Harvesting Cost and Productivity Analysis of Independent Contractors in the Appalachian Region: 1995-1997

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ABSTRACT

The study examined contractor demographics, business and technological characteristics, costs, and production information for 15 independent logging firms in the Appalachians. Contractors represented nine states and were studied from 1995 to 1997. Each contractor's cost and production information was used to determine his economic efficiency for the study period.

Total annual production for the firms ranged from 2,728.26 tons to 213,194.74 during the three-year period. Four contractors' median weekly production decreased from 1996 to 1997, while three contractors increased their weekly median production. Labor was the largest cost category for the smaller production contractors and contracted services tended to be the largest category for the larger producers. Regression analyses found that the cost of producing an additional ton increased from 1995 to 1996 and decreased from 1996 to 1997. Total cost per ton increased for four contractors from 1995 to 1996, while four showed decreasing cost per ton. For 1996 to 1997, five contractors had a cost per ton increase and seven showed a cost per ton decrease. Some of these shifts can be attributed to the fact that several of the mechanized contractors in the Central-Appalachians were "start-up" contractors when the study began.

West Virginia contractors had the highest workers' compensation premiums per ton and Georgia contractors had the lowest. Labor costs per ton were highest for North-Central Appalachian contractors and lowest for the Southern Appalachian contractors. Contractors who produced predominantly sawlogs tended to have higher efficiency rankings than those who produced primarily pulpwood.

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Chapter 1 INTRODUCTION

1.1 Background Information and Study Purpose

In the eastern United States, independent logging contractors usually perform the felling and processing of trees and transport these raw materials to the forest industry (Walbridge and Shaffer 1990). These contractors find themselves trying to operate in an increasingly difficult business environment. Equipment costs have increased dramatically, while hiring and keeping qualified labor have become challenges. Many workers are reluctant to work in an uncontrolled, physically demanding, and dangerous environment, opting to work for plants or businesses that offer more pleasant working conditions and more fringe benefits. Contract rates have not increased in pace with ever-increasing operational costs, and in some instances, have not increased at all. Poor market conditions in the late 1990's brought on by international competition and the need to comply with environmental regulations have forced contractors to bear additional operating costs. Extremely high workers' compensation rates in the more mountainous areas of the United States put these regions at a further economic disadvantage.

Participating contractors are in the upper tier of the logging profession. Contractors of all sizes are represented, yet they share the same common goals. They want to increase the profitability of their business, become more efficient in their operations, and provide a steady and competitive salary for their employees. All of these attributes must be achieved without compromising the safety of their crew or inflicting damage upon the environment. These are the loggers that the industry should covet and can ill afford to lose.

The purpose of expanding the cost and production study into the Appalachians is to provide insight into the status quo of the logging profession in geographical areas other than the traditional southern United States. Since the cost and production study has increased in population size and scope, information can be provided that can aid logging contractors with their business efforts and help consuming firms manage the wood supply system. The problems and conditions in this report do not necessarily reflect the industry as a whole; they simply describe a sample population to serve as a beginning point for exploring strategies to improve the physical and business performance of individual operations and improve relations within the entire industry.

Chapter 2 LITERATURE REVIEW

2.1 Related Research in Harvesting Operations

Most recent efforts in measuring harvesting economic efficiency have examined operations in the coastal plain and piedmont regions of the southern United States. Carter and Cubbage (1995) used econometric stochastic frontier estimation to measure efficiency of pulpwood contractors in the South between 1979 and 1987. The efficiency differences they discovered were attributed to age and experience, the technology used, and the scale of production. Their research was based on aggregate data instead of on individual observations. This basis differentiates their study from more recent cost and productivity studies (Shannon 1998).

Wang and Greene (1999) used a computer simulation program to predict the performance or productivity of harvesting systems. This technique uses an approach starting from the inside and progressing outward. Internal factors are critiqued and used to predict productivity. Stuart (1981) employed this inside-out technique by developing a numerical simulation system for modeling machine and system activities and interactions.

The cost, productivity, and efficiency studies of independent logging contractors conducted through this project differ from the simulation approach. These efforts use an outside-inside approach. The performance of each contractor is analyzed and used to identify factors that are the root causes for his performance, whether internal to his business or the result of external factors. Analysis begins on the outside and progresses toward the inside, not only of the individual operation but also of the complete wood supply system.

Loving (1991) analyzed 24 independent logging contractors in the Southeast and evaluated the excess capacity of these contractors. He concluded that most loggers were unable to achieve possible efficiencies due to the large number of suppliers in competition. Excess logging capacity was determined to be one of the most damaging problems of the wood supply system in the late 1980's and the early 1990's (Loving 1991).

LeBel (1993) built on Loving's work to determine the reasons for lost productivity. He found that weather, quotas, and moving were the most documented causes of lost production. He also established that occasions of weather- related variability significantly outnumbered quota-related variability and that these losses were more likely due to road conditions than logging conditions. LeBel (1993) further explained that better implementation of quality management tools was much needed in wood procurement.

Lebel (1996) initiated the use of a nonparametric statistical tool--data envelopment analysis (DEA)-- on the existing contractor data set to determine technical efficiencies. This method was also utilized by Shannon (1998) on an expanded contractor data base. Upward trends in annual production and costs were evident from 1990 to 1995, generally dropping off in 1996 (Shannon 1998). Walter (1998) studied a subset of 23 independent logging contractors representing six southern states from 1988 to 1994. He evaluated firms on their ability to convert inputs (dollars) into outputs (tons of delivered wood). Walter (1998) noted that loggers expanding their operations in attempt to increase productivity suffered efficiency losses more often than efficiency gains.

Hancock (1991) conducted a similar study in the mountainous regions of Virginia and West Virginia and concluded that increasing production is a critical component to decreasing costs per unit, and consequently, increasing net income. He also documented the negative effect that quotas have on logging contractors. This on-again/off-again buying pattern forced loggers to decrease production and lose potential efficiencies of scale.

2.2 Logging Cost Analysis

Costs can be defined as the amount of resources used in the efforts to achieve a certain goal and are commonly divided into fixed costs or variable costs (Hancock 1991). However, in the short term, all costs are fixed and over time, all costs become variable (Stuart 1998). Logging cost analysis traditionally has been based upon the principle of operating at the production level where unit costs are at a minimum (Matthews 1942). Encouraging contractors to produce in the range of least unit cost is counter-productive to both contractors and wood-consuming entities (Stuart 1997). Shannon (1998) concluded that operating in the area of least costs is not beneficial to the entire wood supply system. Matthews (1942) used the balanced system to emphasize the cost achieved through high efficiency per machine.

According to Miyata and Steinhilb (1981), two methods of cost analysis are commonly used: the machine rate technique and the cash flow technique. The machine rate has been a useful tool in the past; however, this method does have drawbacks. It can be viewed as a quick and simple method of cost comparison (Stuart 1980). Stuart stated that the machine rate is based on general assumptions and contains very little actual or hard data. Miyata (1980) stated that the artificial variables and assumptions can lead to the machine rate approach being misapplied. Based on this evidence, the machine rate should be used guardedly, for it can easily provide inaccurate results. The machine rate is not the recommended method for cost analyses seeking to produce results on a cost per unit basis (Hancock 1991).

Managing cash flows is a critical skill required by all successful wood producers, primarily because cash flows are not always positive (Stuart 1980). A business owner must learn how to weather these difficult times to ensure business survivability.

2.3 Cost Components

Loving (1991) used the cash flow analysis to group information into broad, manageable cost supplies. He found that 75% or more of the total costs fell into three categories: labor, equipment, and consumables. These categories account for up to 90% when contract hauling costs were excluded. According to Loving (1991), businesses were in a stage of maturation when the costs were nearly equal in distribution. Those businesses in decline had a larger proportion of costs allocated to consumables and a smaller proportion in equipment. Growing businesses would reflect more money going to equipment and less being directed toward parts and repairs (Loving 1991).

In addition to the three large cost categories described by Loving (1991), three other cost categories have been examined. Stuart and Grace (1999) noted that contract services tend to increase when firms decide to pay for activities such as trucking, moving, and BMP closure rather than to invest in the equipment or labor to do the job internally. Insurance costs, excluding workers' compensation, increased from 1994 to 1997, but these increases were marginal, primarily as a result of decreasing rates on aging harvesting equipment (Stuart and Grace 1999). They also noted that administrative overhead costs increased by 111% over the same time frame. These forces were driven by the necessity for additional bookkeeping, as well as an increase in demand for further education and employee training. The administrative cost increases were also influenced by the popularity of cell phone usage among contractors and the increased practice of employee drug testing (Stuart and Grace 1999).

Hancock (1991) also found that labor was the largest cost component in the Virginia and West Virginia regions; however, workers' compensation insurance rates could be a significant source of "inflating" total labor costs. Sinclair et al. (1985) studied 23 independent logging contractors in Minnesota and found also that labor was the largest cost component. However, stumpage and contract service expenses were not included in Sinclair's study.

Pulpwood harvesting operations in Brazil were analyzed, and it was noted that harvesting costs were a "trade-off" between capital and labor costs (Ponce 1978). The individual business owner could use personal discretion when determining the most efficient combination of these two inputs. Independent logging contractors are dependent upon cut-and-haul contract rates to provide the revenue to cover operational and other business-related costs (Haggard 1981). Haggard's study analyzed chipping contractors in southern Ohio. Each contractor's cost and production information was paired and used to determine cut-and-haul rates based on a break-even production level.

2.4 Measures of Efficiency

Similar studies have been conducted to determine efficiencies of harvesting operations. "The efficiency of a wood harvesting system is highly dependent on the environment in which it is operating" (Andersson and Laestadius 1987). They concluded that this environment includes social, educational, and industrial factors in addition to weather, terrain, and tract conditions.

Stuart et al. (1998) categorized the causes of inefficiencies into five categories: (1) technical, (2) organizational, (3) natural, (4) administrative, and (5) regulatory. They described technical forces as machine productivity and reliability and organizational forces as the business and operational skills of the owner. Natural factors include weather and soil-related factors. Administrative forces are external factors imposed by the wood-consuming industry, and quotas are a common example of administrative restraints. Finally, Stuart et al. (1998) described regulatory factors as those enacted by governmental agencies, including the Fair Standards Labor Act

(FSLA), the Occupational Safety and Health Administration (OSHA), and the Department of Transportation (DOT).

Chapter 3 METHODOLOGY

3.1 Production and Cost Study

This cost and production study of independent logging contractors has been an ongoing study at Virginia Tech since 1988. Graduate students in the Department of Forestry's Industrial Forestry Operations program have contributed to this effort: Easton Loving 1991, Luc LeBel 1993, LeBel 1996, Mike Walter 1998, James Shannon 1998, and Chris Omohundro (1999) have maintained and expanded the data set. Before 1996, this data set only included loggers from the southern United States. In 1996, the effort was expanded to include contractors in the Appalachian Mountains, the Allegheny Plateau region, and the northeastern United States. Lee Miller (1999), conducting similar research at Mississippi State University, added contractors from the Lake States and the Gulf region.

More than 35 loggers in the Appalachian region were contacted and most agreed to cooperate. Business considerations, market pressures, and a variety of other factors led to a smaller than expected participation. Data from 15 contractors in the Appalachian region, representing nine different states (Figure 3.1) and 36 logger years are included in this analysis. Data from 1995, 1996, and 1997 were provided by the 15 participating contractors; however, all contractors were not able to supply data for all three years of business operation.

Figure 3.1 Geographic location of participating contractors.

3.1.1 Independent Contractor Selection

Logging contractors for this study were recommended by the American Pulpwood Association (APA), APA member companies, or various logging councils or associations. The prospective contractors had to meet established criteria; all had to be regarded as being qualitatively among the top 20% of loggers in their respective regions, operated in accordance with environmental and legal guidelines, and were in good "standing" in their community. The loggers were required to have detailed records and a willingness to cooperate and provide the necessary information. The contractors were visited personally and briefed on the details of the study; any questions or concerns were immediately addressed. If the contractor agreed to participate, subsequent follow-up visits were scheduled.

3.2 Data Set

3.2.1 Data Collection

The first visit after the contractor agreed to participate was a half-day to a full-day visit and occurred on the logging job. The contractor was interviewed to obtain demographic information, and the on-site interview provided a first-hand account of how the contractor conducted his operation. During this interview process, the method of transferring cost and production data was discussed with the contractor, and different methods of transfer were available to make this task as painless as possible. Often, a second visit was scheduled to assist the contractor in gathering the needed information. The second visit usually occurred at the logger's home, shop, or accountant's office. Only information that pertained to the contractor's operational expenses were requested. These costs were then assigned to six different categories by project staff, as shown in Table 3.1 (Walter 1998).

Table 3. 1 Six categories of expenses.

1. Equipment
    - A. Equipment Value (Depreciation or Note Payments, Interest, Lease, Rental, Warranty)
    - B. Taxes (Highway Use, Property Tax, License)

2. Labor
    - A. Wages and Salaries
    - B. Payroll Taxes (FUTA, SUTA, FICA, Medicare)
    - C. Workers' Compensation Insurance (WCI)
    - D. Benefits (Uniforms, Health Insurance, Bonuses)

3. Consumables
    - A. Fuel, Oil, Tires (Fuel Tax)
    - B. Repairs and Maintenance (Supplies, Parts, Chainsaws)
    - C. Misc. (Truck/Equipment Washing, Wrecker Service, Gravel)

4. Administrative Overhead
    - 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. Insurance (Except WCI)
    - A. General Liabiltiy
    - B. Equipment (Fire/Theft/Vandalsim)
    - C. Umbrella Policy

6. Contracted Services (Any expense incurred from services of a third party: contract trucking, equipment moving, etc.)

Production data were sometimes gathered directly from the loggers but more commonly obtained from the records of the forest product companies that they supplied. The production data consisted of the green tons of wood delivered during the study period, requested at the highest resolution possible--daily--but weekly, quarterly, or annual reporting also was used. All production information was analyzed in tons. Any production data not reported in tons (MBF and cords) were converted with local conversion factors. The production data were reported on a daily, weekly, or monthly basis, but on a few occasions, only a yearly total could be provided. All of the information obtained for this study was confidential, and each contractor was assigned a numerical code to ensure that this confidentiality was not breached. Trust continues to be the foundation of this effort.

3.2.2 Equipment Valuation

The annual expense of logging equipment was taken either as depreciation plus interest basis or by note payments plus interest. The most common equipment expense was depreciation, when the cost information was derived from tax returns. When the cost information was obtained from an accountant or from the logger’s financial records, note payments were often the most readily accessible and convenient basis. The most commonly encountered depreciation method was the Modified Accelerated Capital Recovery System (MACRS) set forth by the Internal Revenue Service. The benefits of this method were that the contractor could depreciate most of a piece of equipment’s value during the first three years of ownership when he was amortizing his equipment loan. The straight-line depreciation method, which deducts the same amount each year, stabilizes equipment costs but does not reflect the true cash flow of the business (Stuart 1999).

3.2.3 Inflation

The primary objective of this study was to measure the efficiency of the scarcest asset of the contractor, money. A second objective was to develop indices to measure business performance over time. The mix of inputs to these businesses, plus the effects of changing excise and use taxes, insurance rates, and equipment costs, made developing an accurate inflation index very difficult (Cutshall 1998). Adjusting for inflation would hide more than it would reveal. Contract rates paid for the service of study participants were not so adjusted, and many costs were cut during the study period.

3.2.4 Owners' Salaries

The amount of money loggers take out of their business as their "draw" is personal and privileged information. This figure often included two forms of remuneration, one for the logger's services as a working member of the crew and supervisor and the other for the logger's profit and return on investment. Because this study was concerned only with costs, our concern was to assure that the job was charged only for the owner's actual services.

A flat rate of $20,000, plus a $0.30 per-ton scale adjustment, was calculated for each owner based on a full year's production (Walter 1998). For contractors who started operating sometime during the year, their rate was pro-rated accordingly, with the $0.30 per ton applied. For one business operation, the exact amount of the three equal partners' yearly salaries was used. Since contractors' profits were not studied, this method of estimating officers' salaries was deemed sufficient and justified.

Chapter 4 DEMOGRAPHICS, BUSINESS, AND TECHNOLOGY

Complete demographic information was obtained for 14 contractors. One contractor was not able to provide complete demographic information.

4.1 Demographic Information for Logging Contractors

4.1.1 Age, Experience, and Education

All 15 businesses included in the data set were owned by white males between the ages of 34 and 66 (median age of 44 years). The inter-quartile range (middle 50%) was between 37-47 years of age (Figure 4.1).

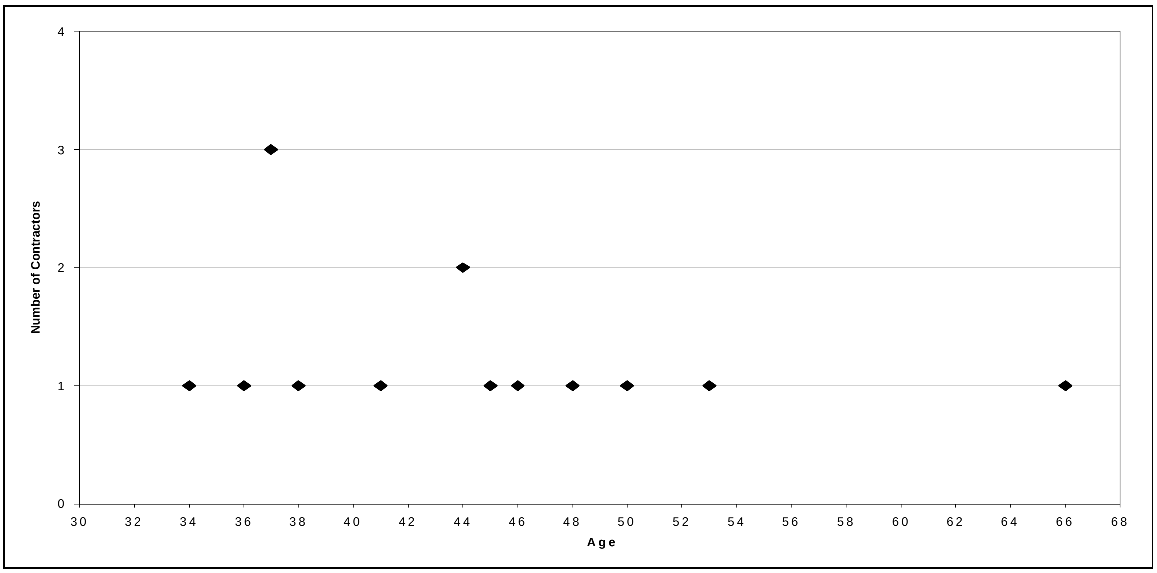

Figure 4.1 Age distribution of independent logging contractors.

The experience level for business owners ranged from 3 years to 27 years, with a median of 19 years and an inter-quartile range from 10.75 years to 21 years (Figure 4.2). This experience level only included the years that the contractors spent in an ownership role of the present business operation. Years spent working for other organizations or progressing through the ranks of a family-owned business were not included.

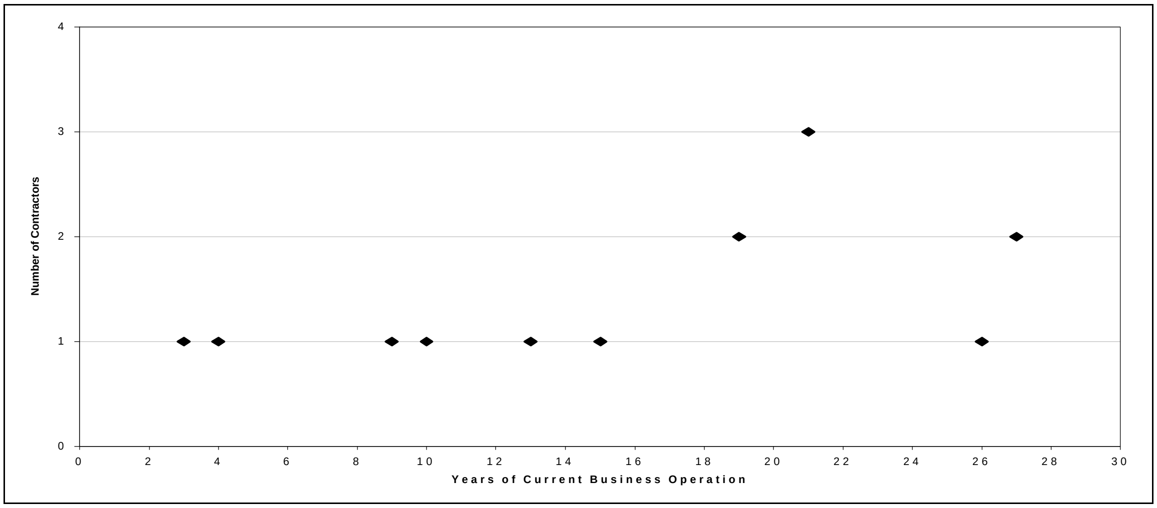

Figure 4.2 Experience level of independent logging contractors.

Every contractor had completed high school, and five had extended their education beyond a high school diploma (Figure 4.3). Two contractors held bachelor's degrees, one in geology and geography and the other in business administration. One contractor earned an associate's degree in business administration, while another contractor earned an associate's degree in agriculture. One contractor had two years of college education but did not earn a degree.

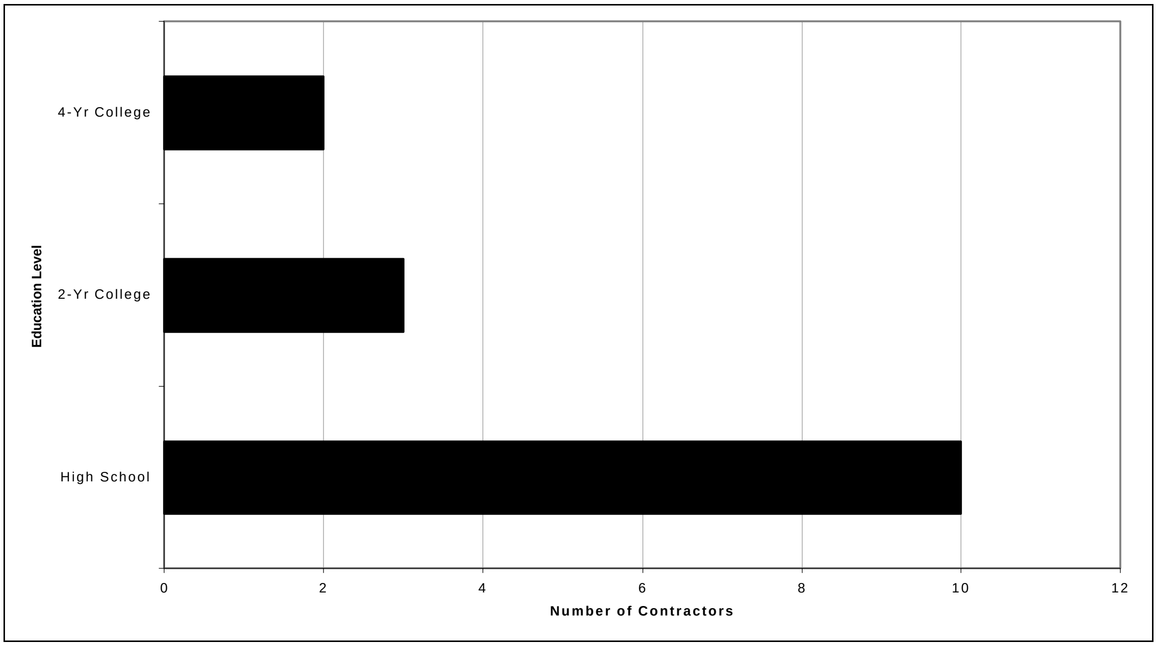

Figure 4.3 Level of education of independent logging contractors.

The oldest and the fifth oldest contractors (66 and 45 years old) had bachelor's degrees, while the five youngest contractors had a high school education. The three contractors with two years of college education are 41, 44, and 50 years of age. These data clearly indicate that there was no definite relationship between contractor age and education level. Four of the five contractors with a post-high school education employed family members in their businesses.

4.1.2 States of Participating Contractors

All 15 contractors operated in mountainous regions across nine different states (Figure 4.4). Ohio and West Virginia each had three participants (20% each), while Georgia and Tennessee each had two contractors (13.33% each). Maryland, Maine, New York, Pennsylvania, and Virginia had one contractor each, or 6.67% of the total.

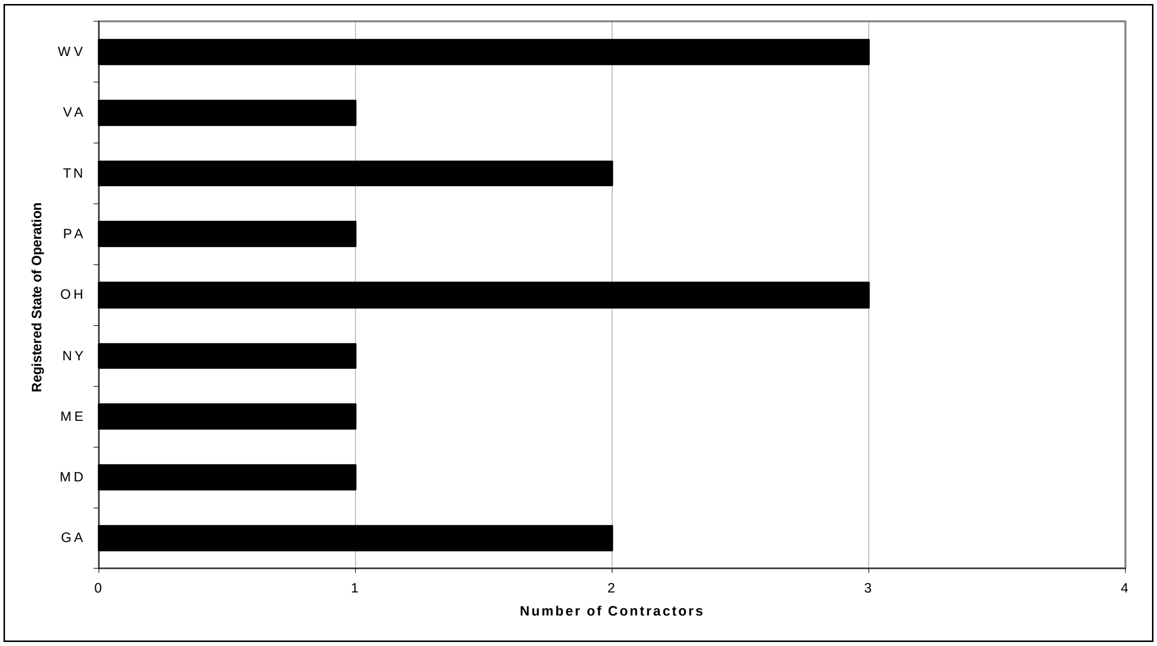

Figure 4.4 Registered state of business operation of contractors.

4.2 Business Structure and Background

4.2.1 Business Organization

The participating contractors used various forms of business organization. Eight (53.33%) were sole proprietors, three (20%) were full C corporations, and two (13.33%) were sub S corporations. One contractor (6.67%) had formed a limited liability company (LLC), and another participant was involved in a general partnership (Figure 4.5).

There are numerous reasons supporting each type of business operation. A full C corporation offers reduced liability and a degree of protection for the owner's personal assets; however, concerns over double taxation, incorporation fees, and increased paperwork often deter interest. A sub S corporation allows distribution of earnings to the shareholders to avoid double taxation (APA 1993). Incorporation requires a board of directors and an annual meeting. Sole proprietorships are the simplest business form to arrange and afford the owner complete control of business decisions. However, a sole proprietor cannot protect his personal assets, and raising additional capital can be difficult. A general partnership increases the ease of raising capital and increasing management experience but exposes each partner to increased liability. An LLC can be viewed as a compromise of the other legal forms of operation. It offers the flexibility of a sole proprietorship or a partnership while affording the luxury of reduced liability without incorporation (Stuart 1999). Virtually all contractors who serve as sole proprietors admitted that they have contemplated incorporation based on advice from an accountant or after seeking legal counsel. In fact, several loggers stated that “I just haven’t gotten around to doing it yet!”

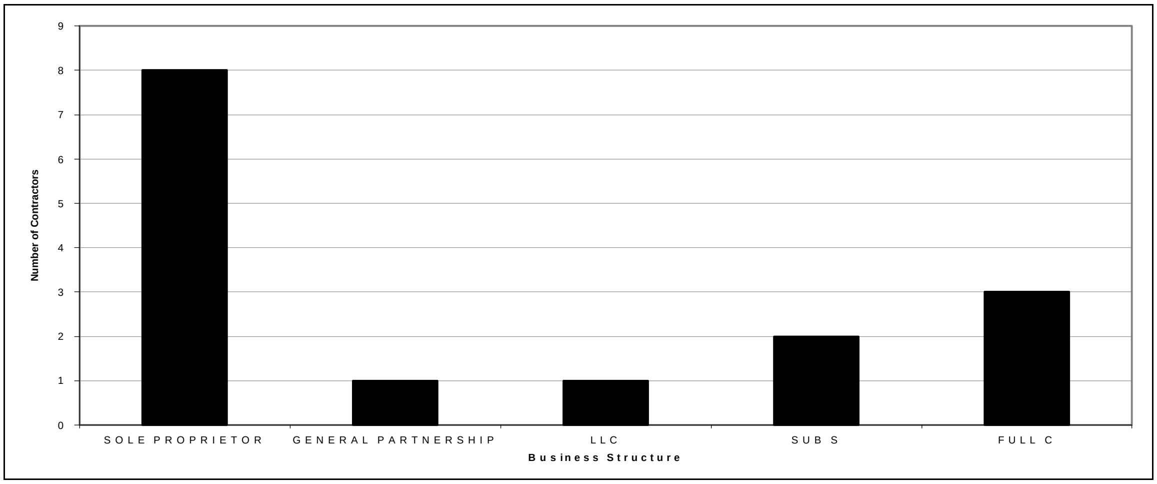

Figure 4.5 Contractor legal forms of business operation.

4.2.2 Trucking Strategies

The contractors surveyed utilized a variety of trucking strategies (Figure 4.6). Three contractors (21.43%) used trucks that belonged directly to the logging business, while five contractors (35.71%) sub-contracted their hauling to companies with separate ownership. Three contractors used a combination of company-owned trucks and contract hauling, while three other contractors formed separate trucking companies in which they serve in an ownership role. One contractor was strictly a cut-and-skid contractor, and all trucking expenses are borne by the forest products company for which he contracts. For the three contractors who own a separate trucking company, two of these companies were incorporated and one is an LLC.

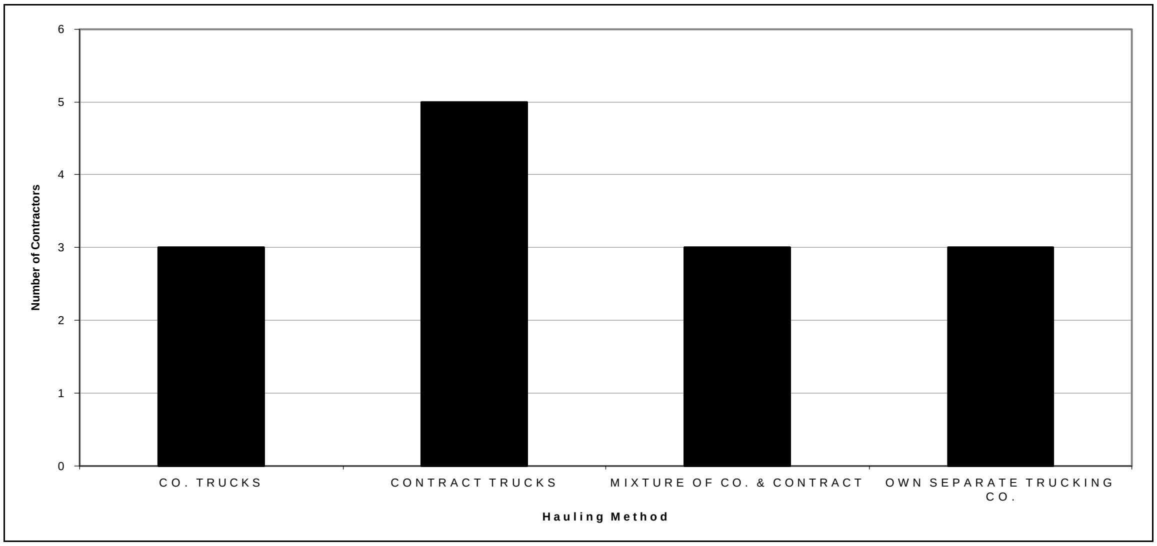

Figure 4.6 Trucking strategies of independent logging contractors.

Trucking was often viewed as a "trade-off." Truck ownership allowed the logger to take direct control of wood transport, including driver, maintenance, and hauling schedules. Unfortunately, trucking also increased liability exposure of the business. When a reliable and responsible contract trucker could be found, many loggers chose to surrender direct control of trucking and eliminate the "headaches" that accompany truck ownership. A common alternative to contract trucking was to establish a trucking company completely independent (in a legal sense) from the logging business and sub-contracting hauling duties to it. This practice can reduce liability for the logging business and may permit drastically lower workers' compensation insurance (WCI) rates for truck drivers. In one of the participant's states, the WCI rate for in-woods employees was $47.90 per $100, payroll while the WCI rate for his truck drivers was $9.41 per $100 payroll! Further analysis of the trucking sector is illustrated in Figure 4.7.

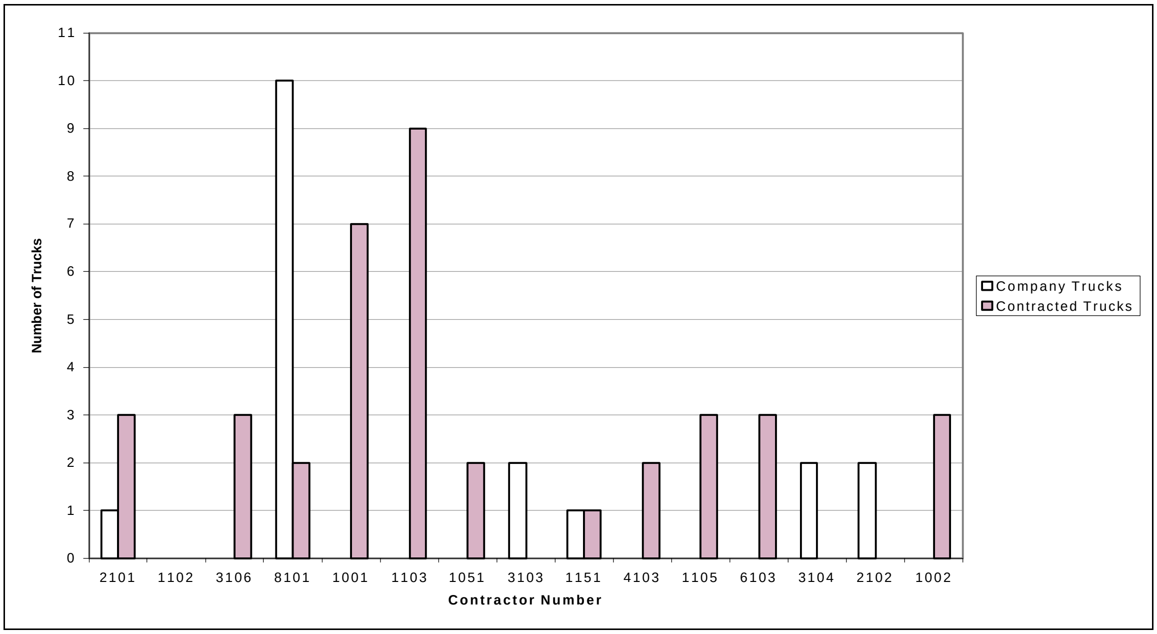

Figure 4.7 Number of trucks used for respective trucking strategies.

4.2.3 Stumpage Acquisition

Shannon (1998) listed three primary means of acquiring raw materials for logging contractors: from company-owned lands (fee lands), stumpage purchased by dealers or brokers, and stumpage purchased directly by the logging contractor. Seven (46.67%) contractors worked on 100% company or fee land and eight (53.33%) contractors purchased some of their own stumpage. Five of the eight contractors who purchased stumpage bought approximately 5%-10% of their own stumpage. Of the remaining three contractors, one bought approximately 30%, another bought approximately 95%, and the final contractor bought 100% of his own stumpage. All of the contractors expressed a desire to buy their own stumpage to increase their flexibility and reduce their dependency on the fee lands of wood-consuming companies. The biggest factors that prevented their efforts to purchase more stumpage are limited timber resources, stiff competition, and trying to compete with the "deep pockets" of Fortune 500 forest products companies. Of the 14 contractors providing stumpage information, 12 (85.71%) harvested at least 90% hardwood, one (7.14%) harvested approximately 90% pine, and one had a 65% / 35% pine to hardwood ratio.

4.3 Labor

4.3.1 Number of Employees

The total number of production and support employees for each operation was often difficult to accurately determine. Production employees varied by season of year or tract being harvested. Support employees-- mechanics, bookkeepers, and supervisors-- were often a function of family participation and business structure. In most instances, the contractors (or their respective wives) were primarily responsible for the bookkeeping duties for their business. Two contractors (13.33%) had full-time mechanics. For others, routine maintenance and minor repairs were typically performed by the contractor and his crew. Dealerships usually handled any major repairs. The two contractors who had full-time mechanics also had secretaries. All relied on accountants for financial and income tax services. Truck drivers and part-time labor fluctuated often, depending on demand and other market-related conditions. The 15 contractors employed a total of 132 regular production employees. The number of employees per job ranged from three to 42 (Figure 4.8), with a median of six and an inter-quartile range from five to 7.5 employees.

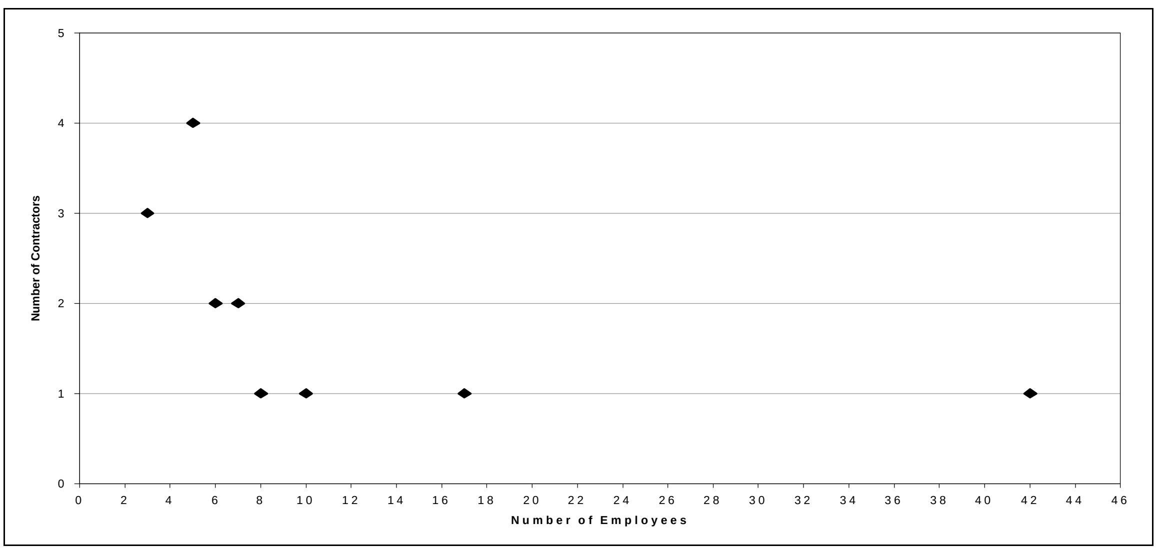

Figure 4.8 Number of employees used by each contractor.

4.3.2 Crew Structure

Eight contractors (53.33%) had multiple crews for at least some of the study period, while seven contractors (46.67%) had only one crew (Figure 4.9). Only one of the multiple-crew operations had more than two crews. This particular contractor had up to eight separate crews. Most contractors who experimented with a multi-crew operation did so sporadically, according to markets and timber availability.

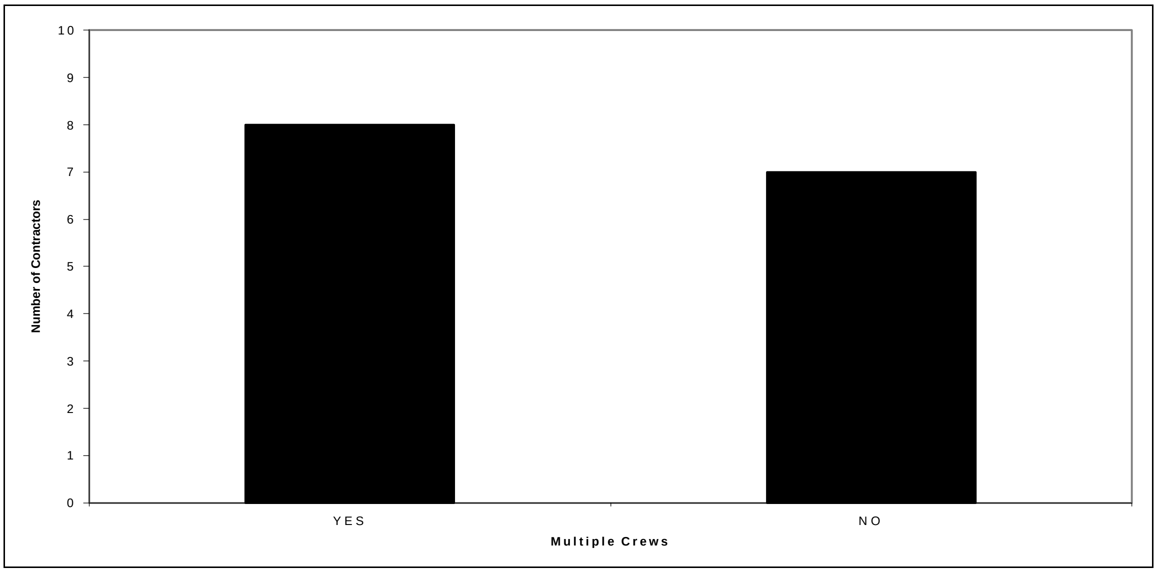

Figure 4.9 Number of contractors using multiple crews.

4.3.3 Family Businesses

Twelve contractors (80%) had family members involved in the business, while three contractors (20%) had no significant family involvement in the business (Figure 4.10). Family businesses were defined as those that had a relative employed by the business or a relative that served as a silent partner. The three non-family businesses did have wives who did bookkeeping, and most received financial compensation but it was not their primary source of income.

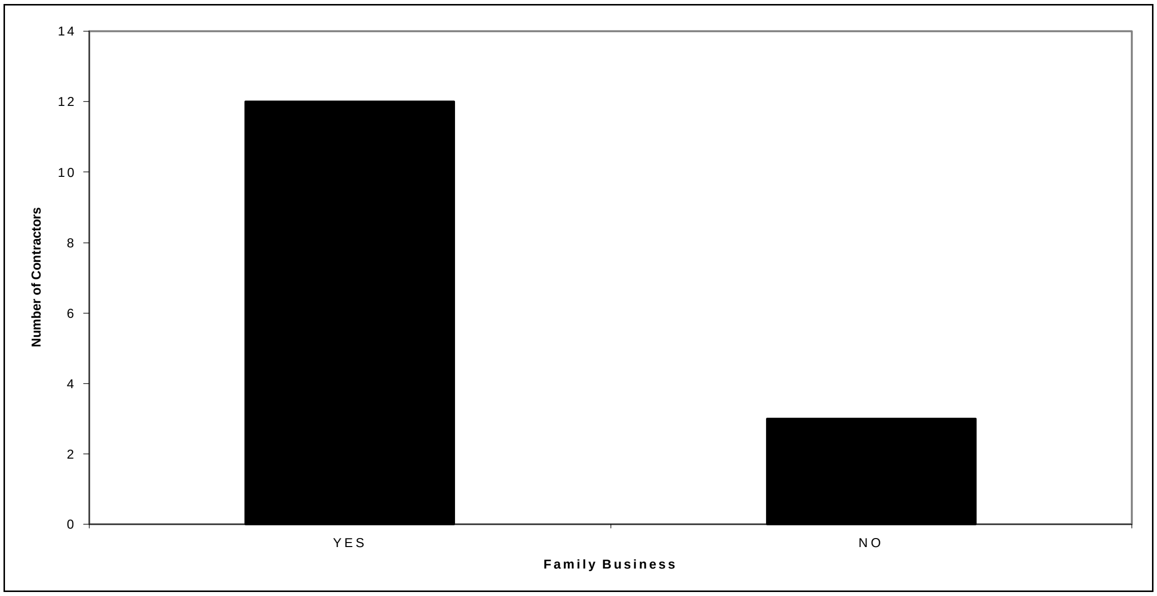

Figure 4.10 Number of contractors operating family businesses.

4.3.4 Other Business Ventures

Eight contractors (53.33%) had businesses other than their logging operation, while seven contractors (46.67%) only logged (Figure 4.11). The other businesses included trucking (3), farming (2), excavating (1), lumber (1), and real estate (1).

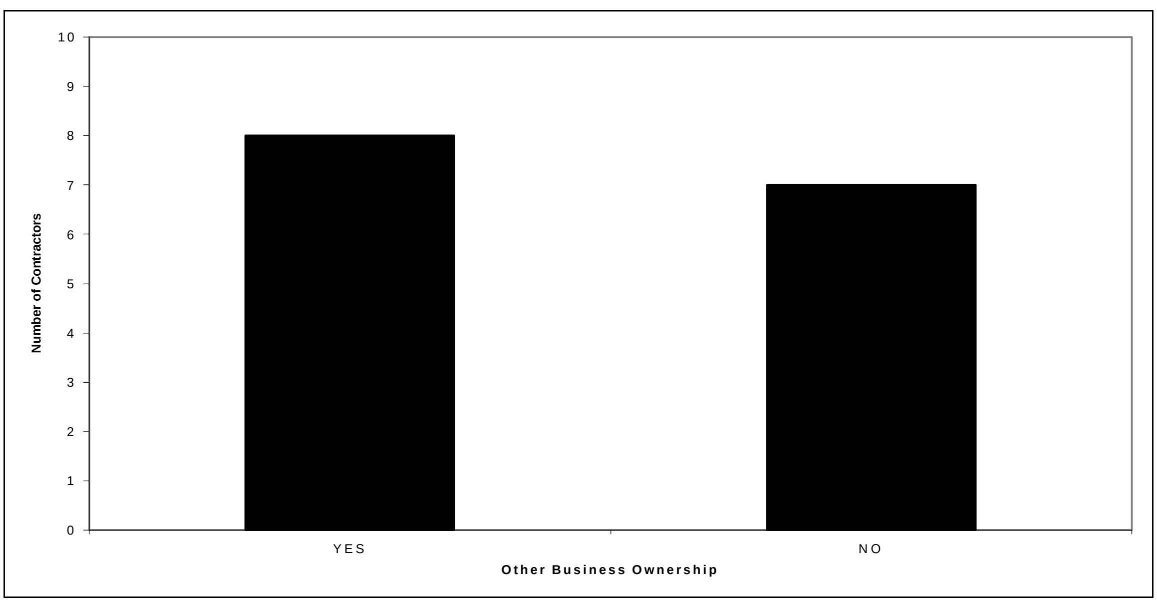

Figure 4.11 Number of contractors owning separate businesses.

4.3.5 Method of Payment

Each contractor selected a method of payment that he felt best complemented his business strategy and maintained the morale of his employees. Five different methods of payment were encountered. Most contractors had experimented with several payment options before settling on the method they now use. Payments methods included hourly, daily, salaried, on a production basis, and combinations of these methods. A common combination was starting the employee out on an hourly basis with “promotion” to a salaried position after a pre-determined probationary period. The payment method a contractor used was often influenced by local competitors. The criteria for determining which method worked best in a particular situation was the one that maintained a steady labor force.

Seven contractors (46.67%) paid on an hourly rate, five (33.33%) used a combination of hourly and salaried, and one (6.67%) used strictly a salaried method of payment (Figure 4.12). A daily method and a production-based method of payment were each used by one contractor. The contractor who opted to pay on a production rate was the highest producing contractor and the owner of the largest operation. The second highest producer paid on a daily basis while the salaried employees worked for the general partnership.

Figure 4.12 Method of payment for each contractor.

4.3.6 Workers' Compensation Insurance

Workers' Compensation Insurance (WCI) is a huge expense that contractors must bear. Traditionally, mountainous or old industrial states have drastically higher WCI rates than agrarian states. Several states have monopolistic state insurance programs and keep other carriers from entering the market. This lack of competition increases premiums and limits the options for contractors. Most contractors purchased WCI from independent insurance agencies and some were members of private, self-insured groups.

All contractors were paying on a $100 basis, but three different billing methods for WCI were observed. An audit each year adjusts the premium to payroll. One contractor fell under his state's exemption clause. This particular business involved three general partners; therefore, legally, they were not considered employees. Ten contractors (71.42%) were billed on a $100 payroll basis, three (21.43%) on a per-cord basis, and one (7.14%) on a per-ton basis (Figure 4.13). Because of the differences in WCI billing methods, it was difficult to compare every contractor's WCI. However, on a $100 payroll basis, the lowest rate was $11.00 and the most expensive WCI rate was $47.90.

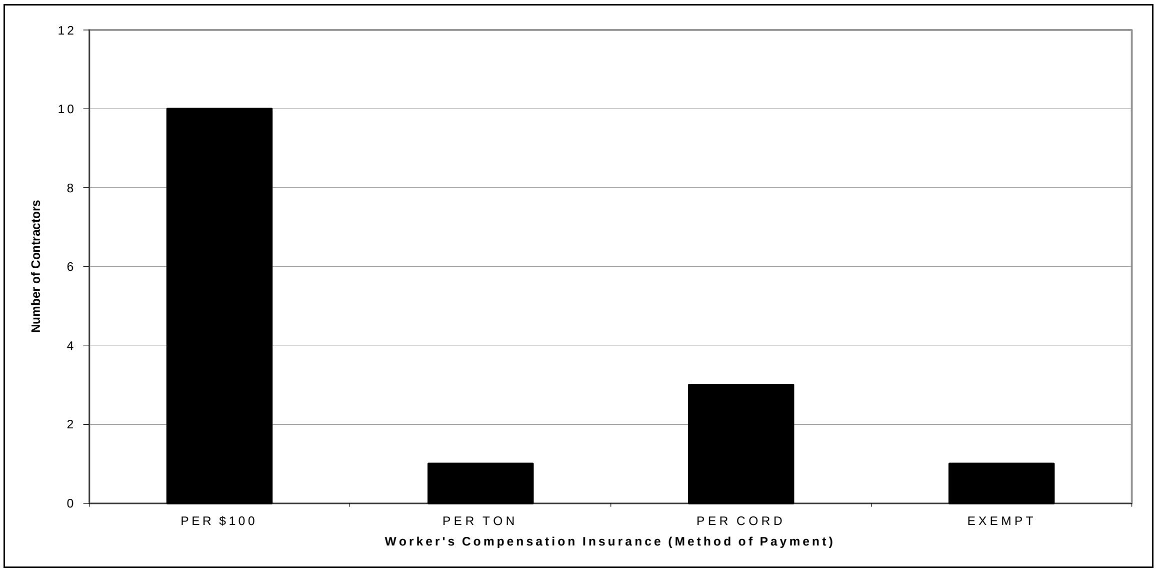

Figure 4.13 Contractor workers' compensation insurance method of payment.

4.3.7 Employee Fringe Benefits

Many people would consider that simply having a job is the best benefit of all! Eight different "fringe" or additional benefits were encountered (Figure 4.14). Of the 15 contractors sampled, three (20%) offered employee loans or financing, two (13.33%) offered 401-k or pension plans, six (40%) offered paid vacation and/or holidays, and seven (46.67%) offered employees transportation to and from the job. Two contractors provided uniforms, five (33.33%) gave Christmas bonuses to employees, eight (53.33%) offered some type of production bonus, and four (26.67%) offered employees a health insurance plan.

Every contractor wanted to offer his employees all of these benefits and more; however, limited financial resources prohibited this practice. Many contractors stated that they were constantly losing skilled and valuable employees to larger firms in the area that offered better working conditions and better benefits. Most of the contractors surveyed had experimented with numerous benefit packages over the years, but, unfortunately, could only offer limited benefits to their employees. Excluding the general partnership, the larger operations offered the most benefits and the smaller contractors offered the fewest fringe benefits.

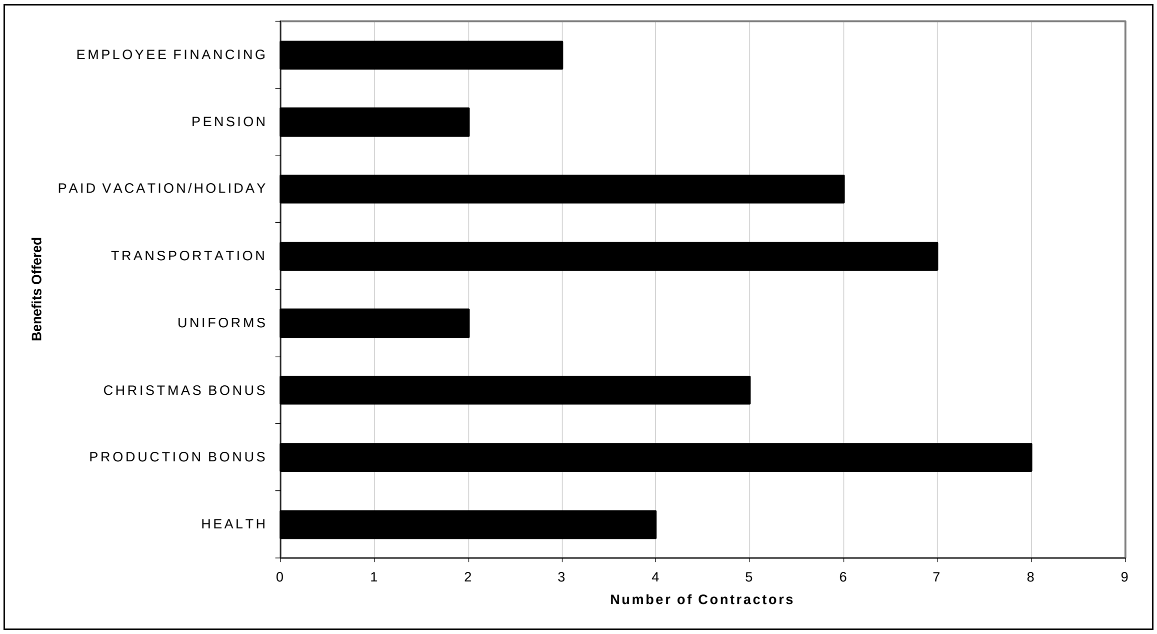

Figure 4.14 Fringe benefits offered to employees.

4.4 Owners' Role

All of the participating contractors can be viewed as a "jack of all trades. " They were vital members of the in-woods labor force of their operation. They were skilled in all areas of operation and could fill in on any piece of equipment as needed. Eleven of the 15 contractors' (73.33%) primary duty on the job was serving as loader operator. Particularly in hardwood regions, the loader operator's merchandising decisions have a significant influence on revenues. Operating the loader allowed these contractors to control wood flow for the operation and remain on the landing, which was the "heartbeat" of the logging operation. Two contractors (13.33%) used self-loading, tri-axle trucks and, therefore, did not own a trailer-mounted or tracked loader. Another contractor (6.67%) spent most of his time shuttling back and forth between his logging crew and his excavating crew. While on the logging job he mainly did bulldozer work building roads. The final contractor elected to operate his Timbco cut-to-length (CTL) felling machine. Many contractors constructed landings ahead of the logging crews, and some filled in as truck drivers.

4.5 Process and Equipment

4.5.1 Process of Operation

The most prevalent mode of operation was the traditional one of manual felling, with delimbing and topping occurring in the woods. Three contractors used gate delimbers (when harvesting pine), two used a CTR™ pull-through delimber, and one contractor used a "stroke" delimber. Two skidders normally were used to skid to the landing, where a trailer-mounted loader and a slasher saw were used to buck the stems and load for transport. Several non-traditional harvesting methods in their respective regions were observed. One such method involved a mobile high lead or cable “yarding” system. Another job used a Jammer™. The Jammer™ consisted of a spool of cable mounted behind the cab of a tracked loader. The cable extended along the top of the loader’s hydraulic boom and had interchangeable tongs that dangle at the end of the stick boom and in front of the grapple. The machine operator spun the tongs by manipulating the boom and released the slack on the cable. The tongs were slung down slope, and the worker at the foot of the slope set the tongs on the targeted stem, which was then retrieved. A clam-bunk forwarder was used to transport the timber to another tracked loader. This method of harvesting required the contractor to make a significant equipment investment. Two other contractors also used forwarders as key components of their harvesting operations.

4.5.2 Equipment Utilized

Four different felling methods were observed among the 15 contractors (Figure 4.15). Seven contractors (46.67%) used chainsaw or manual felling exclusively, while the other eight contractors (53.33%) used some type of mechanized felling during the study period. Both shear head and saw heads were used. Of the eight mechanized contractors, two (13.33%) used strictly shear heads, one contractor (6.67%) used both chainsaws and shear head felling, three (20%) used strictly saw heads, and two used both chainsaws and saw heads.

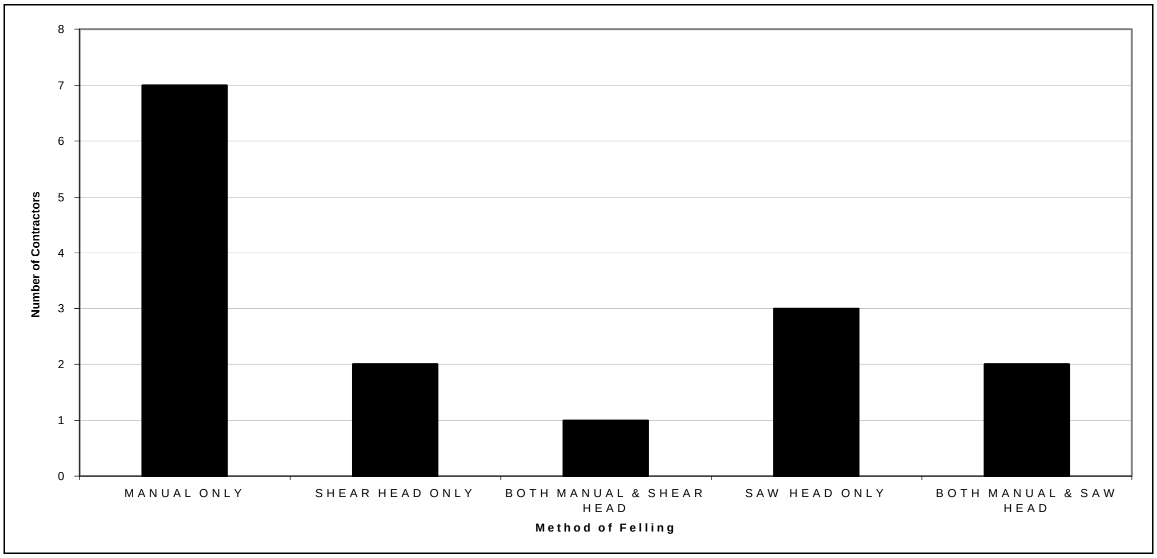

Figure 4.15 Methods of felling for logging contractors.

One of the mechanized contractors did not supply detailed information on the makes and models of his equipment. Fourteen contractors supplied information and reported 10 felling machines, ranging in age from 1994 models to a 1998 model (Figure 4.16). Forty percent were 1994 models, 30% were 1995 models; 1995, 1996, and 1997 models constituted 10% each (Figure 4.16). Thirty percent were TimbCo tracked machines, 20% were on Barko wheeled models, and 20% were on John Deere carriers. A Timberjack tracked machine, a wheeled Franklin model, and a wheeled Hydro-Ax were also used to fell during the study period (Figure 4.17).

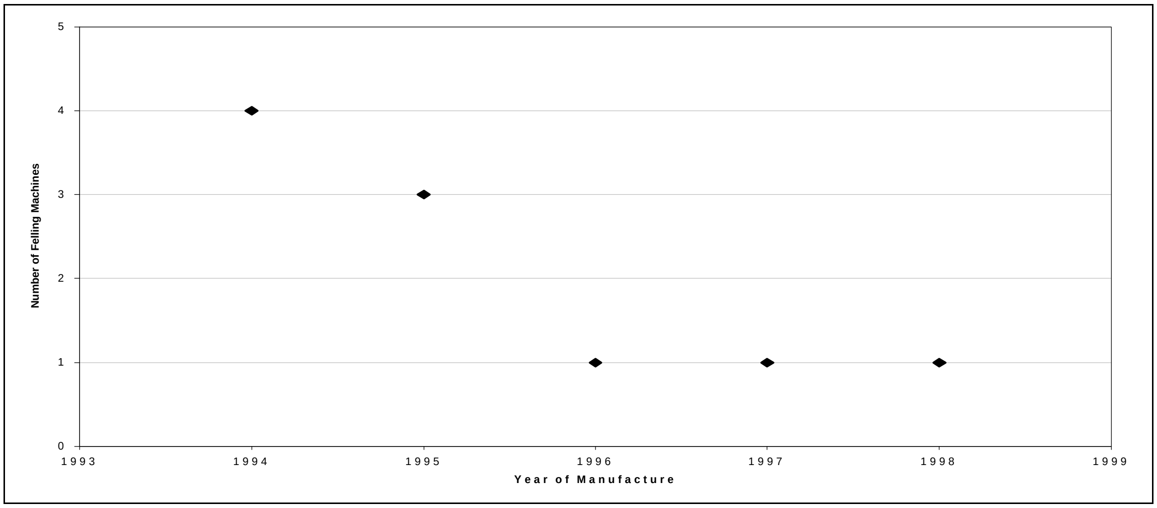

Figure 4.16 Year of felling machine manufacture.

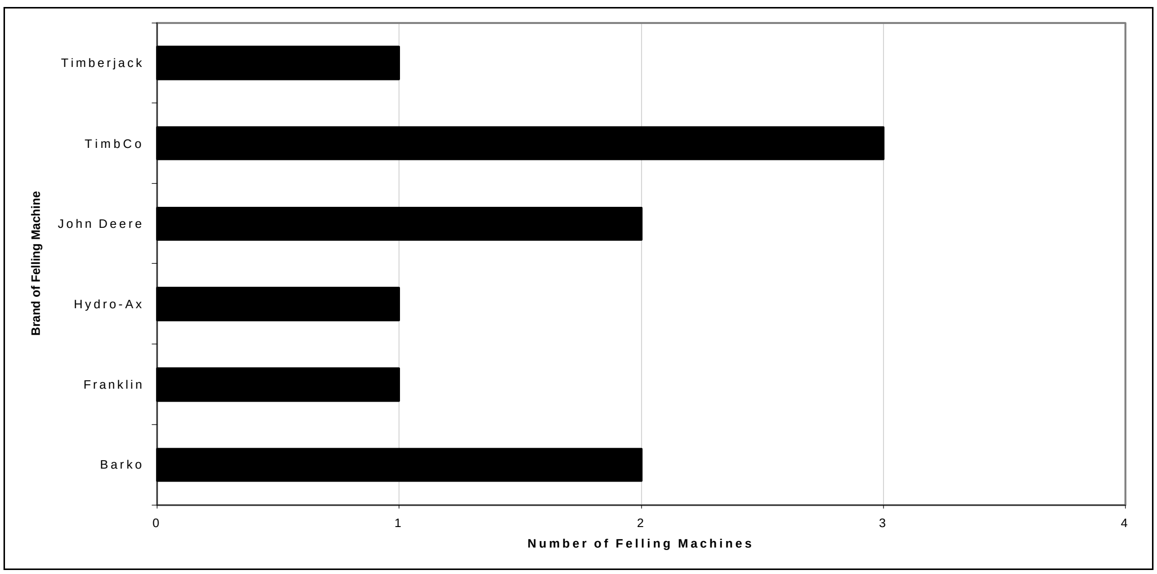

Figure 4.17 Brand of felling machine used by independent logging contractors.

4.5.3 Skidding

Fourteen contractors provided information on skidder age. The largest contractor in the study did not provide the years of his skidder fleet; however, he did provide the brand to which he is loyal. A 1979 model was still in service and two 1998 skidders were being used. Thirty-five skidders, 12 of which were four years old or less, were accounted for in the yearly analysis (Figure 4.18) and the analysis of skidder brand (Figure 4.19). Fifteen

(42.86%) were John Deere, 11 (31.43%) were Timberjack, four (11.43%) were Caterpillar, four were Franklin, and one was a Clarke.

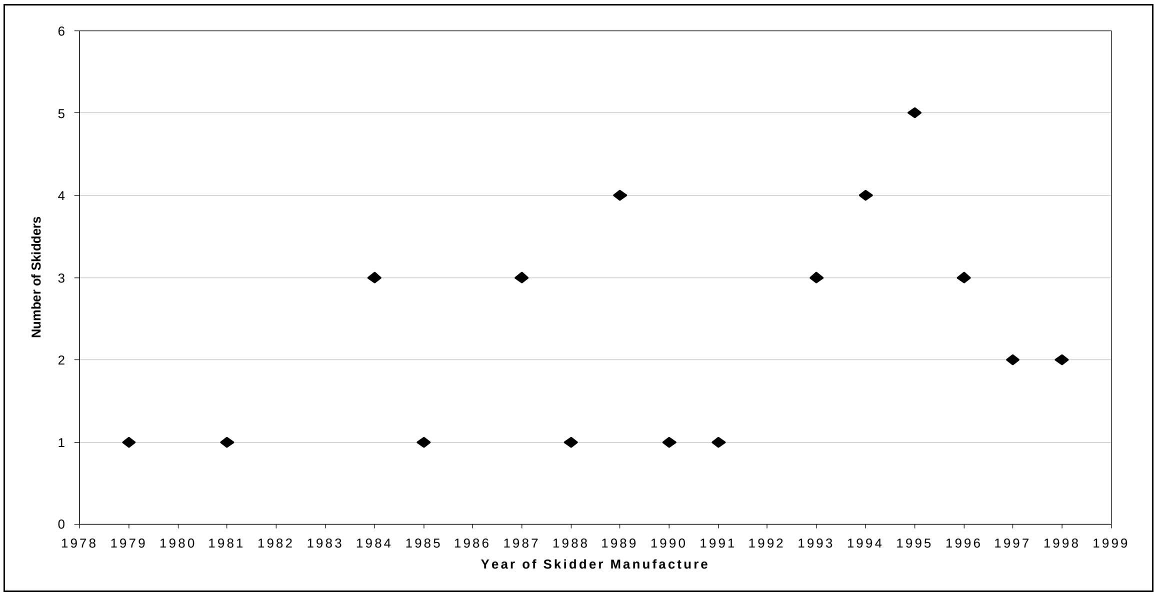

Figure 4.18 Year of skidder manufacture.

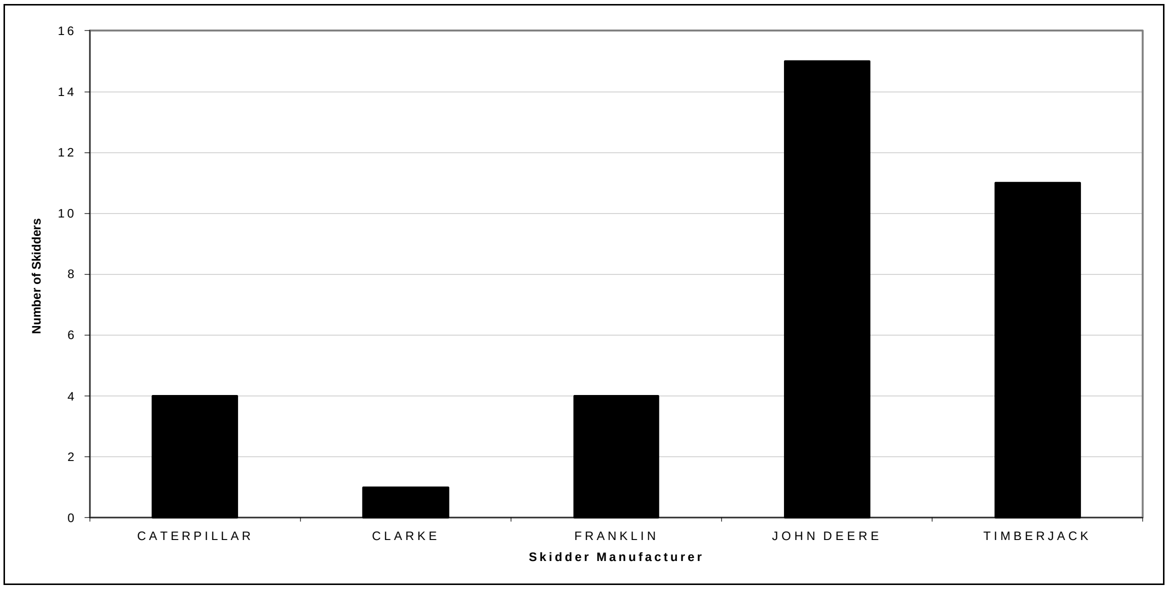

Figure 4.19 Brand of skidder used by participants.

Six contractors (40%) used only cable skidders, four contractors (26.67%) used only grapple skidders, and five contractors (33.33%) used both cable and grapple skidders (Figure 4.20).

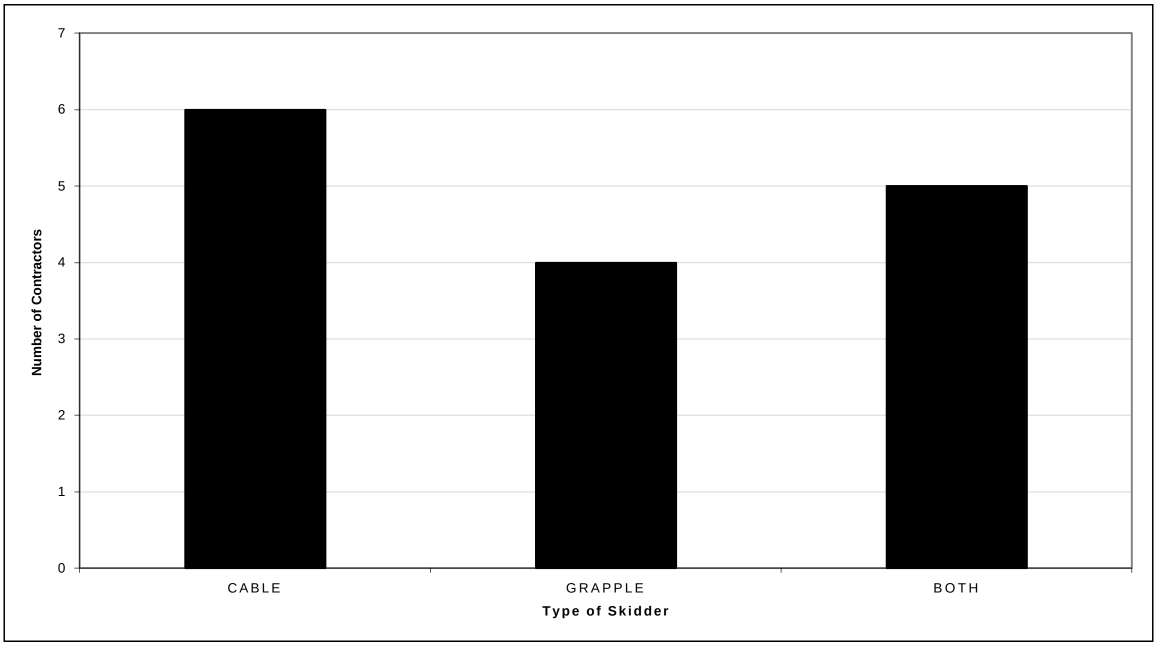

Figure 4.20 Type of skidders used by participating contractors.

4.5.4 Loading

Two contractors used self-loading, tri-axle trucks for loading and hauling, and the largest contractor did not provide detailed information on his loading operations. Therefore, the equipment spread includes 18 loaders owned by 12 participating contractors. The oldest loader reported was a 1978 model and the newest were three 1997 models (Figure 4.21). Of the 18 loaders, 11 (61.11%) were Prentice brand, two (11.11%) were Barko, two were HuskyBrute; one (5.56%) Caterpillar, one Hood, and one Timberjack were also reported (Figure 4.22). The Caterpillar was actually a modified excavating machine used as a full-time loader.

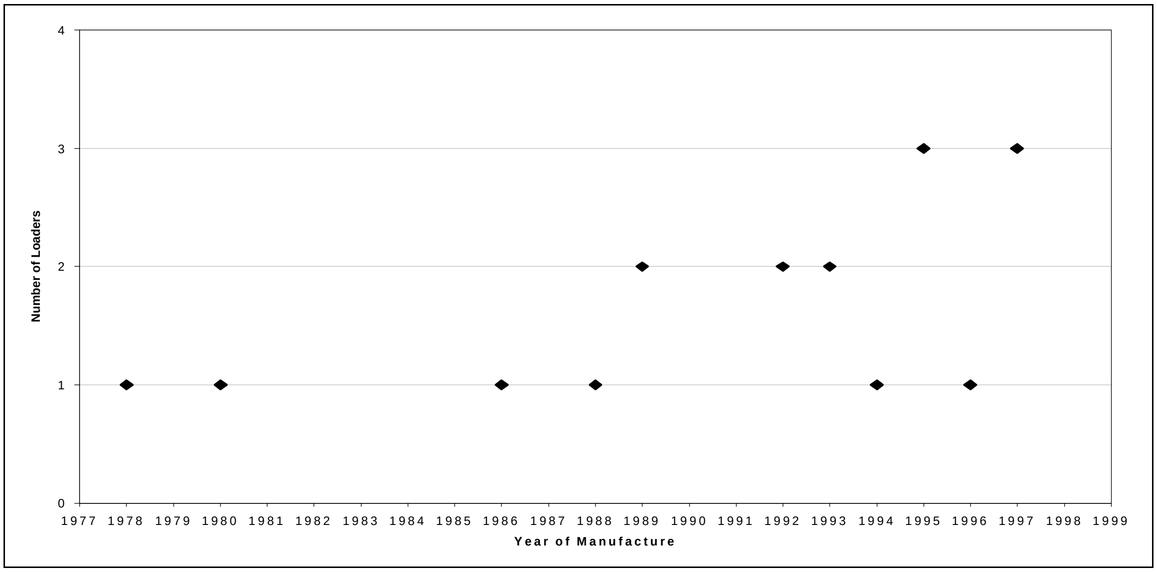

Figure 4.21 Age of loader used by participating contractors.

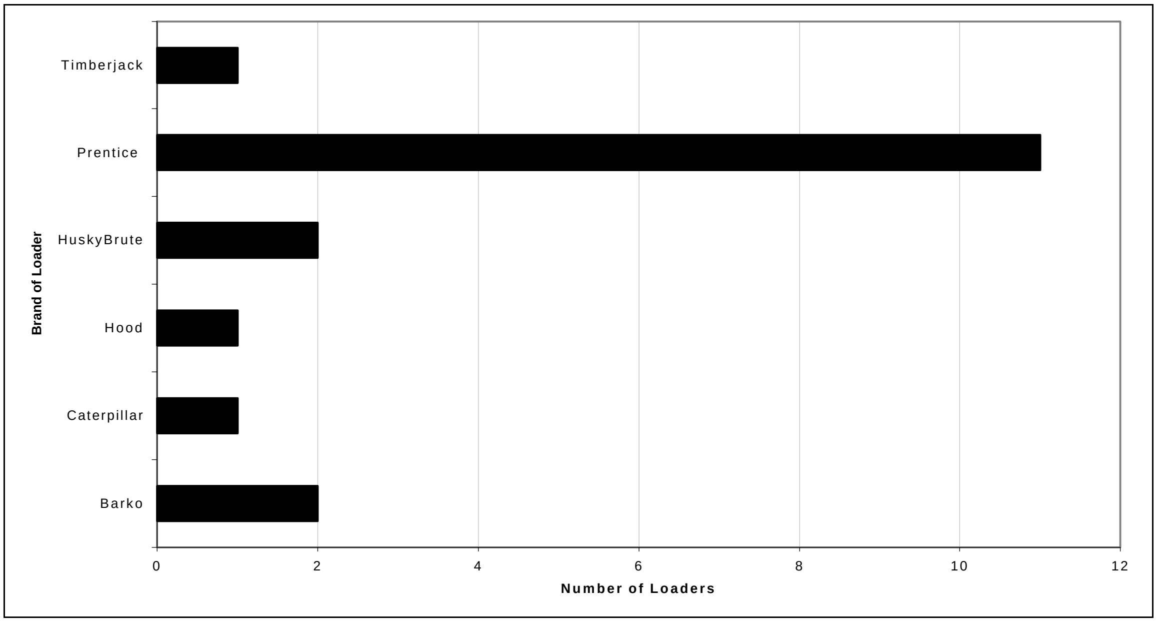

Figure 4.22 Number of loaders used by brand of manufacture.

Chapter 5 PRODUCTION ANALYSIS

Production of participating contractors was analyzed by measuring the total tons of green wood delivered per time period. Production data were reported on weekly, monthly, or yearly basis.

5.1 Production Groups

The participating contractors ranged in size and were divided into two production groups based on total tons delivered for a particular year. The first group consisted of contractors producing less than 25,000 tons and the second produced more than 25,000 tons a year. Small jobs were traditional in the region because of: (1) small tract size, (2) volatile hardwood markets, (3) small sawmills, (4) supplemental income, and (5) lack of entrepreneurial capital. The contribution of each group to the total reported is shown in Table 5.1.

Table 5.1 Production distribution by group (1995-1997).

Year	Group 1 (<25,000 Tons)	Group 2 (>25,000 Tons)
1995	11%	89%
1996	14%	86%
1997	25%	75%

The production of individual contractors in group 1 increased from 1995 to 1997. Group 1 contractors produced 47,353 tons in 1995, 77,185 tons in 1996, and 135, 731 tons in 1997. Group 2 contractors' production increased from 393,414 tons in 1995 to 466,936 tons in 1996. In 1997, the total production for group 2 decreased to 397,566 tons. This trend is predominantly due to the fact that in the early stages of the study many "start-up" contractors entered the profession as a result of industrial expansion in the region. As the study progressed, many of these start-up contractors increased production; therefore, the overall production of group 1 increased. The production decline for group two in 1997 is primarily the result of two contractors “slipping” from group 2 to group 1 during the 1996-97 period, a result of various outside influences.

5.2 Annual Production

Total annual production was reported for eight contractors in 1995 (Figure 5.1) and for 14 contractors in 1996 and 1997 (Figures 5.2 and 5.3). In 1995, production ranged from 2,728.26 tons to 183,083.4 tons, with a median of 31, 987.25 tons. The range for 1996 was from 5,471 tons to 175,023.3 tons, with a median of 26, 061.07 tons. The range for 1997 was from 10,306.69 tons to 213,194.74 tons, but the median production dropped to 24, 019.74 tons. The entry of new contractors during the study period had a definite impact on median production. Figure 5.4 illustrates the production for each individual firm over the three-year study period.

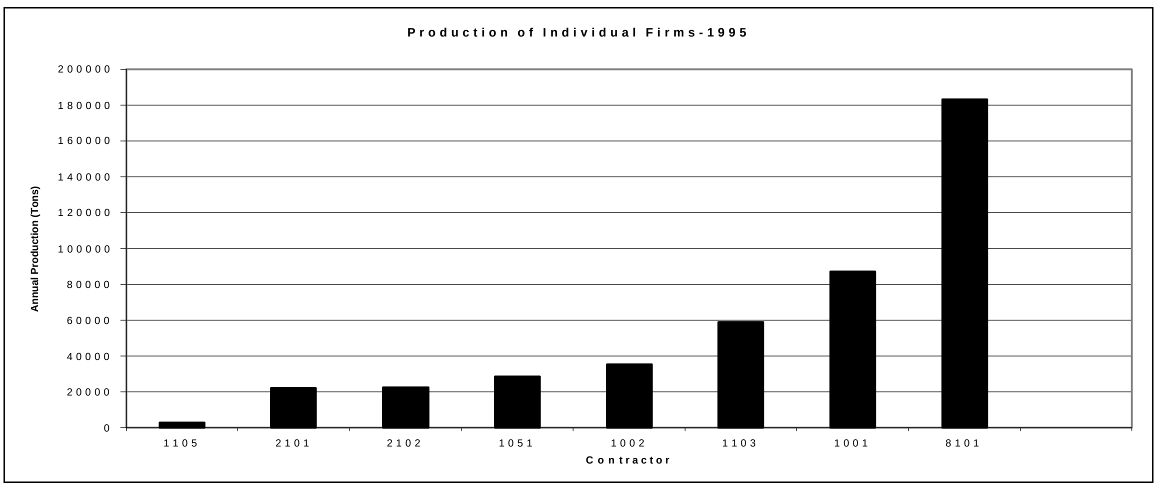

Figure 5.1 Total production by firm (1995).

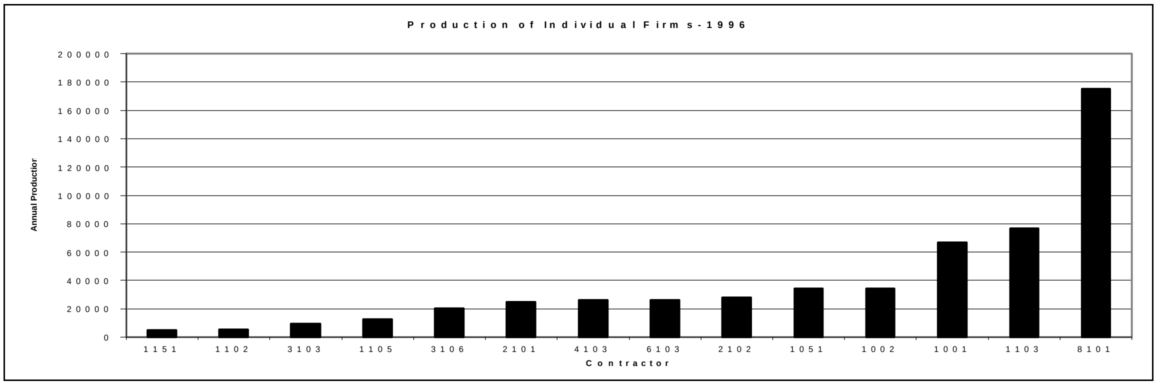

Figure 5.2 Total production by firm (1996).

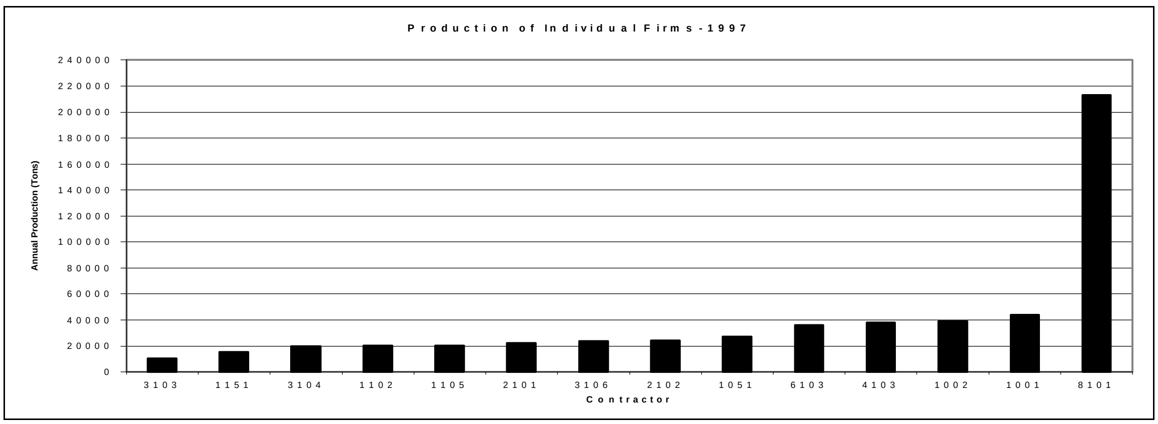

Figure 5.3 Total production by firm (1997).

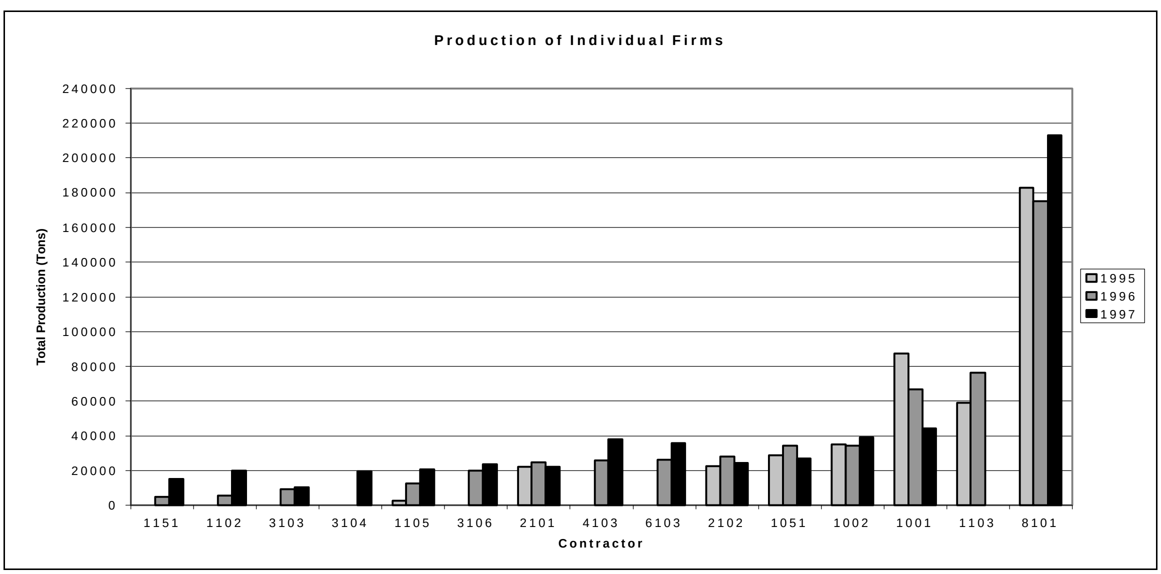

Figure 5.4 Three-year production by individual firm (1995-1997).

The median yearly production of the study population decreased each year of the study period. The population decrease of 18.6% from 1995 to 1996 can be attributed to the fact that several smaller contractors came on board during 1996. Contractors 1151, 1102, and 3103 fell into this category. From 1996 to 1997, the median production for the population decreased 7.8%. Median production changes from 1996 to 1997 were plotted for the seven contractors who reported yearly production for both 1996 and 1997 on a weekly basis (Figure 5.5). Three contractor's weekly median production increased from 1996 to 1997, while four contractor's median production decreased during this period. The increases in median production were 47%, 43%, and 30%, respectively. The decreases in median production were 58%, 23%, 23%, and 11%, respectively. The smaller contractors had good production gains in 1997, while the median tended to drop for the more "established" contractors (2101, 2102, 1051, and 1001).

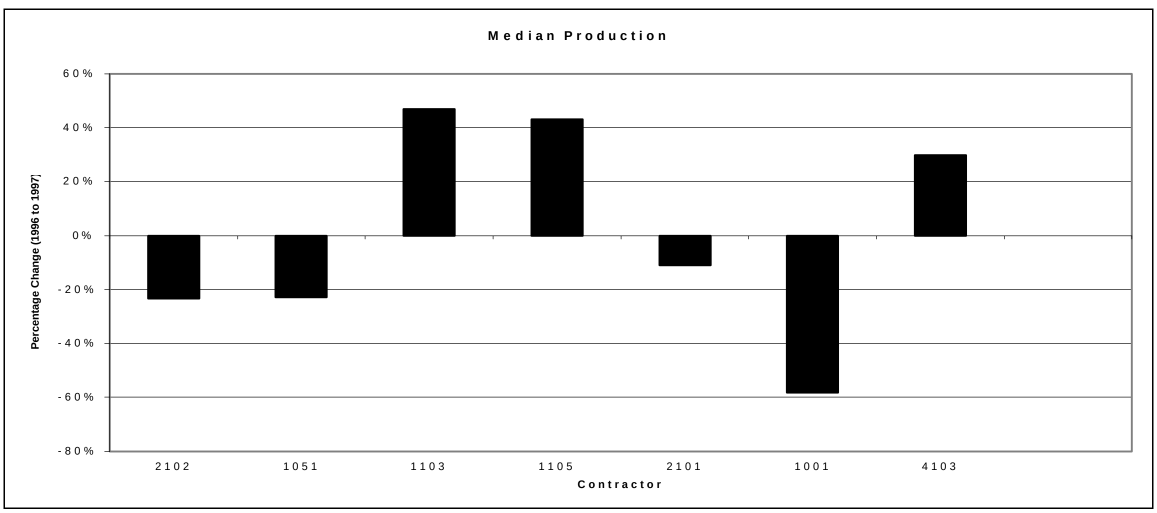

Figure 5.5 Percentage of change in median production from 1996 to 1997.

5.3 Monthly Production

Two contractors provided production data in a monthly format. One contractor was able to provide monthly data for all three years, but the other contractor could provide only monthly production data for 1997. Contractor 8101's cumulative sum (cusum) charts illustrate a quarterly trend. A cusum chart measures the accumulated variation from a production goal or target over time. For each of three years, the first quarter is the strongest quarter of the year, with the contractor “peaking” in late March to early April. The cusum charts for 1995 (Figure 5.6) and 1997 (Figure 5.7) indicate that the fourth quarter is traditionally the contractor’s weakest quarter. This trend probably reflects administrative factors imposed by the mill. The contractor experienced good production periods early in the year but was constrained during the summer months. To keep the logs from deteriorating on the yard, the mill opted to manage their inventory using a just-in-time (JIT) strategy. This approach allowed the mill to build only enough inventory to last approximately two weeks. This contractor was allowed to produce as much as possible through the spring thaw; then administrative regulations were enforced and the contractor could not operate “full throttle.”

The deviation line reflects a particular contractor’s production variation from the average for that time period. The degree of slope for the deviation line influences the cusum trend. When the deviation line is relatively flat, as illustrated in Figure 5.7 (Aug.-Oct. 1997), the cusum tends to show stable periods as well. Figure 5.8 shows that, during 1996 the contractor started the year off on a good note, continued to decline through the second quarter, and started to rebound during the first stages of the third quarter. The latter part of the third quarter was brutal, costing him 10,000 tons. The fourth quarter started off badly but ended with the contractor making a recovery to close out 1996. The contractor’s predictable early surge was probably a result of weather conditions when the ground was frozen and was conducive to harvesting operations. Spring thaw conditions restricted him during the second quarter, forcing him to spend the remainder of the year trying to recapture the lost production. Again, the summer woodyard management strategy is evident from his 1997 production data.

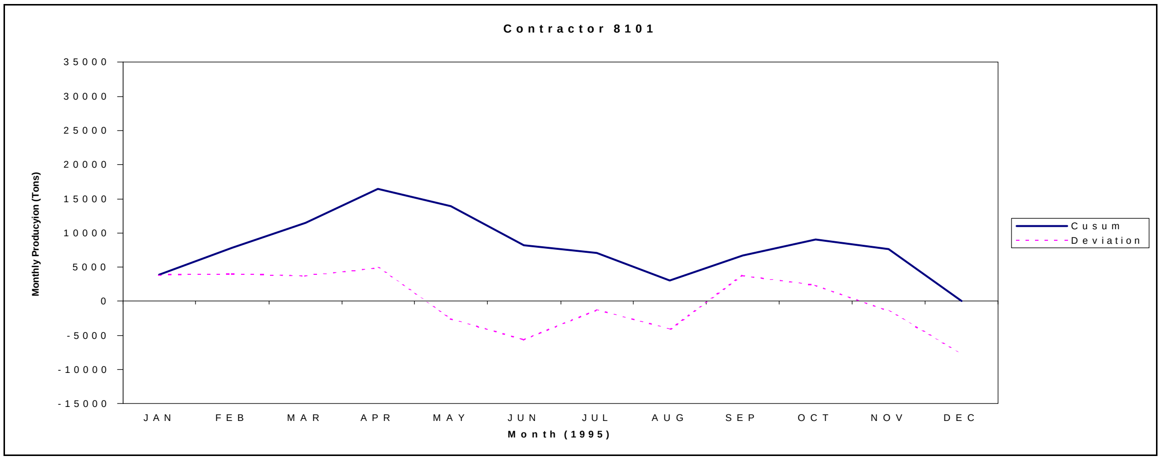

Figure 5.6 1995 Cusum for Contractor 8101.

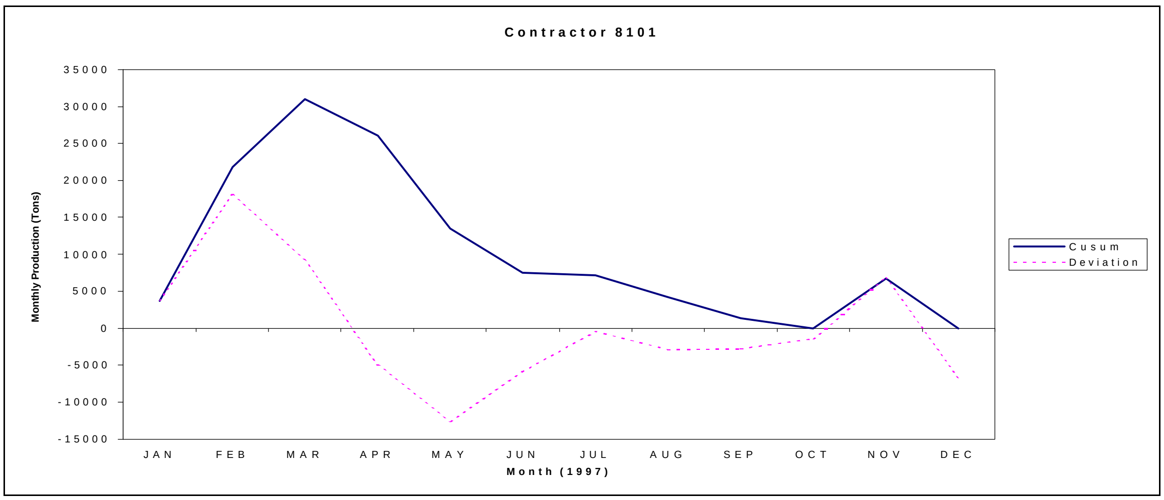

Figure 5.7 1997 Cusum for Contractor 8101.

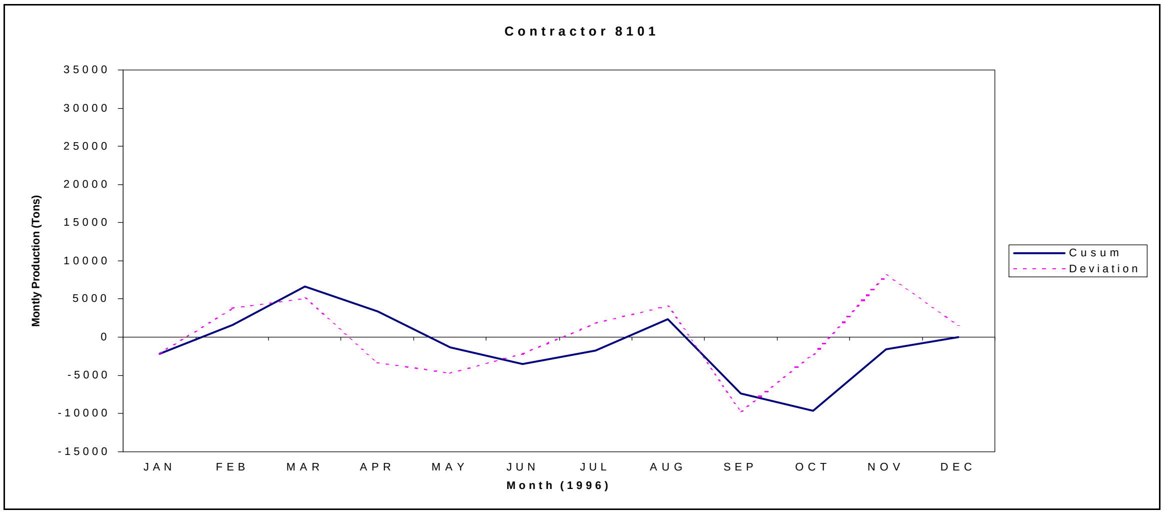

Figure 5.8 1996 Cusum for Contractor 8101.

5.4 Weekly Production

Eight contractors provided weekly production data, with three providing production records for the entire 1995-1997 period. Four contractors provided 1996 and 1997 data. One contractor only started his business in late 1996 and, therefore, could only provide information for 1997. Three distinctive regional trends are evident from weekly production data. These separate trends are referred to as the Southern Appalachian trend, the Central Appalachian trend, and the Northern Appalachian (Allegheny Plateau) trend.

The production trends of two contractors in the Southern Appalachian region were compared. Contractor 1001's 1997 Cusum (Figure 5.9) indicated a strong first quarter, a rapid decline in the second quarter, and a modest recovery in the third. This recovery continued through the last quarter and concluded the year on a positive note for the last several weeks of 1997. Contractor 1051, located in the same region but shipping to a different company, had a very similar path for his 1997 production year (Figure 5.10). Run charts for both contractors (Figures 5.11 and 5.12) for 1996 and 1997 reflect similar patterns in their weekly production variation.

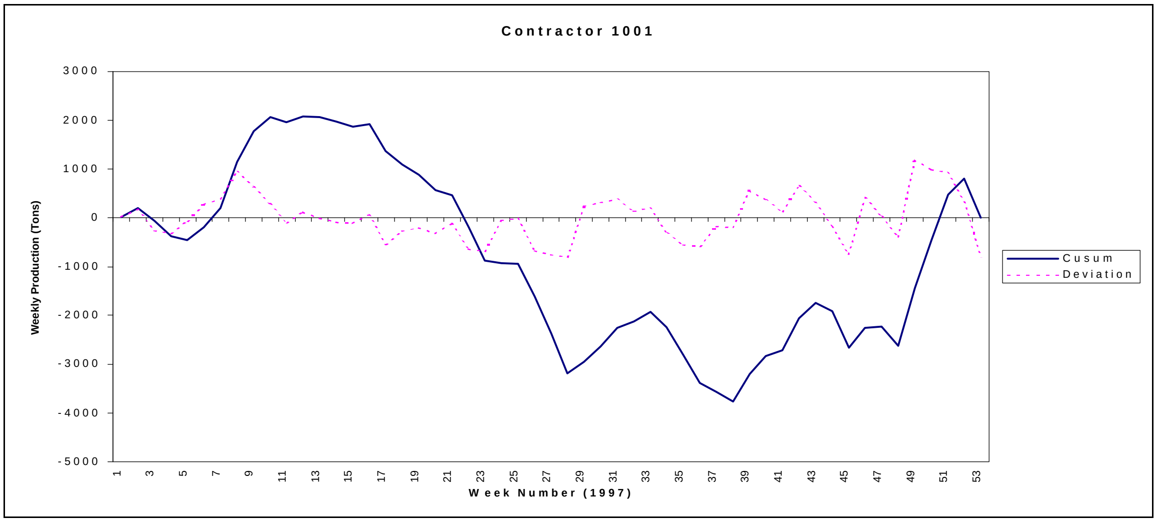

Figure 5.9 Cusum for Contractor 1001 (1997).

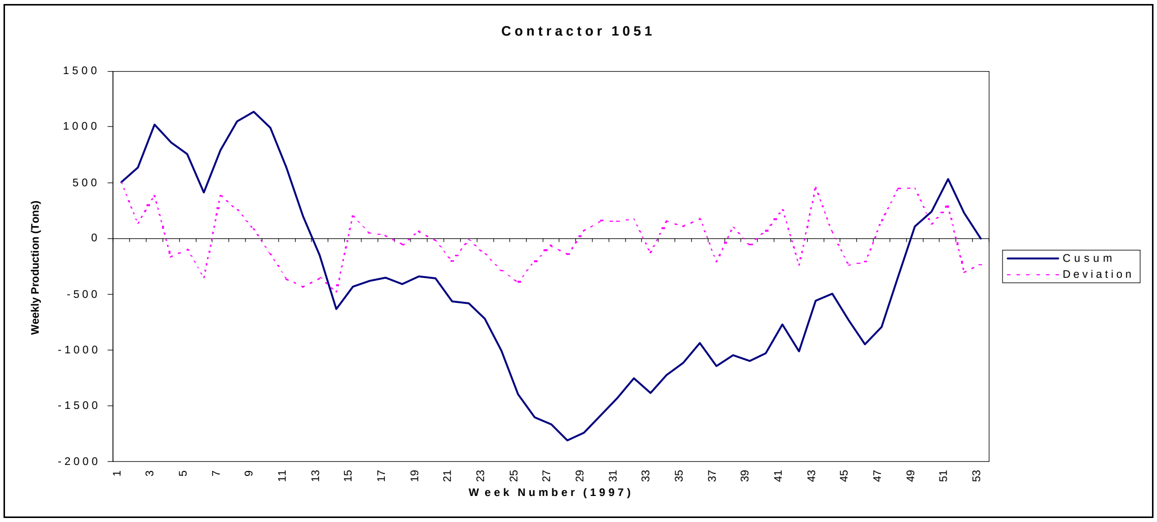

Figure 5.10 Cusum for Contractor 1051 (1997).

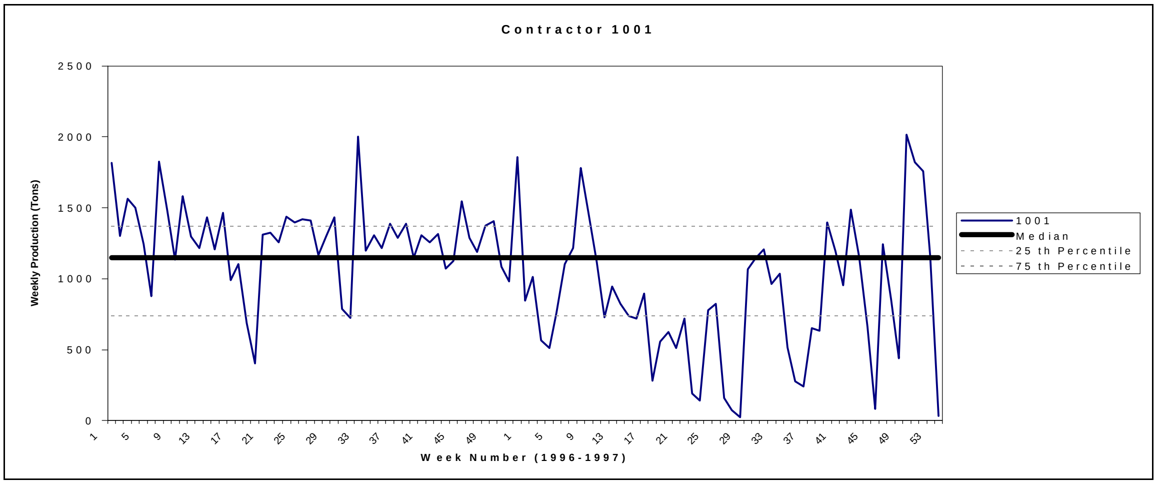

Figure 5.11 Weekly production run chart for Contractor 1001 (1996-1997).

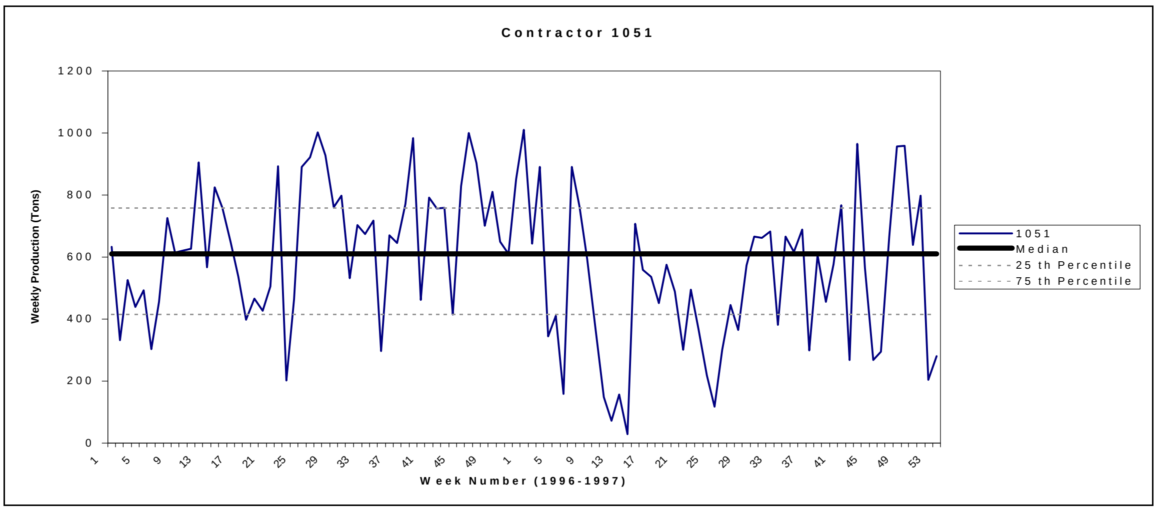

Figure 5.12 Weekly production run chart for Contractor 1051 (1996-1997).

The particular production pattern exhibited by these two contractors mimics the "southern pine trend" reported for parallel research for the same time frame (Omohundro 1999). A major driving force behind this trend was the implementation of production quotas by forest products companies, a common occurrence levied on independent logging contractors to regulate the inventory on company woodyards.

The second, or "Central Appalachian", trend is reflected in the production data of two contractors, both of whom deliver to the same company. Contractor 1103's 1997 Cusum (Figure 5.13) reflected a slow first quarter, a rapid rise from week 11 to week 26, and a relatively stable period through the third quarter. A gradual drop began in mid November and continued to year-end.

Production lagged for Contractor 1105 during the first half of the first quarter but then recovered (Figure 5.14). It continued climbing for the first half of the second and then went into a decline. Since Contractor 1105 had a more difficult second quarter, he was more inclined to rebound during the third quarter. Contractor 1103 had already "peaked" and did not have as much upward elasticity as Contractor 1105. Although these two contractors owned different-sized operations, similar trends were evident in their respective four-week rolling averages for 1996-1997 (Figures 5.15 and 5.16). Weeks 25-30 during 1996 represented low periods for both contractors, and two-year production highs occurred during the late third quarter or early fourth quarter of 1997. The production variability for these two contractors was influenced by "start-up" factors. Contractor 1105 entered the logging profession in 1995, and Contractor 1103 invested heavily in mechanization during the study period. Deviations from the Central Appalachian trend for these contractors may be due to these technical factors. Production for both Contractors 1103 and 1105 dropped during the first six weeks; however, their rates of decline differed. Both contractors recovered the next 13 weeks but each improved at different rates. Contractor 1103 stabilized over the summer, but Contractor 1105 dropped prior to stabilizing. These late-year differences were most likely tract-related.

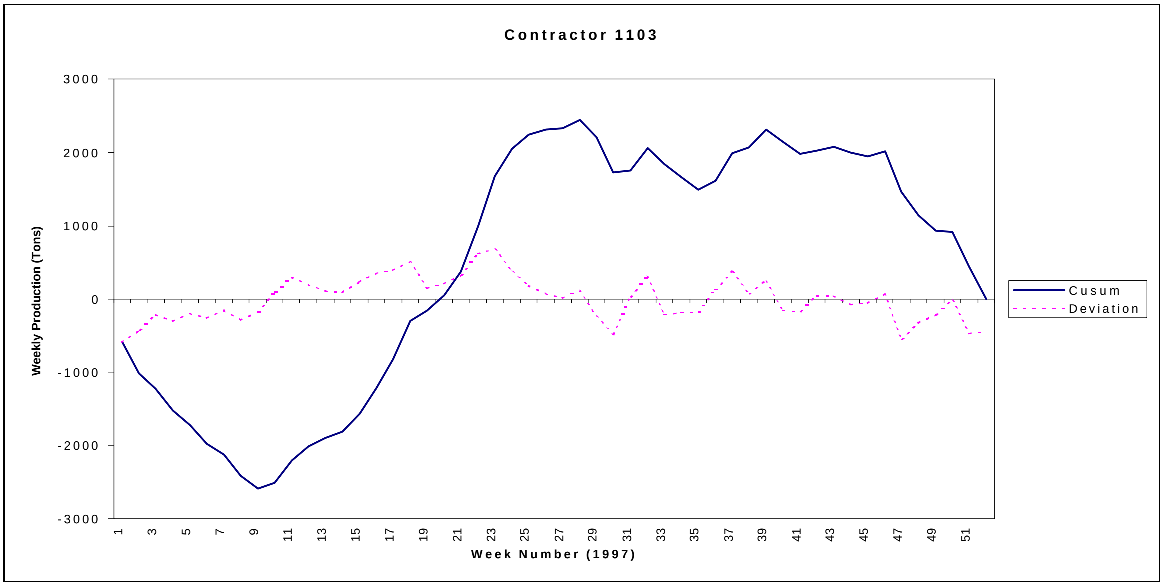

Figure 5.13 1997 Cusum for Contractor 1103.

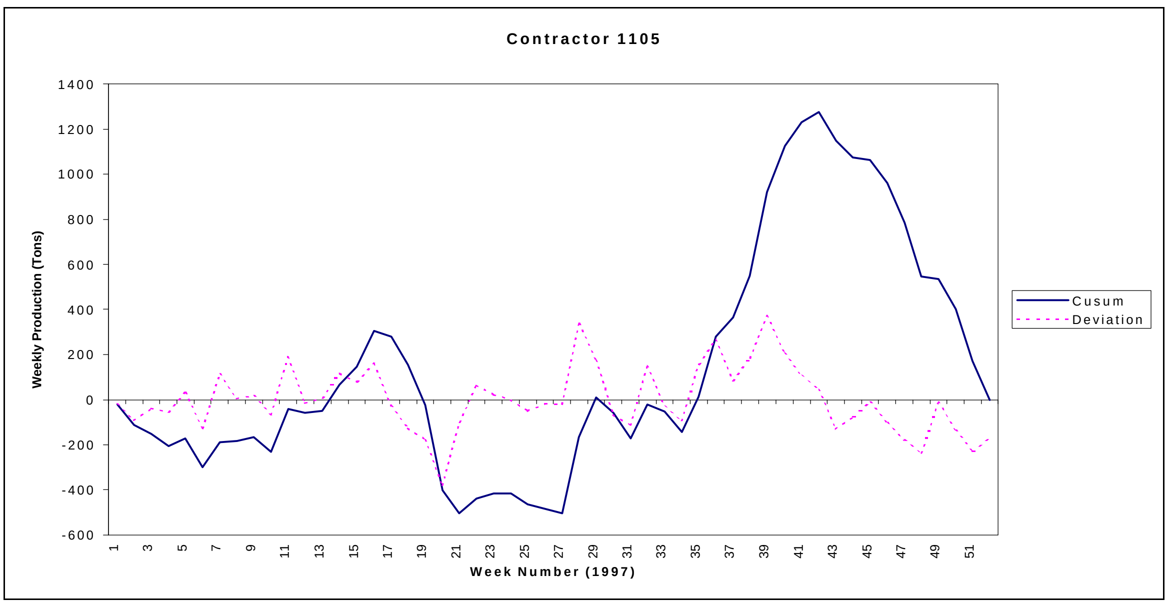

Figure 5.14 1997 Cusum for Contractor 1105.

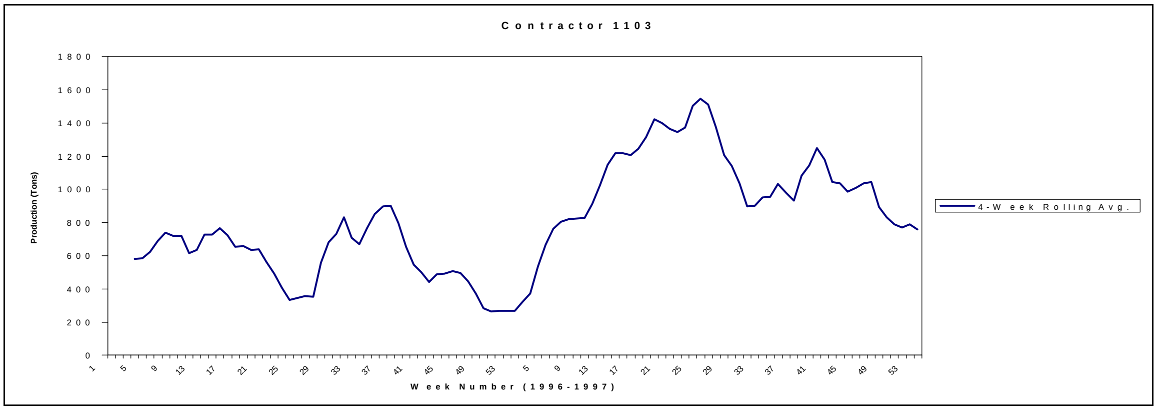

Figure 5.15 Four-week rolling average for Contractor 1103 (1996-1997).

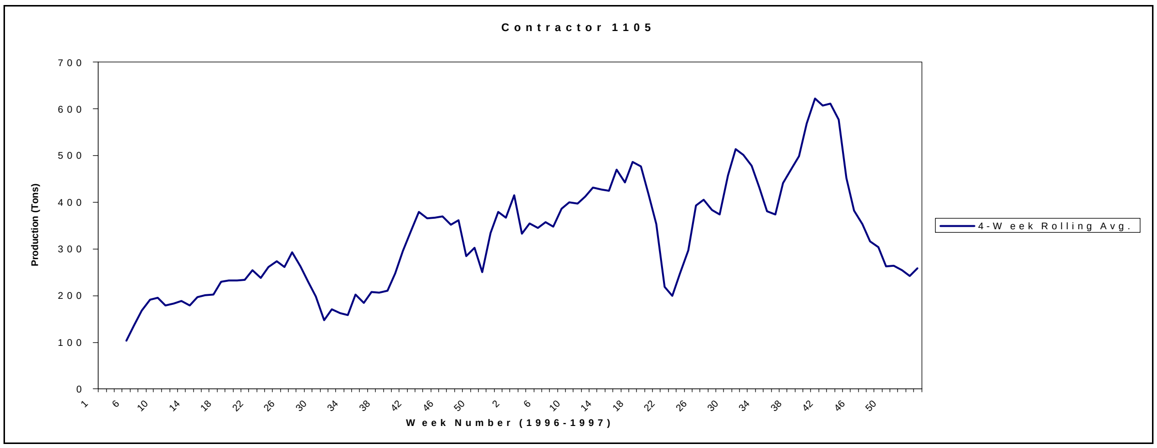

Figure 5.16 Four-week rolling average for Contractor 1105 (1996-1997).

A final production trend was evident in the production data of two contractors in the Allegheny Plateau region. Contractor 2101 and Contractor 2102 exhibited this "Northern Appalachian" trend. Contractor 2101's 1996 Cusum (Figure 5.17) indicated a strong first quarter followed by a steady decline in the second quarter for 1996. A period of recovery occurred for the third quarter followed by a gradual decline for the fourth quarter. This specific up-down, up-down trend also describes the 1996 Cusum for Contractor 2102 (Figure 5.18); however, his second and fourth quarter dives were more drastic, yet his third quarter recovery was more gradual than that of Contractor 2101.

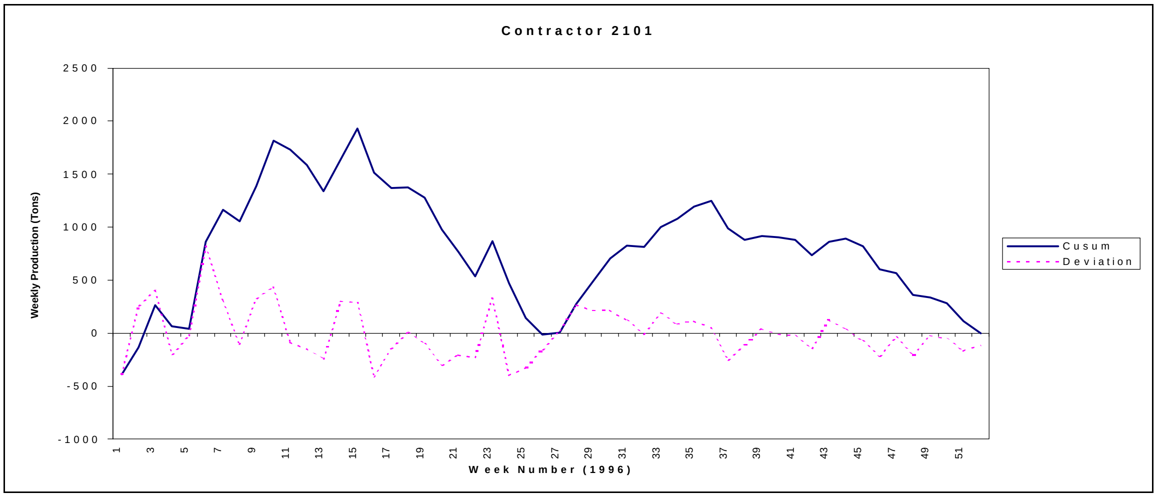

Figure 5.17 1996 Cusum for Contractor 2101.

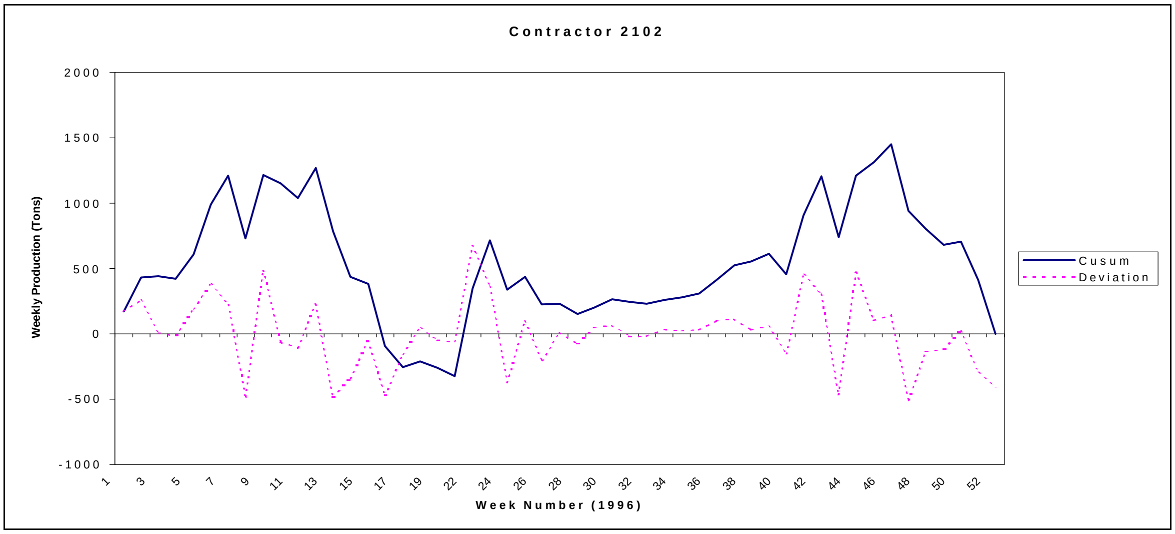

Figure 5.18 1996 Cusum for Contractor 2102.

Weekly production run charts (1995-1997) for Contractors 2101 (Figure 5.19) and 2102 (Figure 5.20) indicated many instances where both contractors operated well outside the inter-quartile range (region between the 25th and 75th percentiles) on both the high and low sides. This increase in production variability is likely the result of two factors. These two contractors were more influenced by adverse weather conditions and were not as weather-resilient as their peers in other geographical areas of the country. They also operated on some of the poorest soil types of any loggers in the cost and production study (Stuart 1999). Both contractor's run charts indicated a definite period of spring thaw for

1996, a time that kept loggers from operating because of an increase in the potential for soil disturbance.

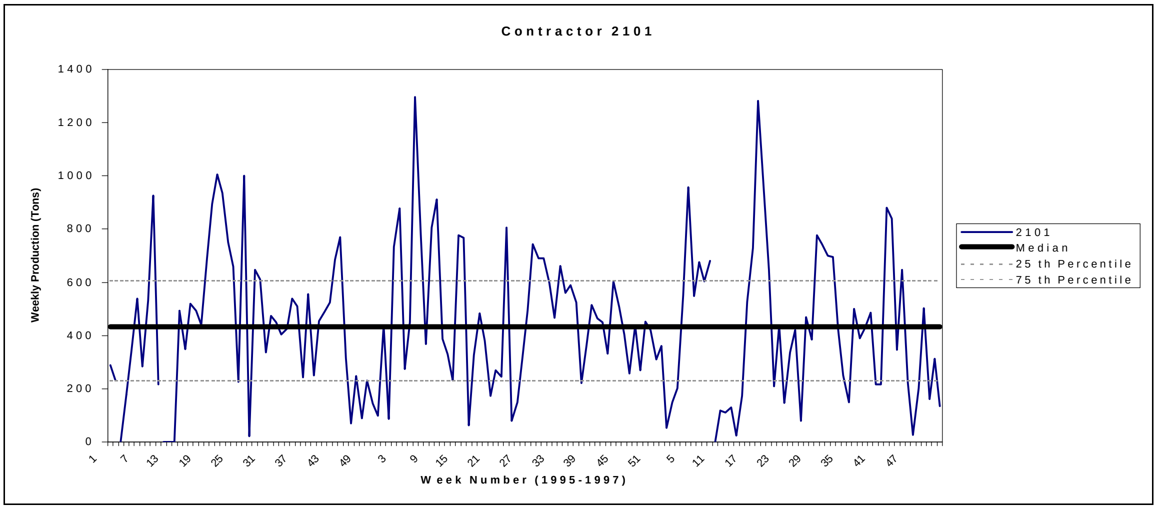

Figure 5.19 Weekly production run chart (1995-1997) for Contractor 2101.

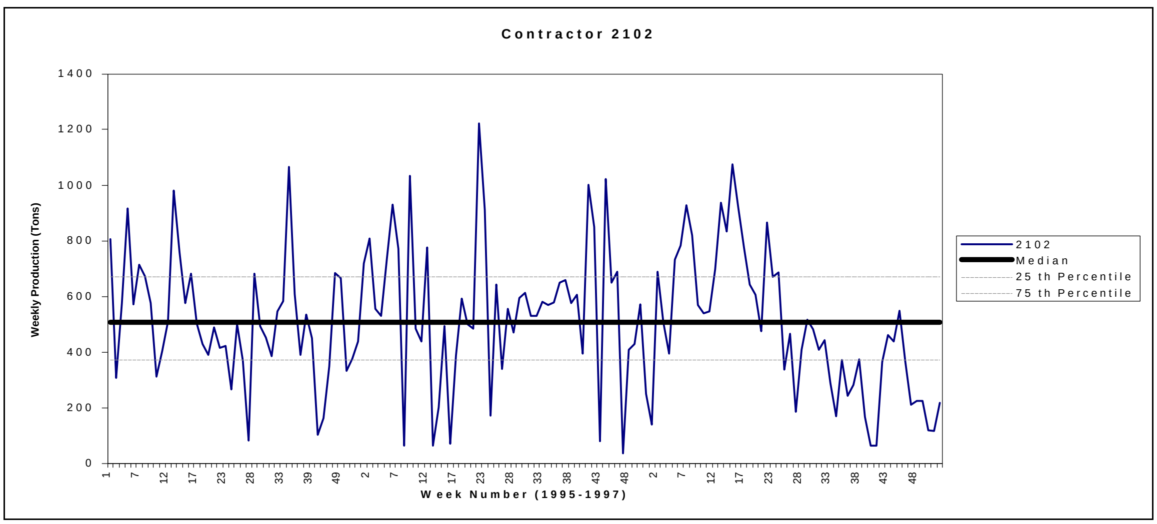

Figure 5.20 Weekly production run chart (1995-1997) for Contractor 2102.

It should be noted how the good weeks on the run charts drive the cusum. This indicates the effect that the few “good” and “bad” weeks have on business performance.

5.5 Weather-Related Variability Factors

Conventional wisdom holds that a strong negative correlation exists between rainfall and production. Analysis of daily precipitation for three areas within the region of study indicates that this common belief is a misconception for this group of contractors. Daily precipitation data were obtained from the National Oceanic and Atmospheric Administration (NOAA 1999) for Chattanooga, TN; Beckley, WV; and Erie, PA. This information was paired with the production data for the contractors who operated in each of these respective regions for July 1, 1996-December 31, 1997.

Production run charts paired with the corresponding precipitation for Contractor 1001 (Figure 5.21) and Contractor 1051 (Figure 5.22) illustrate that very little correlation exists between the normalized production data and the weekly percentage of the average precipitation.

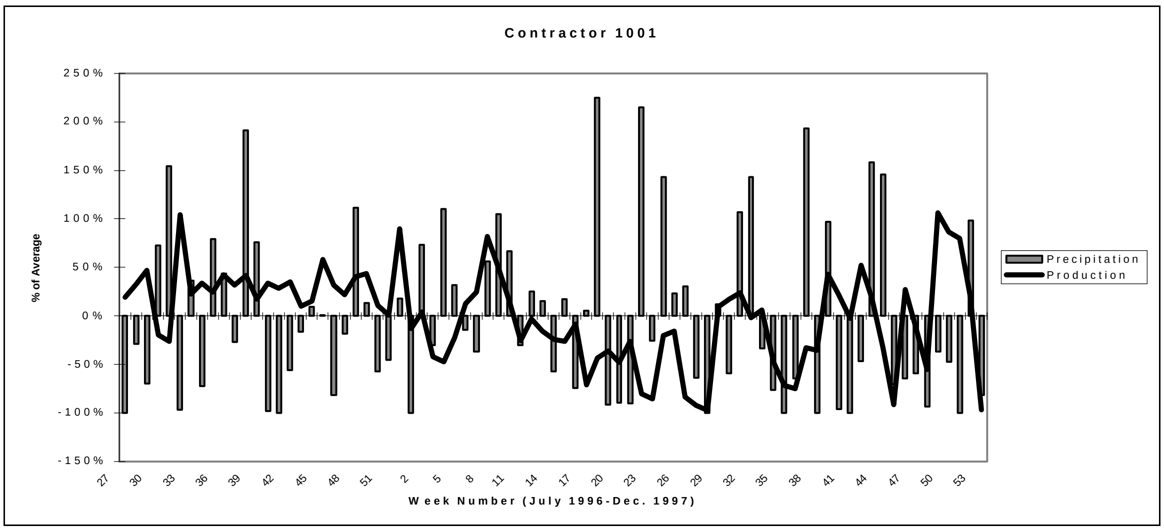

Figure 5.21 Normalized production with precipitation for Contractor 1001.

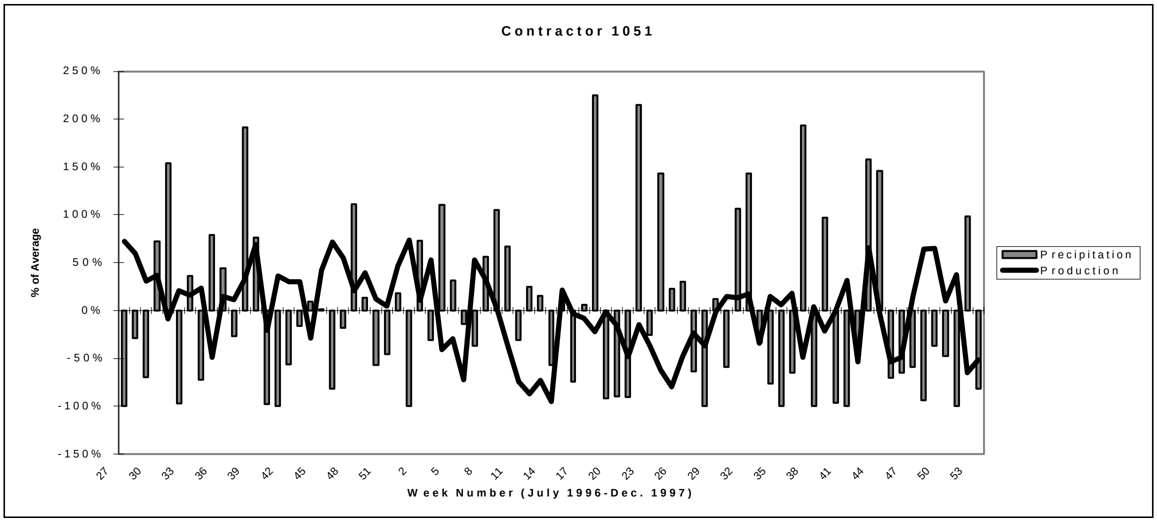

Figure 5.22 Normalized production with precipitation for Contractor 1051.

Figure 5.22 shows that production fell during week 34 (1997) when precipitation was 150% of normal but rose during week 40 when rainfall was 200% of normal. Similar counter patterns can be seen for weeks 20 and 24 of 1997, as well as weeks 35 and 45 of 1997. Similarly, production dropped for Contractor 1103 in week 31 of 1996 when rainfall was at 130% of normal but increased slightly in week 33 when rainfall was at 350% of normal (Figure 5.23). Comparable trends were evident for Contractor 1105 (Figure 5.24). A brief period of direct relationship for both contractors occurred during the latter part of the third quarter (1997) and early stages of the fourth quarter (1997) when the precipitation was below average and the production was above average. Other than this exception, precipitation appeared to be a poor predictor of production potential.

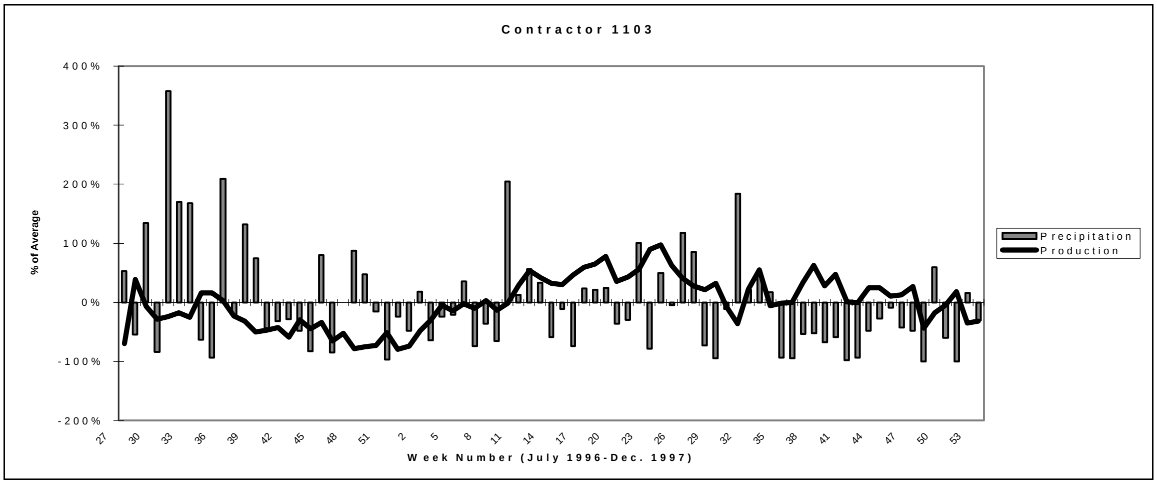

Figure 5.23 Normalized production with precipitation for Contractor 1103.

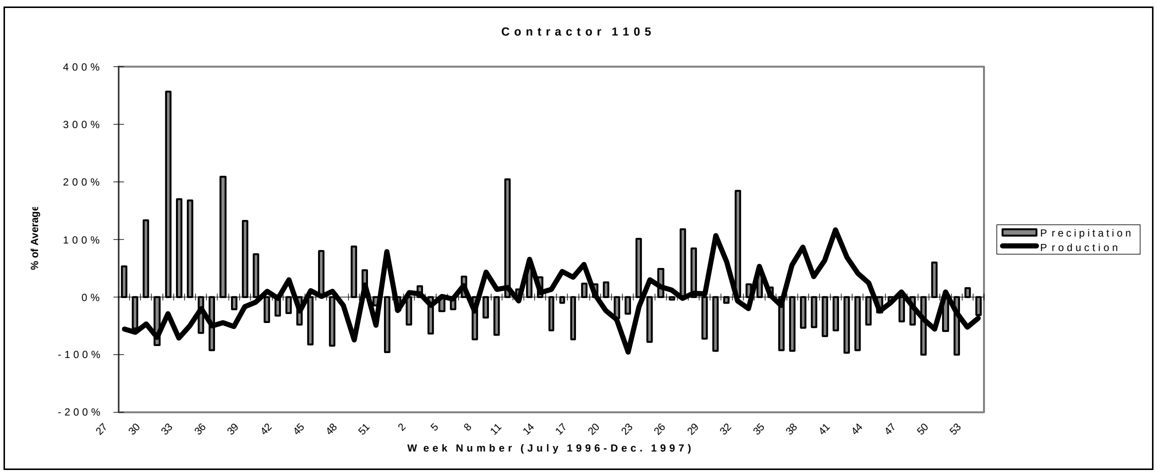

Figure 5.24 Normalized production with precipitation for Contractor 1105.

Contractors 2101 and 2102 represent a third precipitation region, and their respective run charts (Figures 5.25 and 5.26) further support the claim of a weak relationship between precipitation and production capability. No apparent correlation exists in this region of operation.

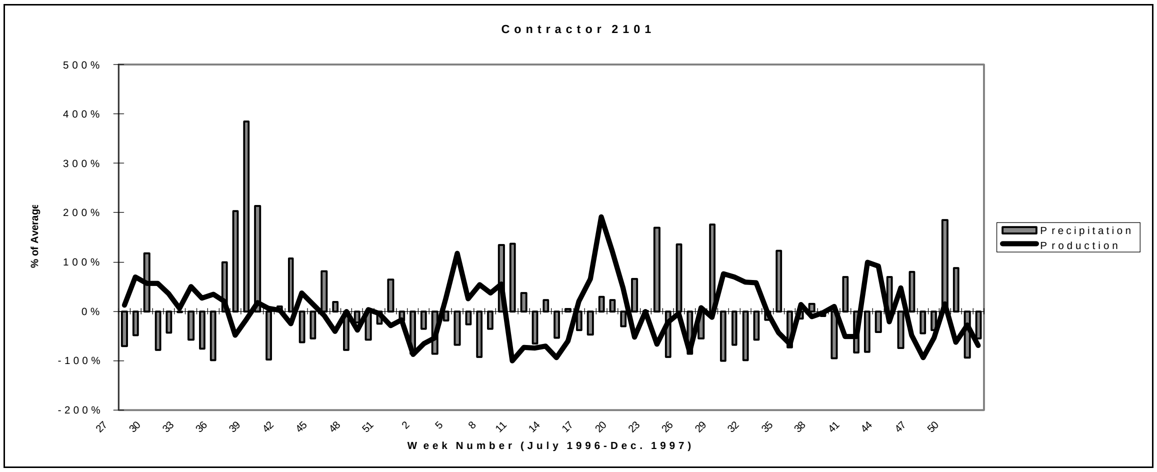

Figure 5.25 Normalized production with precipitation for Contractor 2101.

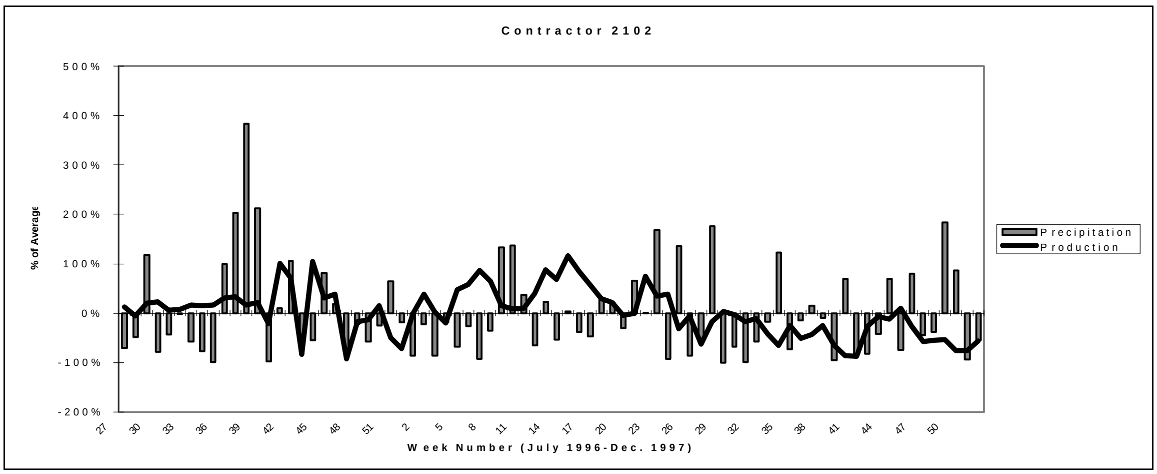

Figure 5.26 Normalized production with precipitation for Contractor 2102.

A linear regression (Figure 5.27) was applied to the precipitation and production data set for the population representing Chattanooga, Beckley, and Erie areas. The regression equation was calculated as $y= -0.0553x + 0.0522$, the R^2 value was 0.0092, and the correlation coefficient was –0.09594. Only 0.92% of the variation in weekly production was explained by precipitation. These factors provide further evidence to support the claim that virtually no correlation exists between precipitation and weekly production. Precipitation is a significant factor in daily production; however, most jobs have the capability to respond and recover quickly. The reaction is further complicated by quotas, mill turnaround, and other exogenous forces that affect loggers in good and bad weather.

There is too much unconstrained variability to use precipitation as an accurate predictor for production (Stuart 1999).

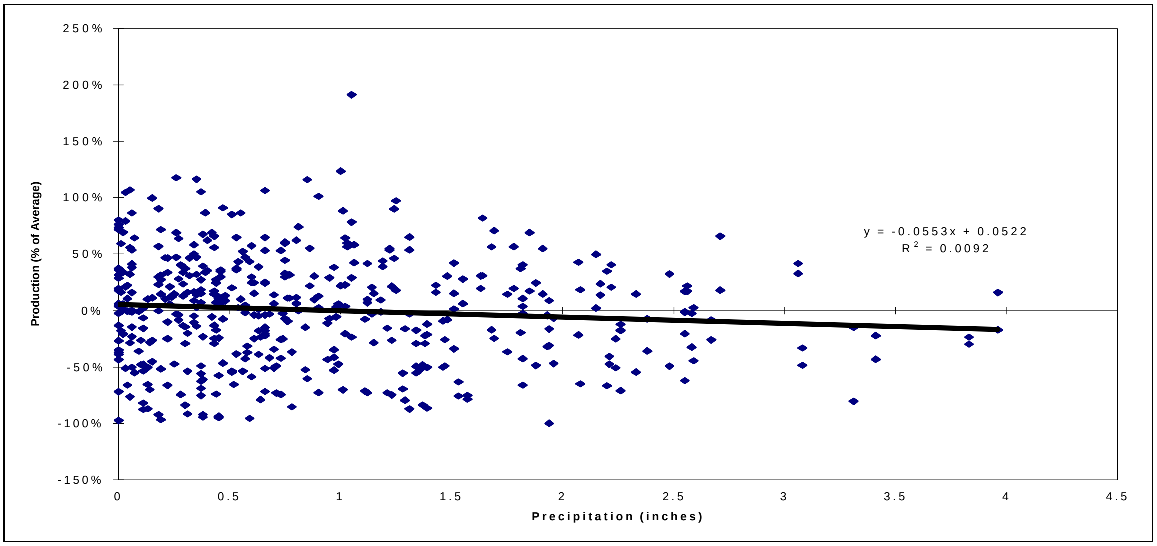

Figure 5.27 Regression of precipitation on production for three regions.

These contractors were among the better contractors in their respective regions and therefore were more likely to make an effort to "weatherproof" than the general population of loggers, so forces other than weather were likely to be in control during fluctuations in wood flow. Tract conditions and market-related issues factor into the equation and the effect of these elements likely overwhelmed weather influences (Stuart 1999).

Chapter 6 COST ANALYSIS

Total annual business expenses were provided by 15 contractors, 14 of whom were able to provide detailed cost information distributed among the six cost categories. As mentioned in Chapter 5, not every contractor was able to provide data for the entire three-year study period. Each contractor's cost data were analyzed for the time frame for which it was provided.

6.1 Cost Allocation

6.1.1 Cost Allocation by Production Group

Each production group's total cost allocation by category is shown in Table 6.1. These findings support the conclusions reported in studies of southeastern loggers. Equipment, consumables, and labor constitute the "big three" cost categories; however, contract service expenses represent a much larger percentage of the total costs for Appalachian loggers. Labor was the largest expense category for production group 1 for the entire three-year period. The second largest expense category in 1995 and 1997 was consumables, followed by contracted services in 1995 and equipment in 1997. In 1996, equipment was second, followed by contracted services and consumables, respectively.

Contracted services were the largest expense category for production group 2 in 1995 and 1996, followed by labor for both years. In 1996, equipment, labor, and contract services were almost evenly distributed. The increased presence of contracted service expenses for the study population is partly cultural: splitting harvesting into cut-and-skid and load-and-haul operators historically has been more common in this region than in the South. The category also included more contracted road and BMP work than in other regions. Many Appalachian operators were not large enough to support a bulldozer.

Table 6.1 Total cost allocation by production group.

Year	# of Contractors	Equipment	Consumables	Labor	Contract Services	Insurance	Admin O.H.
			Group 1 (<25,000 Tons)				
1995	3	18%	21%	35%	20%	3%	3%
1996	6	25%	17%	31%	22%	3%	3%
1997	7	21%	25%	36%	10%	3%	5%
			Group 2 (>25,000 Tons)				
1995	5	15%	14%	30%	34%	5%	2%
1996	8	28%	13%	27%	26%	3%	3%
1997	6	18%	16%	28%	30%	4%	4%

6.1.2 Cost of Production for Individual Firms

The change in the overall cost of production for the eight contractors who provided data for 1995 and 1996 was marked by increasing total annual cost of production (Figure 6.1). The cost of adding one additional ton of output increased from $25.54 in 1995 to $27.74 in 1996, an increase of 7.93%. The intercept shifted from negative $126,887 in 1995 to negative $210,778 in 1996. This shift could reflect that the minimum economic size of operation has become larger or an effort was mounted to reduce fixed investment in the business (Stuart and Grace 1999).

A similar analysis for the 12 contractors who provided data for the 1996-1997 period indicated a cost decrease during this period (Figure 6.2). It is important to note that the 1995-1996 and 1996 –1997 populations were different; therefore, two 1996 values for slope were obtained. The cost of adding one additional ton of output decreased from $24.77 in 1996 to $22.72 in 1997, a decrease of 8.28%. The intercept shifted from negative $145,894 in 1996 to negative $86,928 in 1997. This shift could reflect that the minimum economic size of operation became smaller or an effort was made to increase fixed investment in the business (Stuart and Grace 1999). For both sets of regression equations, the R^2 values remained relatively high; 86%-99% of the variation in annual costs was explained by production.

These analyses must be used guardedly. The fact that both the slope and intercept coefficients changed in each analysis may indicate that short-term compensating strategies were adopted by those at the extremes of the range, leaving the central portion rather unaffected.

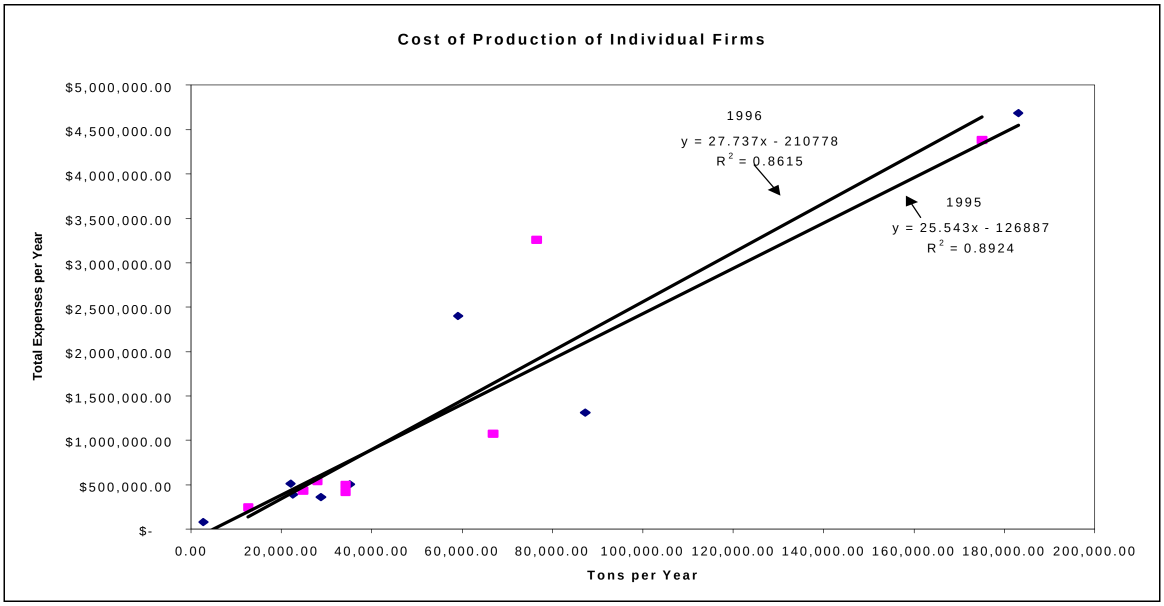

Figure 6.1 Regression of annual cost against annual production for eight contractors (1995-1996).

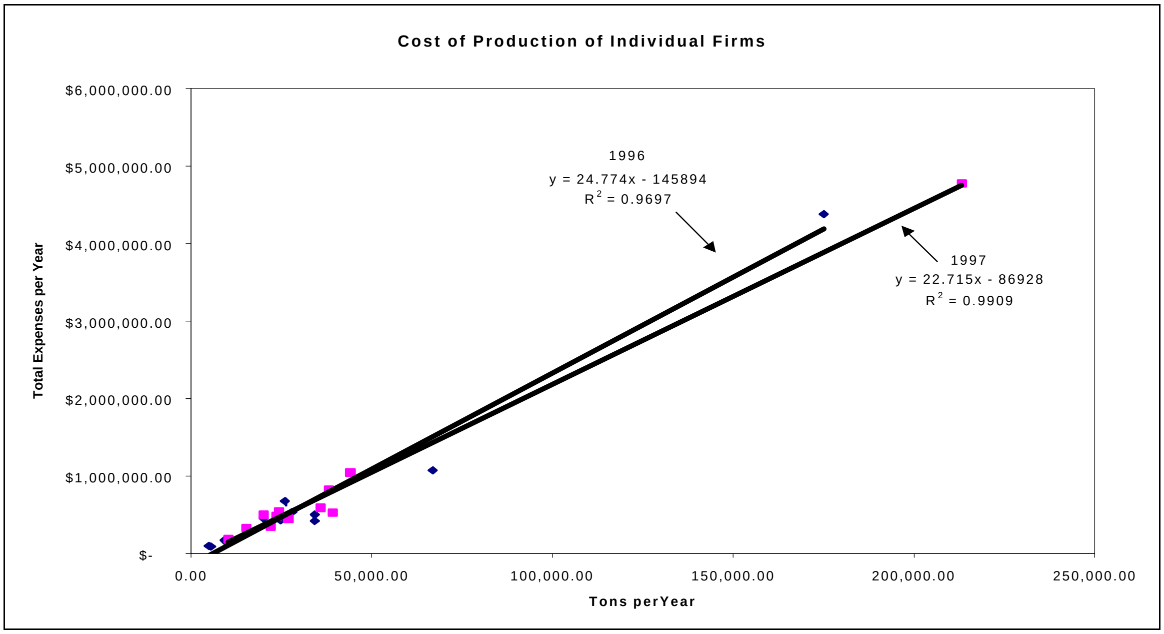

Figure 6.2 Regression of annual cost against annual production for 12 contractors (1996-1997).

6.2 Total Expenditures by Contractor

Five contractors provided detailed cost information for 1995-1997. Figure 6.3 shows the expenditure by cost category and the amount each category contributed to the overall expense for each business. For Contractor 1001, expenditures in each category decreased from 1995 to 1997, the lone exception being the increase of the equipment category from 1995 to 1996. When the upper and lower bounds of a category were parallel, the expenditure in that category was the same for both years. Labor and contract service expenditures changed the most, year to year, for these five contractors because most of these contractors shifted between single and multiple crews according to market demand, tract conditions, and time of year.

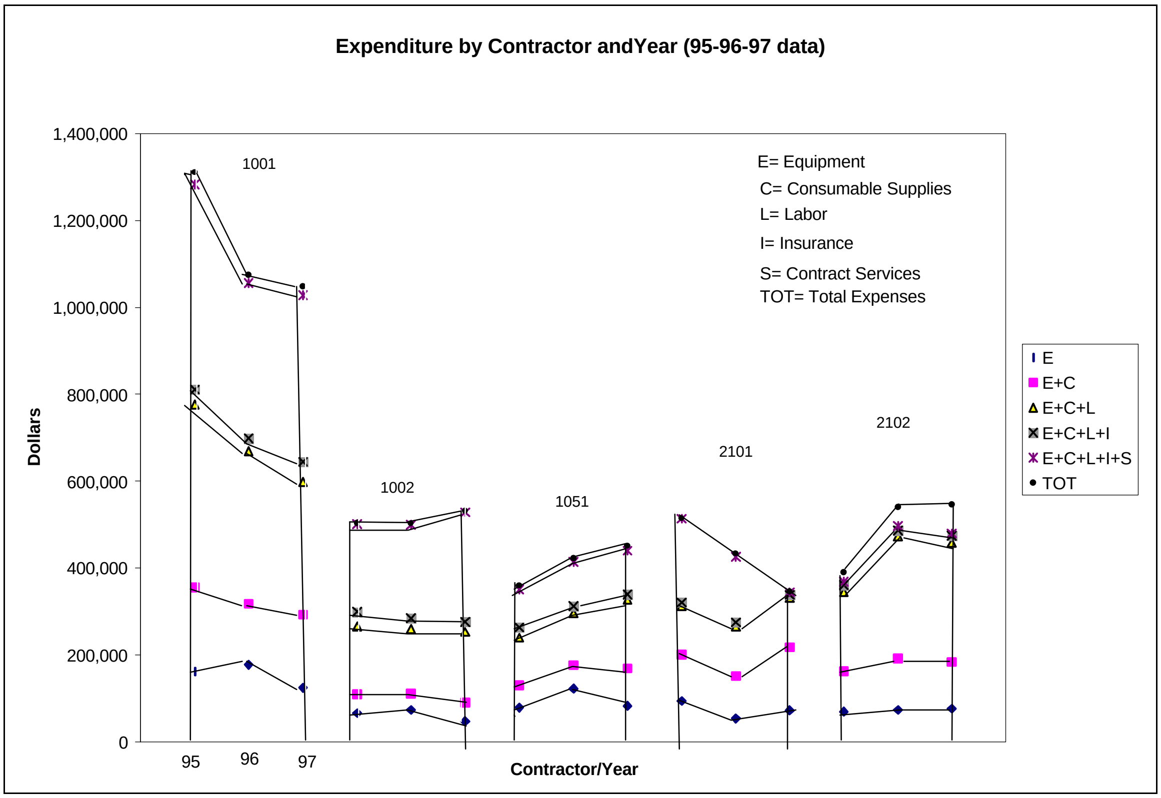

Figure 6.3 Total expenditures by contractor (1995-1997).

A similar analysis was done for the six contractors who provided only 1996-1997 data (Figure 6.4). Contractor 1102 clearly showed signs of increasing the size of his business operation. He was a start-up contractor in 1996 and dramatically increased his operation during the next business year. His total costs increased from $90,882 in 1996 to $502,521 in 1997, an increase of 552.94%. Contractor 1151, also a start-up contractor in 1996, made major increases in total expenditures from 1996 to 1997. His costs increased 323.91%, from $101,881 in 1996 to $330,005 in 1997. Contractors 3103 and 3106 increased slightly during this time period, with Contractor 4103 showing a modest increase due to a merger with a family member's operation, forming a larger and more diversified business. Contractor 6103 showed a modest decline in total expenditures from 1996 to 1997, primarily because of a significant decline in the amount paid out for contracted services: $72,626.64 in 1996 to $18,621 in 1997, a decrease of 74.36%.

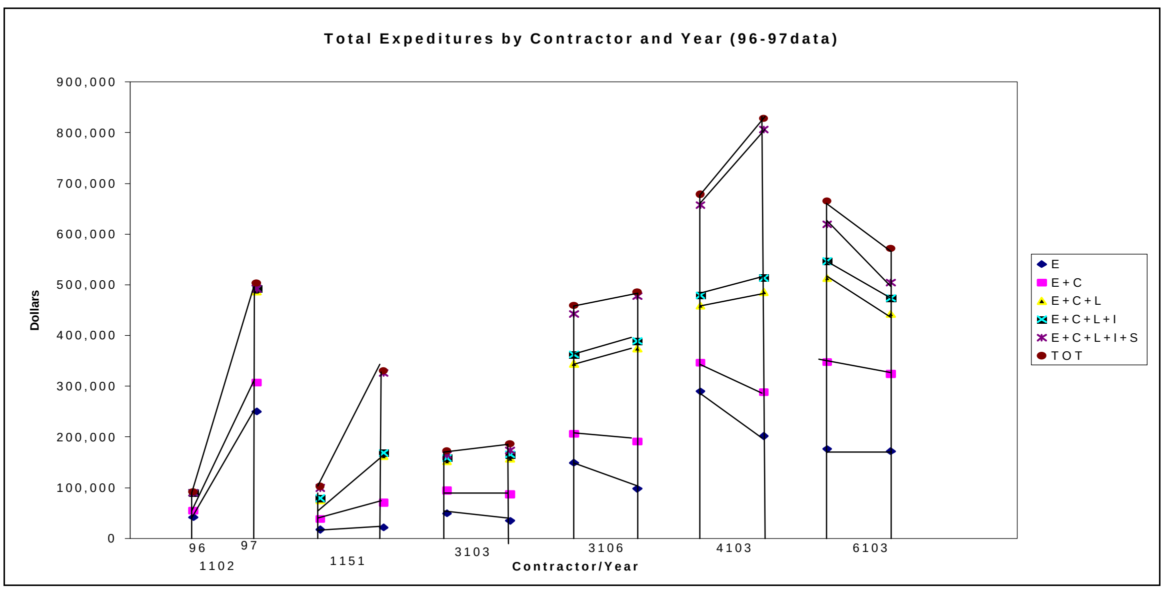

Figure 6.4 Total expenditures by contractor (1996 –1997).

Two contractors, 1103 and 1105, only provided 1996 and 1997 data. Contractor 1103 increased the mechanization of his operation during this period. His total expenditures increased $861,192 from 1995 to 1996, with cost allocation in equipment, insurance, and contracted services increasing at higher proportions than the other categories (Figure 6.5). Most notable were his equipment cost expenditures, which rose from $386,520 in 1995 to $1,115,252 in 1996, an increase of 288.54%.

Figure 6.5 Total expenditures by contractor 1103 (1995-1996).

Contractor 1105, another start-up contractor in 1995, showed rapid gains in total business activity from 1995 to 1996 (Figure 6.6). This trend is quite expected for "up and coming" contractors, trying to build equity and increase the size and efficiency of their operation. The most drastic change occurred in the contracted services component. He was working as a cut-and-skid contractor in 1995 but converted to a cut-and-haul contractor in 1996, adding $66,000 in contracted trucking to his costs. This business grew in other areas as well (Figure 6.6). Equipment expenditures increased approximately four-fold from 1995 to 1996. Consumables increased three-fold and labor increased 1.5 fold. Administrative overhead costs and insurance remained stable. Total cost for this logger increased from $79,631 in 1995 to $242,542 in 1996, an increase of 304.58%.

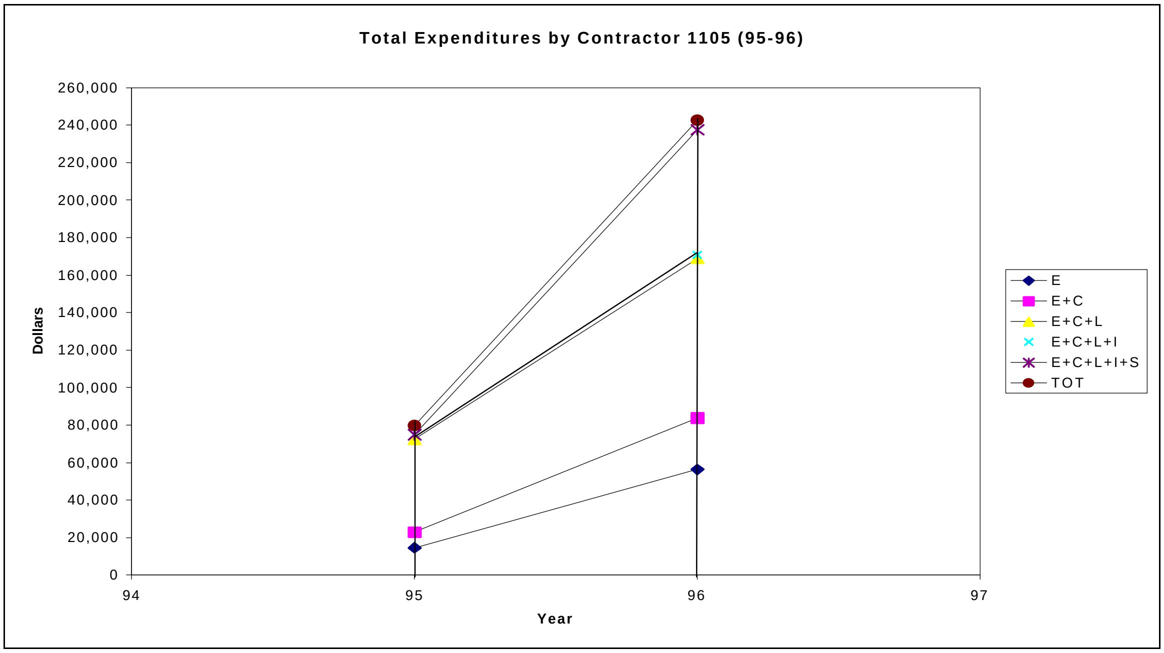

Figure 6.6 Total expenditures by contractor 1105 (1995-1996).

6.3 Annual Cost per Ton

6.3.1 Total Cost per Ton

The total of the cost components per ton for the study population from 1995 to1997 is shown in Figure 6.7. The range for the annual total cost per ton is quite large, reflecting the diversity of physical and business environments along the Appalachians. Several of the contractors produced a large percentage of sawlogs and commanded higher contract rates per ton in return. Log-making, especially in high-quality hardwoods, requires care and attention.

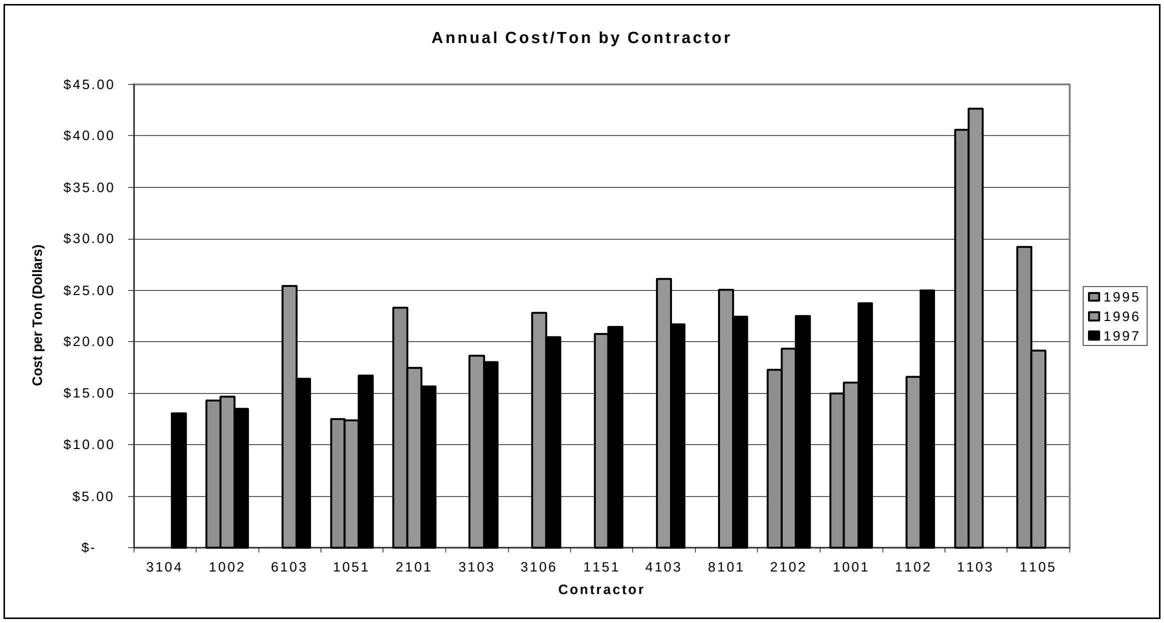

Figure 6.7 Total cost per ton by contractor (1995-1997).

Figure 6.8 shows the total cost per ton shift for the eight contractors providing 1995-1996 cost data. Half showed an increase, half a decrease. The increases ranged from $0.50 to $2.00/ton. Two contractors reduced costs drastically, one by $6.00 and the other by $8.00/ton. The cost increases for Contractors 1001 and 1002 were primarily the result of decreased production or decreased wood orders. Their respective costs remained stable. Contractor 2102's total costs increased faster than his production from 1995 to 1997, reflecting the increased costs of expanding his business size. Contractor 1103 was also in a major growth phase and was investing in mechanization. Contractor 8101's costs decreased slightly, while production held stable resulting in a $0.55 decrease in cost per ton. Contractor 1051's decrease in cost per ton was very marginal ($0.15); it is hard, therefore, to attribute this shift to any one factor. Contractor 1105's cost per ton decrease of $10.02 was the result of his shift from a start-up to a stable operation during the period. Improved economies of scale lowered his cost per ton in 1996, a drastic improvement from the significant start-up costs of 1995. Contractor 2101's total costs decreased from 1995 to 1996, but his production increased as the result of organizational changes in his business.

Figure 6.8 Total cost per ton shift (1995-1996).

Five of the 12 contractors providing 1996-1997 data experienced cost increases, while the remaining seven had decreases (Figure 6.9). Contractor 1001 showed a $7.67 increase. His 1997 throughput was 22,000 tons less than 1996's. Contractor 1102 had an increase of $8.37, primarily due to start-up costs and initial equipment investment. Both 1051 and 2102 were caught in a situation where annual throughput fell by roughly 20% but costs remained stable. Contractor 6103 showed a $9.01 cost per ton decrease from 1996 to 1997. He made a significant equipment investment in 1996, which began paying off in 1997 when his total costs fell from $664,976 to $590,465, while production increased by 37.43%. Contractors 1002, 3103, 3106, 4103, and 8101 increased production from 1996 to 1997 and kept total costs relatively consistent. Contractor 2101 produced slightly less in 1997 than in 1996 (-2,711.86 tons); however, he was able to lower his total costs by $87,062.43. This was accomplished by making organizational changes to improve his efficiency.

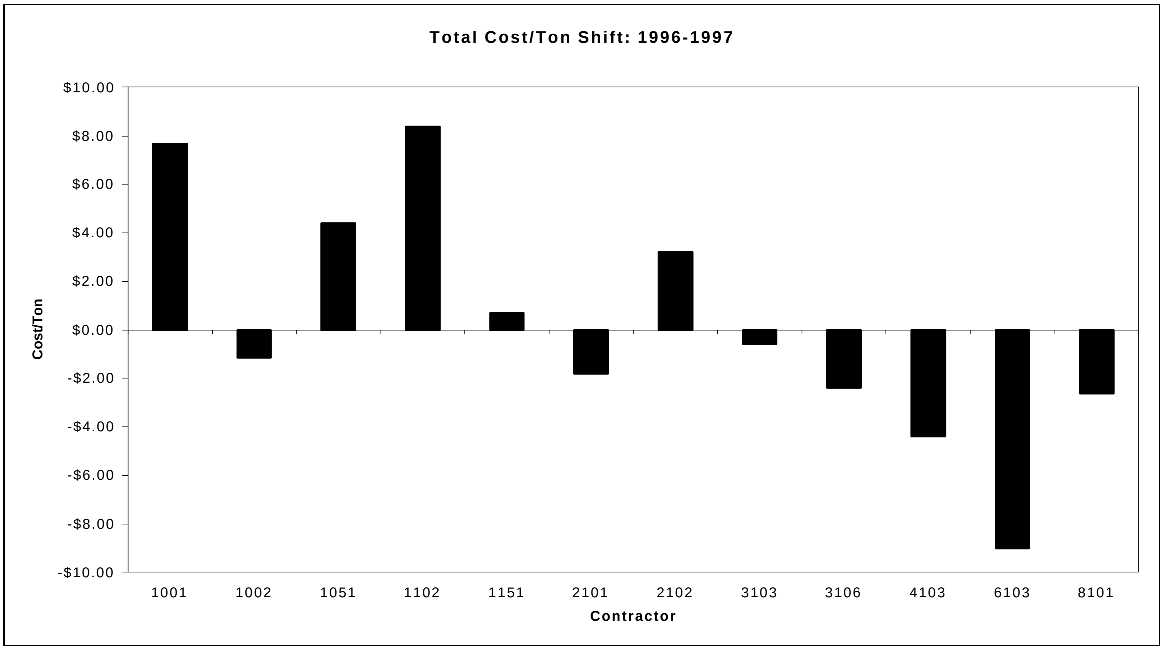

Figure 6.9 Total cost per ton shift (1996-1997).

6.3.2 Shifts by Cost Categories

Shifts in cost per ton from 1996 to 1997 were assessed for the contractors who provided detailed cost and production data. Shifts were measured in total cost per ton on twelve contractors and for each cost category for 11 contractors (one contractor failed to provide detailed cost information).

6.3.2.a Total Cost/Ton

Conventional wisdom holds that increased production results in decreased per-unit costs and vice versa. Figure 6.10 shows that this was indeed the case for nine of 12 loggers providing data, but the response was not predictable. Six contractors increased production and reduced cost per ton, but one increased production by nearly 40,000 tons and enjoyed a $2.50/ton reduction in costs at the same time that costs fell $9.00/ton for a production increase of 8,000 tons for another. Three contractors reduced production and experienced increased cost per ton. Two contractors increased their production, but their cost per ton increased as well. Both of these were among the smallest contractors in the study, were start-up contractors in 1996, and had made significant financial investments in their businesses. One contractor reduced his production and also reduced his cost per ton.

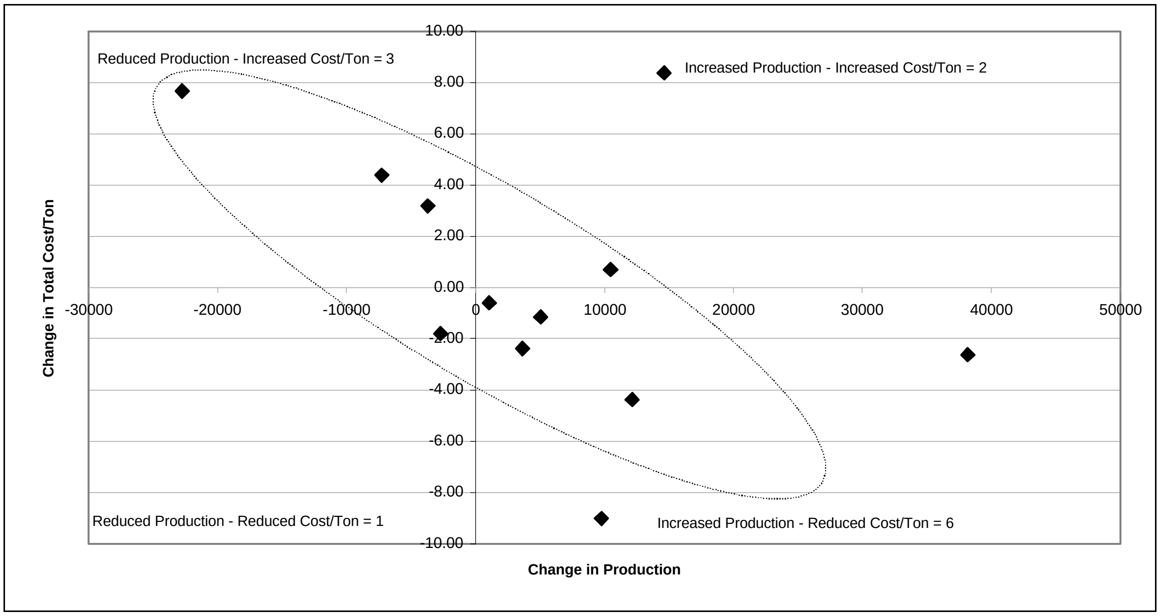

Figure 6.10 Total cost per ton shift (1996-1997).

6.3.2.b Equipment Cost/Ton

The shifts in equipment cost per ton fit the latter scenario (Figure 6.11). Nine of 11 observations occur within the expected zone. Six contractors increased their production and reduced their equipment cost per ton, and three reduced their production and increased their equipment cost per ton. One contractor increased production and increased equipment cost per ton, and one contractor reduced production and reduced equipment cost per ton. The contractor who increased production and increased equipment cost per ton was a start-up contractor, while the other contractor who reduced both variables only reduced his equipment cost per ton by $0.52 per ton.

Shifts in equipment costs are "chicken and egg" in nature (Stuart 1999). Adding equipment is often seen as a way to increase production, but that increase must be sufficient to offset or reduce the incremental cost per ton. If equipment costs are held constant, year to year, equipment cost per ton should decrease as production increases and increase as output falls.

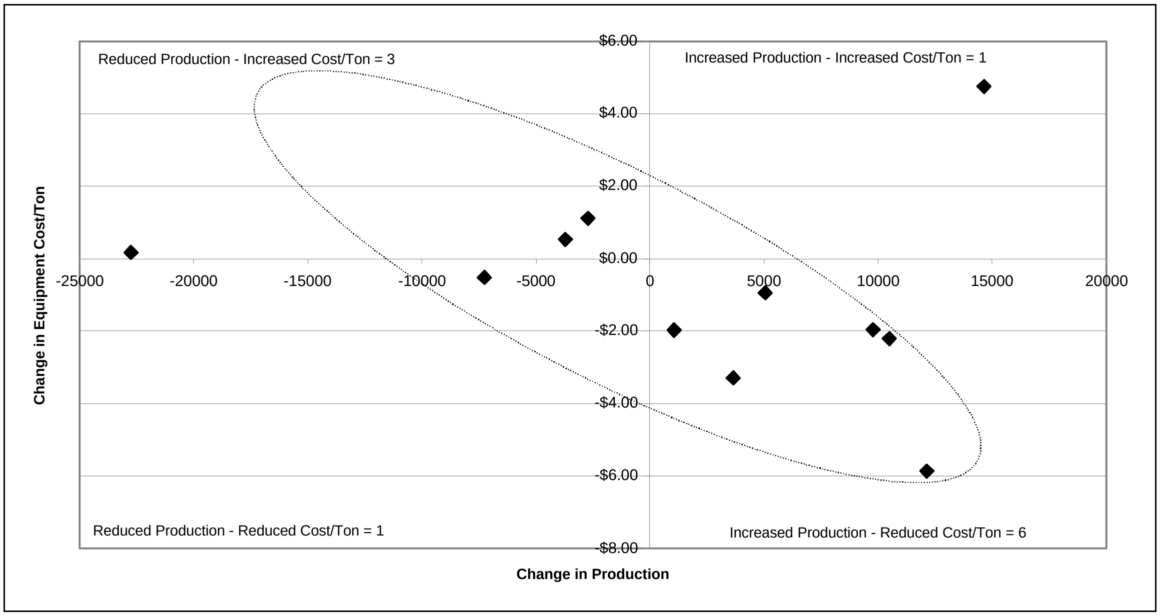

Figure 6.11 Shift in equipment cost per ton (1996-1997).

6.3.2.c Labor Cost/Ton

Labor cost/ton shifts are more complex. If the contractor pays on a salary system, the observations would be expected to fall in the upper left or lower right quadrants. Since employees are paid a flat rate, each additional ton of output would lower the per-ton labor costs (and vice versa). The salary system distributes labor costs with increased production.

Contractors who pay on an hourly or hourly/plus basis could see unit costs remain constant or increase as production increases. If costs remain constant, the same amount of labor is required per unit and shifts would move left or right along zero cost/ton axis. If bonuses are offered for increased production, shifts should fall in either the lower left quadrant or the upper right quadrant. Contractors who pay by piece rate should be unaffected by production. One would expect these loggers to "hover" around the horizontal axis.

Labor cost shifts were less organized than equipment costs per ton. Figure 6.12 shows that eight of 11 observations fell in the expected zones and even then the scatter was greater than for equipment costs. Three contractors increased their production and reduced their labor cost per ton, while four contractors reduced their production and increased their total labor cost per ton. Four additional contractors increased production, yet also increased their labor cost per ton. The type of felling method used by these contractors might be one contributing factor. Three of the four contractors with increased production-increased costs used manual felling.

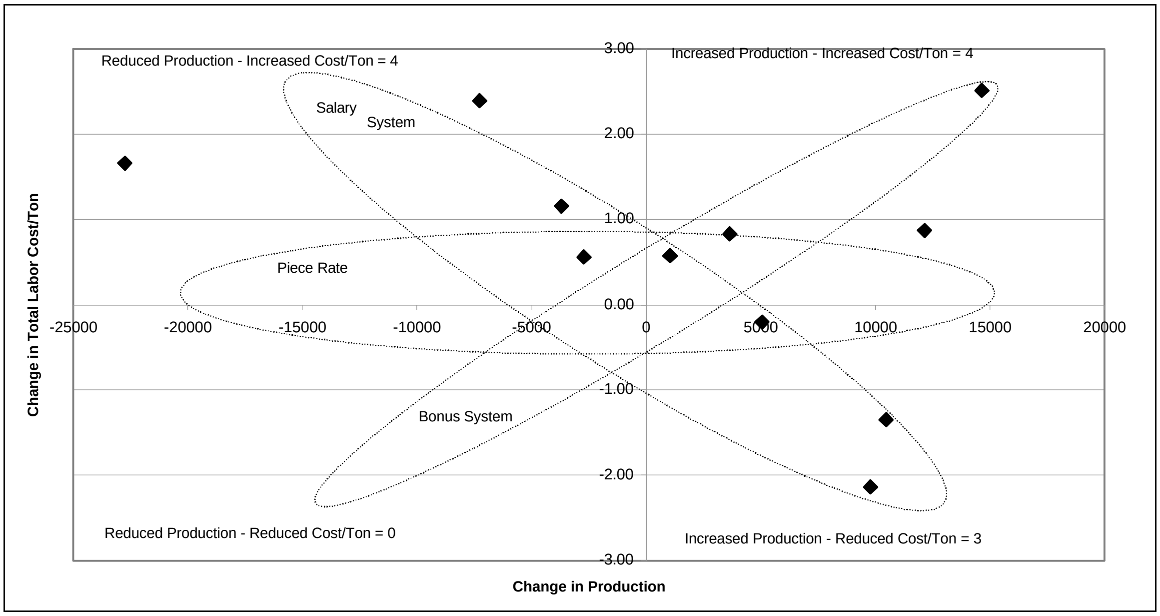

Figure 6.12 Shift in total labor cost per ton (including WCI): 1996-1997.

6.3.2.d Consumables Cost/Ton

Figure 6.13 illustrates the shifts in consumables costs per ton. Consumables are commonly considered a variable cost and thus should hover around the horizontal axis. It should take the same amount of fuel/oil, tires, or parts to produce the first unit of output as it does to produce the n^{th}. As production increases consumable supplies should also increase proportionally; therefore, per-unit consumable costs/ton should remain stable. Seven of 11 observations did fall within the expected range, while four contractors increased production and increased consumables cost per ton. The interesting fact is that the four in this category for labor are also in this category for consumables. One contractor met the classic expectation and was not in a quartile because his production increased but he had absolutely no change in his consumables cost per ton from 1996 to 1997.

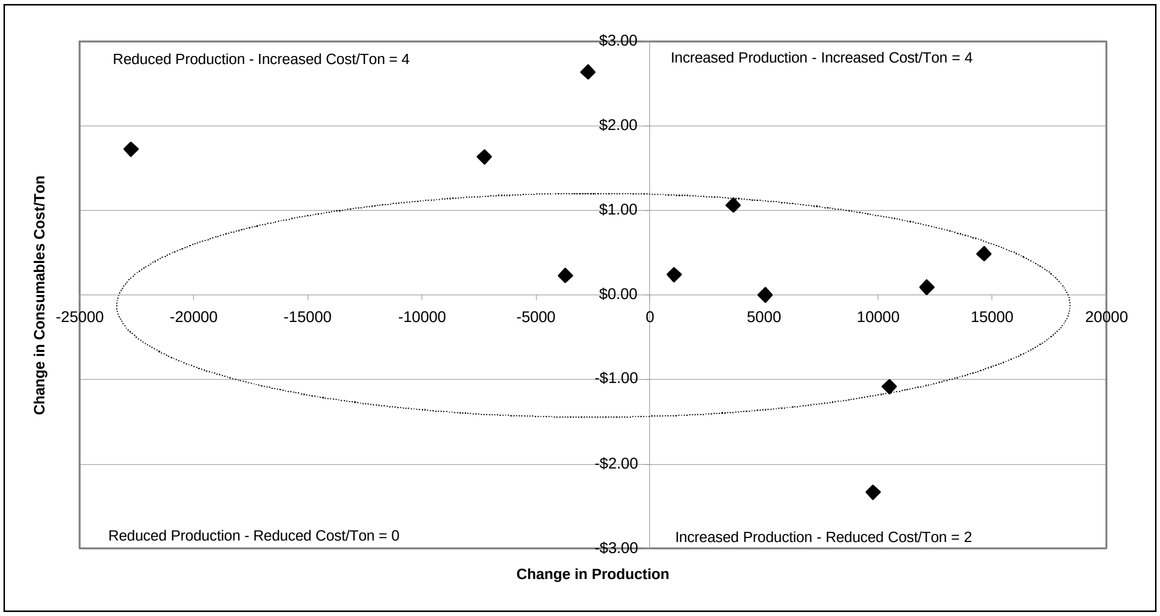

Figure 6.13 Shift in consumables cost per ton (1996-1997).

6.3.2.e Contracted Service Cost/Ton

Changes in contracted service costs for 1996-1997 are shown in Figure 6.14. Contract trucking expenses for those who contract all hauling should increase in relatively close proportion to production increases. This principle would lead one to believe that contract trucking cost per ton should remain unaffected by production increases. If the logger uses a mix of his own and contracted trucks, the cost per ton would shift depending on the amount of contract hauling. Seven of the 10 contractors using contract trucking followed the expected pattern. Two contractors reduced both production and contracted service costs per ton, one by a slight margin and one by nearly $6.00/ton. Four contractors increased production and increased contracted service cost per ton; three slightly and one by more than $6.00/ton. Of these four, three are the same contractors who have previously been falling in this category. The other contractor is a start-up contractor who increased his contracted services expense from 1996 to 1997 by 775.66%.

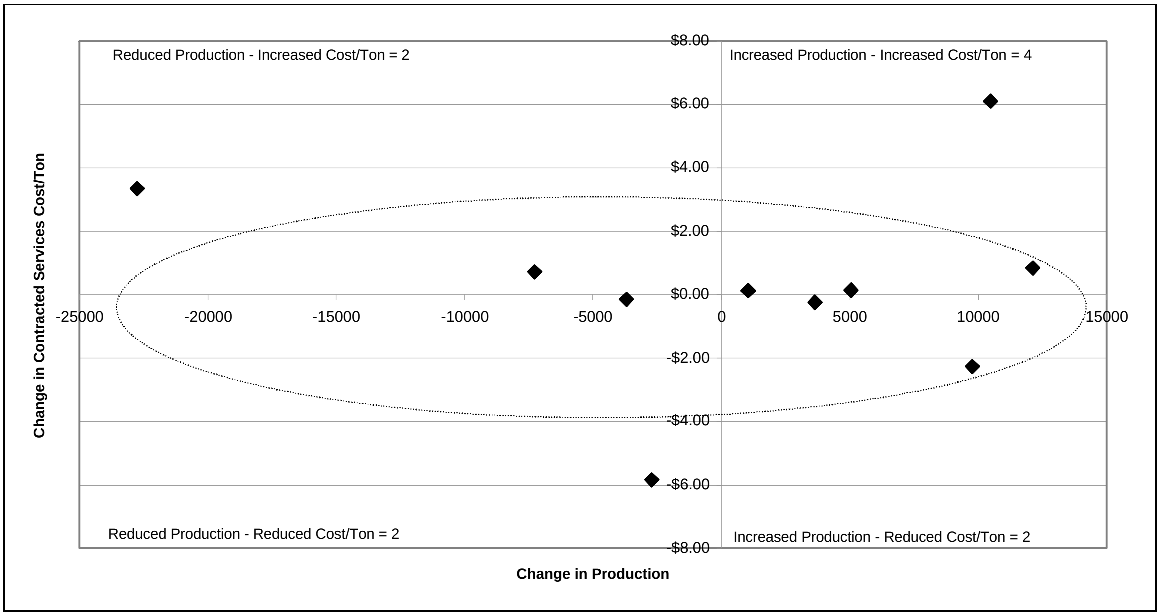

Figure 6.14 Shift in contracted service cost per ton (1996-1997).

6.3.2.f Insurance Cost/Ton

Changes in insurance cost per ton (excluding WCI) are represented in Figure 6.15. The behavior shown in Figure 6.15 was expected because insurance costs are usually fixed on an annual basis and would be distributed across increased or decreased production. This expected behavior should produce observations in the upper left and lower right quadrants. Five contractors increased production and reduced insurance cost per ton, and two contractors reduced production and increased insurance cost per ton. Two contractors reduced production and reduced insurance cost per ton, while one contractor increased both variables.

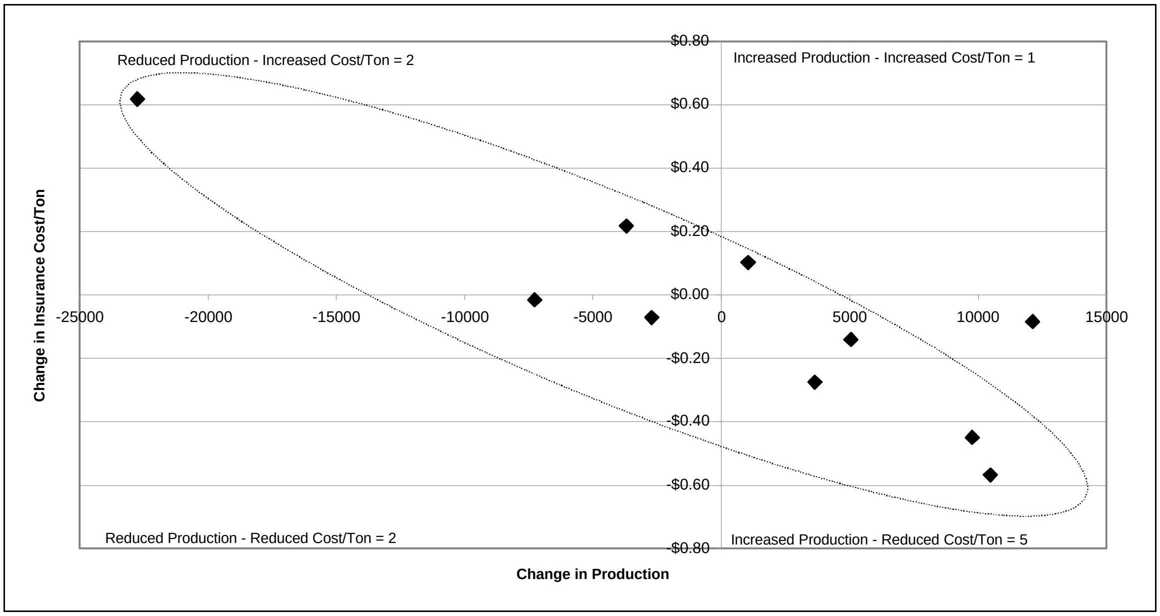

Figure 6.15 Shift in insurance cost per ton (1996-1997).

6.3.2.g Administrative Overhead Cost/Ton

Finally, changes in the administrative overhead (AOH) category were analyzed (Figure 6.16). One would expect AOH per unit costs to be affected by production based on similar arguments made for insurance costs. Of 11 total observations, eight occurred in the expected zone. Four contractors increased production and AOH cost per ton decreased and three reduced production and increased AOH cost per ton. Three contractors increased both variables, and one reduced both variables. The three contractors in the upper right quadrant all have consistently fallen in this category for the other cost categories. The one contractor in the lower left quadrant cut his AOH expenses dramatically (-68.83%).

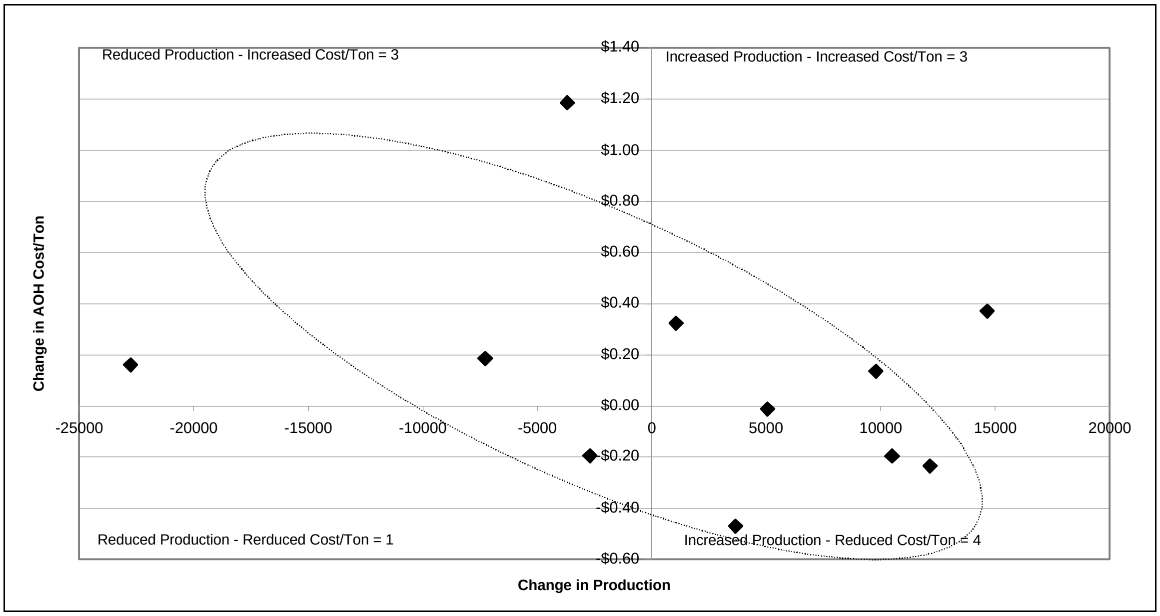

Figure 6.16 Shift in AOH cost per ton (1996-1997).

This preliminary, cursory analysis of the relationships between production and cost categories demonstrates that the reaction for this population generally fits the micro-economic theory (Stuart 1999). This may be a function of:

a) Several of the contractors were "start-up contractors" and the shifts simply reflect the business transition from start up to steady state.
b) Mechanization is in the early stages in much of the region. The cost reduction with increased capital expenditure reflects technological improvement.
c) Most of the operations were free to produce. Only those in the southern Appalachians were lumbered with significant administrative constraints.

The investigation also demonstrates that the relationship is not simple nor is the change in cost per ton easily predicted. Again, the particular (and perhaps peculiar) situation of individual contractors affect the response.

6.4 Workers' Compensation Insurance Trends

Worker's compensation insurance (WCI) expenses were reported by state for four different localities. The trends of WCI (using a three-year average) were compared for Ohio, Georgia, Tennessee, and West Virginia. Ohio contractors' WCI was found to be 2.14% of their annual total expenses and Georgia's was 2.67%, followed by Tennessee at 3.10% (Figure 6.17). West Virginia's WCI accounted for the highest percentage of total annual expenses (4.00%).

Figure 6.18 shows the WCI expense on a per-ton basis. Georgia's averaged $0.37 per ton, Ohio's was $0.42 per ton, and Tennessee's was $0.60 per ton. Once again, West Virginia was the highest of the four states, with WCI expenses calculated as $1.00 per delivered ton. Georgia and Ohio switched positions for the cost-per-ton analysis in part because Georgia contractors were high-production pulpwood contractors. On a per-ton basis, Georgia's expenses were lower than the low-production Ohio contractors.

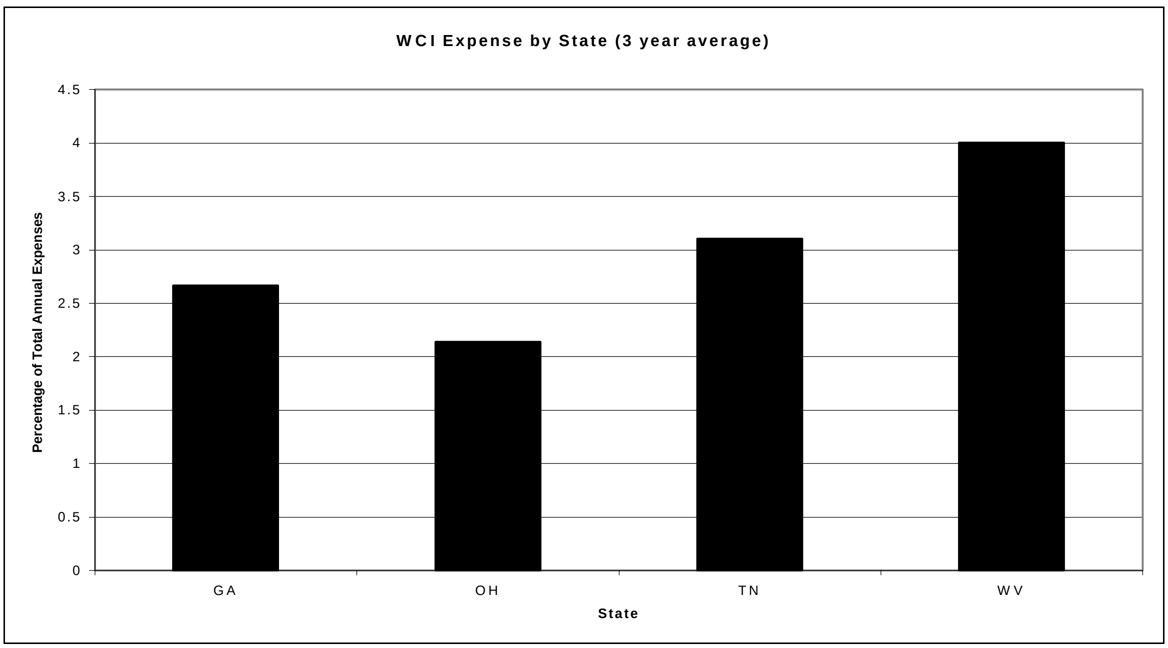

Figure 6.17 WCI percentage of total annual expenses by state (three-year average).

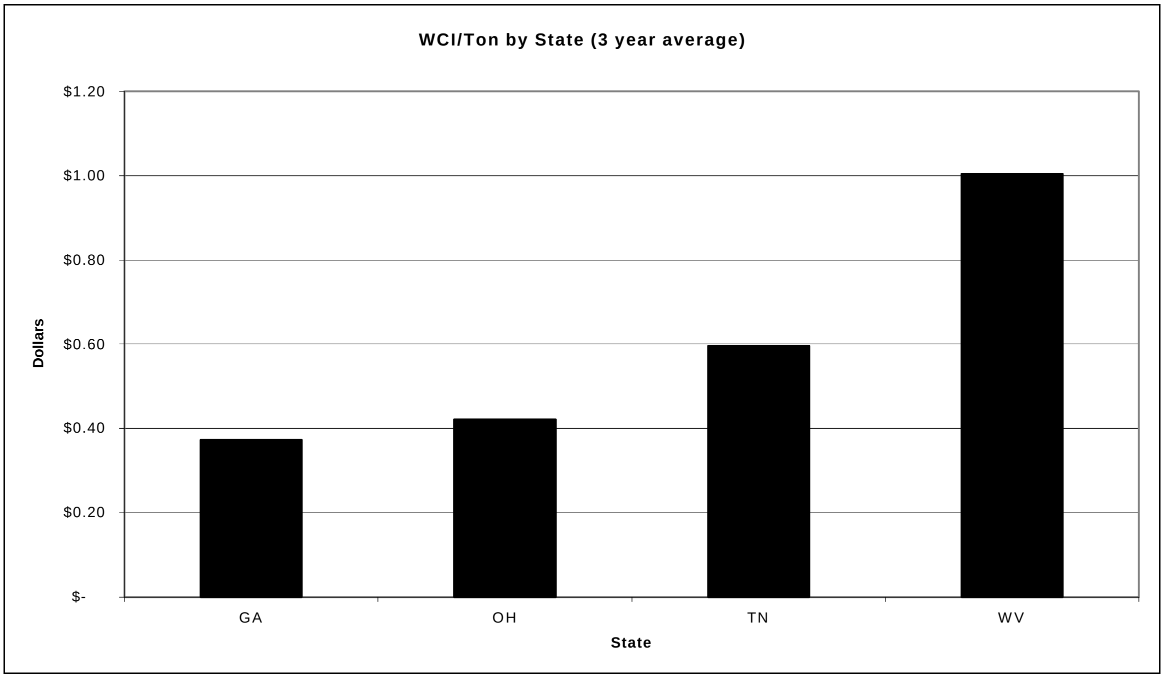

Figure 6.18 WCI per delivered ton by state (three-year average).

6.5 Labor Cost Trends

Total labor costs (including WCI and officer's draw) on a per-ton basis were reported by region (Figure 6.19). The Southern Appalachian region had three contractors, the South-Central region two, the North-Central region six, and the Northern Appalachian region two. The three-year average labor cost (1995-1997) was used and reported by region. The Southern Appalachian contractors' labor cost per ton averaged $4.79. The loggers in this region would be expected to have the lowest cost per unit since they are predominantly pine pulpwood contractors. The South-Central Appalachian contractors' labor cost per ton was $5.69. It is to be expected that this region would have the second lowest per unit costs because of the pine/hardwood mix for this geographic region. The North-Central Appalachian had the highest labor per-unit costs reported. Their per-unit costs were $0.98 higher than those in the Northern Appalachian region ($8.34 vs. $7.36). It might be expected that the prime hardwood region of the Northern Appalachians would have the highest cost because of the care required to protect value. Loggers in the North-Central Appalachian region, however, have to rely on manual felling because steep slopes cause their labor costs per unit to be higher than those of the mechanized contractors in more gentle terrain. The North-Central region also had three West Virginia contractors, whose high WCI premiums would certainly inflate labor cost per unit.

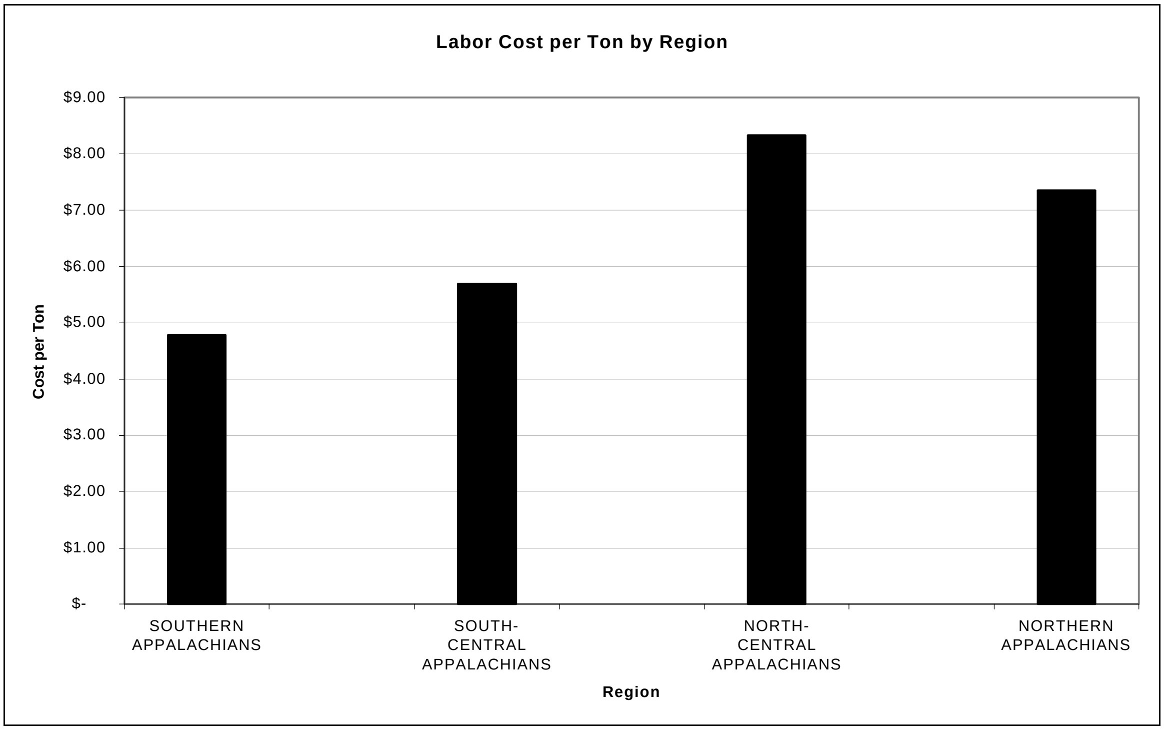

Figure 6.19 Labor cost per unit by region (three-year average).

6.6 Economic Efficiencies per Contractor

Stuart and Grace (1999) defined economic efficiency as the tons produced per dollar spent. Economic efficiency ratings were calculated for the eight contractors who provided 1995-1996 data (Figure 6.20) and for the 12 contractors who provided 1996-1997 data (Figure 6.21). Four contractors increased their economic efficiency between 1995 and 1996. The increases for two of these were modest, while the other two were minimal. The largest increases were by a contractor in the Central Appalachian region who overcame start-up costs to improve his efficiency in 1997 and an established contractor in the Northern Appalachian region who made several technical changes to improve his efficiency.

Four contractors decreased their economic efficiencies from 1995 to 1996. Two decreases were marginal, while the other two efficiency decreases were modest in scope.

Modest declines were experienced by a Northern Appalachian contractor whose cost increased in 1996 and by a Southern Appalachian contractor who experienced a major production decrease from 1995 to 1996. This contractor believed that administrative barriers imposed by procurement policies contributed greatly to his production woes. The other two contractors in the Southern Appalachian region either slipped in efficiency or showed very little efficiency change from 1995 to 1996.

Using an overall ranking scale, the Southern Appalachian contractors had the highest efficiency rankings, despite a general trend of decrease from 1995 to 1996. The Central Appalachian contractors tended to have the lowest economic efficiency rankings, even considering their yearly efficiency gains. The Northern Appalachian contractors consistently ranked between the other two regions.

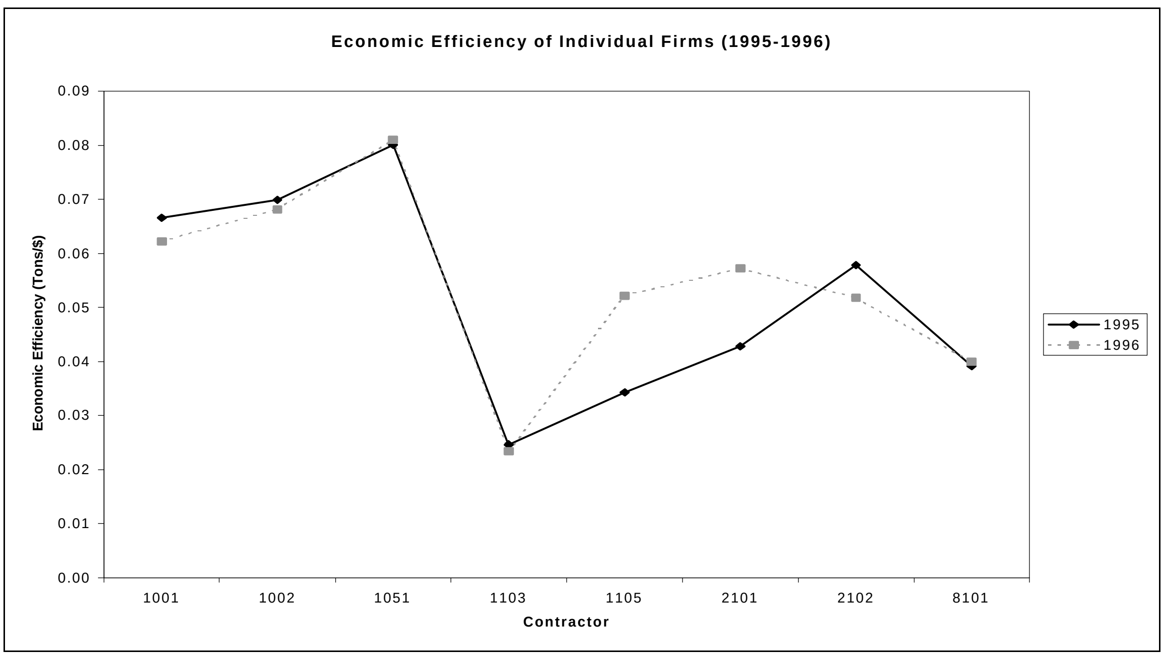

Figure 6.20 Economic efficiency of individual firms (1995-1996).

Of the 12 firms providing 1996-1997 data, seven showed efficiency increases and five showed a decrease. The overall efficiency trends for 1996-1997 indicated that the Southern Appalachian contractors had drastic decreases in economic efficiency. Their efficiency rankings were higher in 1996 than those of the contractors in the other regions; however, their decrease in 1997 forced their rankings below those of the other two regions. In fact, one Southern Appalachian contractor left the logging business in early 1998 as a direct result of administrative, organizational, and natural forces that plagued him during the study period. Contractors in the Northern Appalachian region (including the Allegheny Plateau and the Ohio Valley) tended to increase their economic efficiency during the study period. Their rankings in 1996 were the lowest of the three regions; then 1997 efficiency increases shifted their rankings to those among the highest. Contractors in the Central Appalachian region showed mixed results. Several of these contractors increased their economic efficiency; however, these increases were marginal and sporadic. It is interesting to note that after the 1997 economic efficiency shifts, all three regions tended to either increase or decrease toward the center.

Those contractors in the Central Appalachian region who showed favorable efficiency improvements were more diversified in their product mix (sawlogs vs. pulpwood). On an entire study population basis, contractors who produced more sawlogs than pulpwood tended to have a better probability of increasing their economic efficiency than those who harvested pulpwood exclusively.

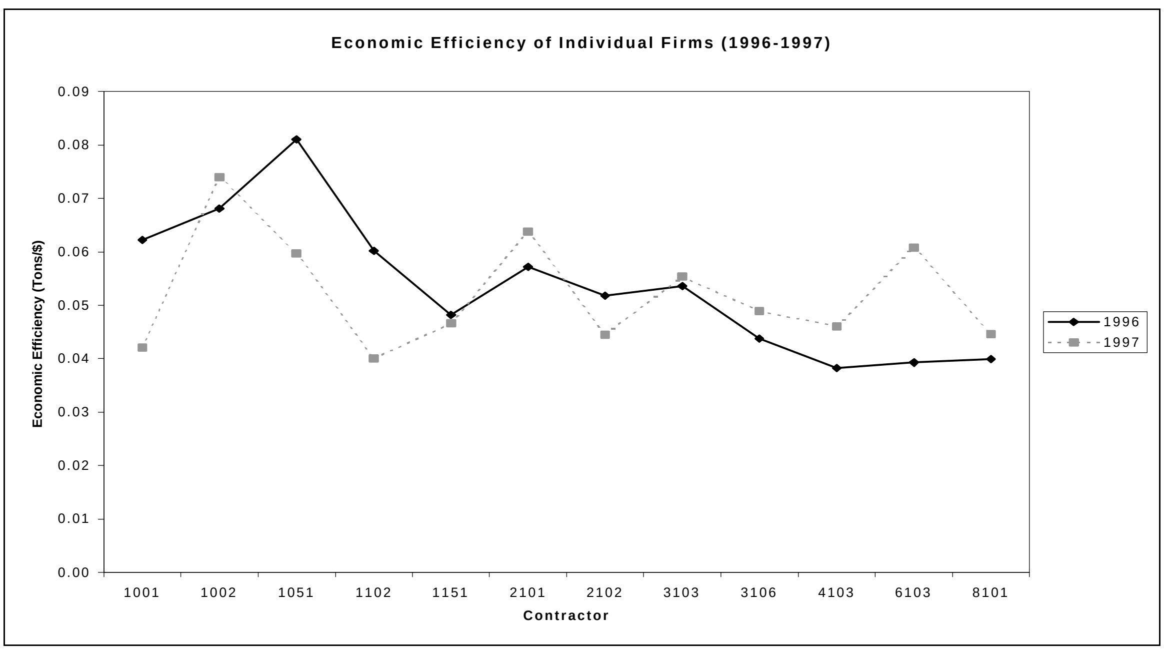

Figure 6.21 Economic efficiency of individual firms (1996-1997).

Chapter 7 SUMMARY AND CONCLUSIONS

7.1 Demographics, Business, and Technology

The contractors included in the study operated in mountainous regions of nine different states. They ranged in age from 34 to 66, with a median of 44. The experience level for the participants ranged from three years to 27 years, with a median experience level of 19 years.

Ten contractors had high school educations, two had earned bachelor's degrees, two had earned associate's degrees, and one contractor attended two years of college but did not earn a degree. Eight businesses were sole proprietorships, three were structured as Full C corporations, two as Sub S corporations, one formed an LLC, and one was a general partnership. Three contractors hauled with trucks that were owned by the logging business, five contractors sub-contracted their hauling to trucking firms with separate ownership, three contractors used a combination of company-owned trucks and contracted trucks, and three contractors had formed separate wholly owned companies.

Workers' Compensation Insurance varied dramatically across the study area. Ten contractors paid their WCI on a $100 payroll basis, three paid on a per-cord basis, one by the ton, and the general partnership did not pay WCI because the owners were the only crew members, allowing the business to meet the state's exemption clause. On a payroll basis, WCI ranged from $11.00 to $47.90 per $100 of payroll.

Eight contractors purchased a portion of their own stumpage, while seven contractors worked only on company land or stumpage. Seven different employee fringe benefit programs were found. Three contractors offered employee loans or financing, two offered 401-k or pension plans, six contractors offered paid vacation/holidays. Seven contractors offered employee transportation to and from work, two contractors offered uniform services, five offered Christmas bonuses, eight offered production bonuses, and four contractors offered employee health insurance.

The number of employees for each business ranged from three to 42, with a median of six. Eight contractors had multiple crews over the study period and 12 businesses involved family members. Eight contractors owned businesses other than their logging businesses.

Seven contractors paid their employees on a hourly basis, one paid strictly by salary, and five used a strategy of hourly leading to salaried positions. One contractor paid on a daily rate and another paid on a production basis.

All 15 owners were working members of their logging operations and filled in whenever and wherever needed. Most delimbing and topping occurred in the woods; however, three gate delimbers, two CTR pull-through delimbers, and one stroke delimber were reported.

Two harvesting methods were found that were not common in their respective regions. One contractor used cable yarding, and another contractor employed a tong-throwing machine. Seven contractors relied strictly on manual felling; eight used mechanized felling equipment. Of these eight contractors, two used only shear heads, one used both a shear head and manual felling, three used saw heads, and two used both saw heads and manual felling. The age for these felling machines ranged from 1994 models to one 1998 model.

Equipment ages for skidders ranged from one 1979 model to 1998 models. Six contractors used only cable skidders, four contractors used only grapple skidders, and five contractors had both cable and grapple skidders. Two contractors used self-loading tri-axle trucks. All others used stand-alone, trailer-mounted loaders ranging in age from 1978 to 1997 models.

7.2 Production Data

The population was split into two production groups based on total annual production. Group 1 produced less than 25,000 tons and group 2 produced in excess of 25,000 tons. Group 1's average production increased by 366.67% from 1995 to 1997 and group 2's production decreased by 23.40% during this time period.

Total annual production ranged from 2,728.26 tons to 183,083.4 tons in 1995, from 5,471 tons to 175,023.3 tons in 1996, and from 10,306.69 tons to 213,194.74 tons in 1997. The respective medians decreased for each year, which is probably a result of new, smaller entries to the study population.

Three distinctive quarterly production trends were discovered, likely related to seasonal weather patterns. The Southern Appalachian contractors tended to show a strong first quarter, a rapid second quarter decline, a period of modest recovery in the third quarter, and to conclude the year on a positive note. The Central Appalachian contractors tended to show a slow first quarter (the winter months), a rapid rise in the second quarter, a relatively stable third quarter, and a steady decline beginning in mid-November and continuing to year end (the onset of winter weather). The Northern Appalachian contractors showed a strong first quarter, followed by a steady decline in the second quarter (spring "break up"). Their third quarter (summer) was a period of recovery followed by a gradual decline in the fourth quarter (onset of winter). Run charts for each contractor illustrated the effects of the few "good" and "bad" weeks. The cusums were very heavily affected by these few weeks, and it was evident that it does not take extended periods of production better or worse than average to "drive" the cusum charts.

Precipitation was a poor indicator of production primarily because there was too much unconstrained variability in the system. Market demand, mill regulations, organizational strategies, and tract conditions were confounding influences.

7.3 Cost Data

Labor was the largest expense category for production group 1 over the three-year period. Consumables were the second, followed by contracted services in 1995 and equipment in 1997. Contracted service costs were found to be a significant expense for logging contractors in the Appalachians. Contracted service expenses were the largest cost category for the larger production group in 1995 and 1997.

A regression analysis based on data from eight contractors (1995-1996) found that the cost of adding an additional ton of output increased from $25.54 in 1995 to $27.74 in 1996, an increase of 7.93%. A separate regression analysis from a different contractor population, based on 1996-1997 data from 12 contractors, found that the cost of adding an additional ton of output decreased from $24.77 in 1996 to $22.72 in 1997, a decrease of 8.28%.

The diversity of the study population led to a variety of cost allocations by category. Structural changes, as well as businesses expansion and reduction efforts, affected cost allocation for each contractor. The presence of several start-up contractors tended to be a key variable in cost allocation changes.

The overall cost per ton ranged from $12.34 to $42.64 for the entire population during the study period. For the eight contractors providing 1995-1996 data, four showed an increase in cost per ton, while four showed cost per ton decreases. Twelve contractors provided 1996-1997 cost data; four showed cost per ton increase, and seven showed a cost per ton decrease.

The changes in cost per ton were analyzed for each cost category, and the observations fell within the expected “zones” at least 50% of the time for each cost category. Total labor cost per ton and contracted service cost per ton showed the most deviation from the expected range. The different methods of payment for labor among contractors was a primary cause. For contracted service, the range of payment amount is so wide that it might cause a skewed result.

Workers' Compensation Insurance trends were analyzed by state as a percentage of the total expense amount and on a cost-per-ton basis. Ohio contractors' WCI rates were the lowest percentage of total expenses (2.14%), followed by Georgia (2.67%), Tennessee (3.10%), and West Virginia (4.00%). Georgia had the lowest WCI cost per ton ($0.37), followed by Ohio ($0.42), Tennessee ($0.60) and West Virginia ($1.00).

Total labor cost per ton were also analyzed by geographic region. The Southern Appalachian region had the lowest labor cost per ton ($4.79). The South-Central Appalachian region was the second lowest at $5.69 per ton. The Northern Appalachian region had labor costs of $7.36 per ton, and the North-Central Appalachian region had the highest labor cost per ton ($8.34).

Study contractors in the Southern Appalachians were found to have the highest efficiency rankings among the Appalachian regions in 1995, followed by the Northern Appalachians, and finally by the Central Appalachians. In 1996, the Southern Appalachian contractors showed a substantial decline in economic efficiency, while the contractors in the other regions tended to increase. As a result, the gap was narrowed, and the overall economic efficiency rankings for the three regions in 1997 were much closer than in previous years.

7.4 Suggestions for Future Research

1. Future study should be expanded in the Appalachians and New England. These regions are undergoing significant technical, economic, and social change, and the wood supply systems are in a vulnerable state. More intensive monitoring may point to emerging issues and problems before they reach a critical level.

2. The differences between sawlog producers and pulpwood producers are more distinct in the Appalachians and New England than in the Southand are likely to remain so for the foreseeable future. Care should be taken that both types of operators are represented in the sample.

3. The changes in harvesting intensity, technology, and social expectations in both the Appalachians and New England state provides an excellent opportunity to observe changes and strategies over time. Region-wide observations can provide a basis for early identification of successes and problems, allowing the changes to be made more smoothly and effectively.

4. Increased mechanization is necessary in much of both regions. The labor intensive, "low-tech" operations are not capable of satisfying the increased social and environmental expectations of timber harvesting. The industry potential and social environment in which this mechanization must take place are quite different from previous experience in the West and South. Increased attention should be given to these broader issues.

5. Regulatory and administrative forces—workers' compensation, water quality, road and bridge weights--can have a major effect on the long-term evolution of production forestry and wood costs in both regions. The forces behind these must be understood and met with positive demonstrations of physical performance as well as social and economic contributions to the regions.

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