpwood Logging Contractor Survey - Southwest and Southeast Technical Divisions of the American Pulpwood Association. Tech. Bull. 162. Miss. Agric. and For. Exp. Sta., Mississippi State University, Mississippi State, MS. 16 p.
- Watson, W.F., J.M. Kucera, R.K. Matthes, and R.A. Kluender. 1977. Pulpwood Producer Census – Southwest and Southeast Technical Divisions of the American Pulpwood Association. Unnumbered Series. Miss. Agric. and For. Exp.Sta., Mississippi State University, Mississippi State, MS. 6 p.
- Weaver, G.H., R.A. Kluender, W.F. Watson, W. Reynolds, and R.K. Matthes. 1981. Pulpwood Producer Census – Southwest and Southeast Technical Divisions of the American Pulpwood Association. Unnumbered Series. Miss. Agric. and For. Exp. Sta., Mississippi State University, Mississippi State University, Mississippi State, MS. 11 p.
- Weaver, G.H., R. Izlar, R.A. Kluender, W.F. Watson, and R.K. Matthes. 1982. 1980 Survey of High Volume Independent Wood Producers in the South. Unnumbered Series. Miss. Agric. and For. Exp. Sta., Mississippi State University, Mississippi State University, Mississippi State, MS. 6 p.

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