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An Analysis Of The Harvesting Costs And Productivity Of Logging Contractors Within The Eastern United States

Jeffrey Jaudon Smith

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AN ANALYSIS OF THE HARVESTING COSTS AND PRODUCTIVITY OF LOGGING CONTRACTORS WITHIN THE EASTERN UNITED STATES

By

Jeffrey Jaudon Smith

A Thesis
Submitted to the Faculty of Mississippi State University in Partial Fulfillment of the Requirements for the Degree of Master of Science in Forestry in the Department of Forestry

Mississippi State, Mississippi

December 2009
AN ANALYSIS OF THE HARVESTING COSTS AND PRODUCTIVITY OF LOGGING CONTRACTORS WITHIN THE EASTERN UNITED STATES

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A data set was compiled from detailed information provided from 26 independent logging contractors from throughout the Eastern United States over a five year period from 2000 to 2004. The age distribution of the logging contractors in the study has increased over time with the percentage of contractors over the age of 55 rising from 15% to 32%. The median age of all equipment including feller-bunchers, skidders, loaders, bulldozers, service vehicles, and haul trucks increased over the period. While the median age of all equipment increased, the age of service and support equipment saw the greatest increase. The total average cost per ton increased 13% over the five year period from $13.99 in 2000 to $16.11 in 2004, due mostly to increases in fuel costs and higher use of contract services. Total production for all firms increased by a net of 450,000 tons over five years.
ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS .............................................................................................................. ii

LIST OF TABLES ........................................................................................................................ v

LIST OF FIGURES ...................................................................................................................... vi

CHAPTER

I. INTRODUCTION .......................................................................................................................... 1
   1.1 Background Information ...................................................................................................... 1
   1.2 Study Objectives ................................................................................................................ 3

II. LITERATURE REVIEW .............................................................................................................. 5
   2.1 Early Research ................................................................................................................... 5
   2.2 Recent Studies ................................................................................................................... 13
   2.3 Cost and Productivity Studies .......................................................................................... 20

III. METHODS AND PROCEDURES .......................................................................................... 25
   3.1 Contractor Selection .......................................................................................................... 25
   3.2 Coverage Area .................................................................................................................. 26
   3.3 Recruitment and Data Acquisition .................................................................................... 27
   3.4 Demographic and Business Information .......................................................................... 27
   3.5 Production Information .................................................................................................. 28
   3.6 Cost Information .............................................................................................................. 28
   3.7 Data Analysis .................................................................................................................. 30

IV. LOGGING CONTRACTOR BUSINESS DEMOGRAPHICS ..................................................... 31
   4.1 Contractor Location .......................................................................................................... 31
   4.2 Contractor Demographics ............................................................................................... 33
   4.3 Business Characteristics .................................................................................................... 36
   4.4 Timber Procurement ........................................................................................................ 38
   4.5 Species Harvested ............................................................................................................. 39
4.6 Labor Demographics .................................................................40
4.7 Equipment Demographics .......................................................46

V. LOGGING COST ANALYSIS .................................................56
5.1 Expense Categorization .........................................................56
5.2 Quartile Analysis .................................................................58
5.3 Expense Categories ..............................................................59
  5.3.1 Consumable Supply Costs ...............................................60
  5.3.2 Labor Costs .................................................................62
  5.3.3 Contract Services Costs ..................................................65
  5.3.4 Administrative Overhead Costs .......................................66
  5.3.5 Insurance Costs ............................................................68
5.4 Shifts in Production and Costs ................................................69

VI. COST PER TON ANALYSIS ..................................................74
6.1 Cost per Ton Quartile Analysis ...............................................74
6.2 Year to Year Changes in Average Cost per Ton ......................76
6.3 Cost per Ton Regression Analyses ........................................85
6.4 Regional Annual Cost per Ton Shifts ....................................94

VII. PRODUCTION ANALYSIS ...................................................99
7.1 Production Quartile Analysis ................................................99
7.2 Yearly Production Shifts .......................................................102
7.3 Regional Production Analysis ..............................................103

VIII. SUMMARY AND CONCLUSIONS .....................................110
8.1 Overview ..............................................................................110
8.2 Logging Contractor Business Demographics .......................110
  8.2.1 Contractor Demographics .............................................111
  8.2.2 Business Demographics ................................................111
8.3 Logging Cost Analysis ........................................................114
8.4 Logging Cost per Ton Analysis ............................................116
8.5 Production Analysis ............................................................118
8.6 Conclusion ...........................................................................119
8.7 Suggestions for Further Research .........................................122

LITERATURE CITED .................................................................123
LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Cost Category Descriptions Adapted from Loving (1991).</td>
<td>29</td>
</tr>
<tr>
<td>4.1 Median age of equipment in 2004 as compared to 2000.</td>
<td>48</td>
</tr>
<tr>
<td>5.1 Quartile statistics for 26 firms' total expenses from 2000 to 2004.</td>
<td>58</td>
</tr>
<tr>
<td>6.1 Cost per ton quartile statistics and changes for 26 firms' total expenses from 2000 to 2004.</td>
<td>75</td>
</tr>
<tr>
<td>6.2 Comparison of average and median logging cost per ton by year.</td>
<td>86</td>
</tr>
<tr>
<td>7.1 Production quartile statistics for 26 logging firms from 2000 to 2004.</td>
<td>100</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Location of logging contractors involved in the study.</td>
<td>26</td>
</tr>
<tr>
<td>4.1 Participation by state of logging contractors throughout the Eastern United States</td>
<td>32</td>
</tr>
<tr>
<td>4.2 Participation by region of logging contractors throughout the Eastern United States</td>
<td>33</td>
</tr>
<tr>
<td>4.3 Age distribution of participating logging contractors in 2004 as compared to 2000</td>
<td>34</td>
</tr>
<tr>
<td>4.4 Education level and training obtained by participating logging contractors</td>
<td>35</td>
</tr>
<tr>
<td>4.5 Business structures utilized by logging contractors in 2004 compared to 2000</td>
<td>37</td>
</tr>
<tr>
<td>4.6 Stumpage acquisition methods by percentage used by logging firms 2004</td>
<td>39</td>
</tr>
<tr>
<td>4.7 Combinations of species harvested by logging firms 2004</td>
<td>40</td>
</tr>
<tr>
<td>4.8 Number of harvesting crews operated by logging firms 2004</td>
<td>41</td>
</tr>
<tr>
<td>4.9 Number and type of employees used by logging firms 2004</td>
<td>42</td>
</tr>
<tr>
<td>4.10 Payment methods used by logging firms 2004</td>
<td>43</td>
</tr>
<tr>
<td>4.11 Fringe benefits offered by logging firms 2004</td>
<td>44</td>
</tr>
<tr>
<td>4.12 Fringe benefits offered by logging firms in 2004 as compared to 2000</td>
<td>45</td>
</tr>
<tr>
<td>4.13 Number and age of logging contractor’s production equipment 2004</td>
<td>46</td>
</tr>
<tr>
<td>4.14 Number and age of contractor’s logging support equipment 2004</td>
<td>48</td>
</tr>
<tr>
<td>4.15 Percentage and age of feller-bunchers in 2004 as compared to 2000</td>
<td>50</td>
</tr>
</tbody>
</table>
FIGURE

4.16 Percentage and age of skidders in 2004 as compared to 2000. ......................... 51
4.17 Percentage and age of loaders in 2004 as compared to 2000. .......................... 52
4.18 Percentage and age of semis in 2004 as compared to 2000. ........................... 53
4.19 Percentage and age of service vehicles in 2004 as compared to 2000. ............... 54
4.20 Percentage and age of bulldozers in 2004 as compared to 2000. ..................... 55

5.1 Median cost category shifts as a percentage of total spending. ......................... 57
5.2 Equipment as a percentage of total costs for all study participants 1988 to 2004. .......................................................................................................................... 59
5.3 Consumable supplies as a percentage of total costs for all study participants 1988 to 2004 .......................................................................................................................... 61
5.4 Diesel fuel price trends for on-road and off-road use from 2000 through 2004. .......................................................................................................................... 62
5.5 Total labor as a percentage of total costs for all study participants 1988 to 2004. .......................................................................................................................... 63
5.6 Worker's Compensation Insurance (W.C.I.) as a percentage of total costs for all study participants 1988 to 2004. .......................................................................................................................... 64
5.7 Contracted services as a percentage of total costs for all study participants 1988 to 2004 .......................................................................................................................... 65
5.8 Overhead costs as a percentage of total costs for all study participants 1988 to 2004 .......................................................................................................................... 67
5.9 Insurance costs as a percentage of total costs for all study participants 1988 to 2004 .......................................................................................................................... 69
5.10 Total production and expense shifts for 26 logging firms from 2000 to 2001. .... 70
5.11 Total production and expense shifts for 26 logging firms from 2001 to 2002. .... 71
5.12 Total production and expense shifts for 26 logging firms from 2002 to 2003. .... 72
<table>
<thead>
<tr>
<th>FIGURE</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.13</td>
<td></td>
</tr>
<tr>
<td>6.1</td>
<td>73</td>
</tr>
<tr>
<td>6.2</td>
<td>77</td>
</tr>
<tr>
<td>6.3</td>
<td>78</td>
</tr>
<tr>
<td>6.4</td>
<td>79</td>
</tr>
<tr>
<td>6.5</td>
<td>80</td>
</tr>
<tr>
<td>6.6</td>
<td>81</td>
</tr>
<tr>
<td>6.7</td>
<td>82</td>
</tr>
<tr>
<td>6.8</td>
<td>83</td>
</tr>
<tr>
<td>6.9</td>
<td>84</td>
</tr>
<tr>
<td>6.10</td>
<td>87</td>
</tr>
<tr>
<td>6.11</td>
<td>88</td>
</tr>
<tr>
<td>6.12</td>
<td>89</td>
</tr>
<tr>
<td>6.13</td>
<td>90</td>
</tr>
<tr>
<td>6.14</td>
<td>91</td>
</tr>
<tr>
<td>6.15</td>
<td>92</td>
</tr>
<tr>
<td>6.16</td>
<td>93</td>
</tr>
</tbody>
</table>

viii
<table>
<thead>
<tr>
<th>FIGURE</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.17</td>
<td>Shifts in total annual cost per ton for sixteen logging firms located within the coastal plains region 2000 - 2004.</td>
</tr>
<tr>
<td>6.18</td>
<td>Shifts in total annual cost per ton for eight logging firms located within the Piedmont region 2000 - 2004.</td>
</tr>
<tr>
<td>6.19</td>
<td>Shifts in total annual cost per ton for two logging firms located within the Appalachian Mountain region 2000 - 2004.</td>
</tr>
<tr>
<td>7.1</td>
<td>Production quartiles for 26 logging contractors from 2000 to 2004.</td>
</tr>
<tr>
<td>7.2</td>
<td>Production shifts for 26 logging contractors from 2000 to 2004.</td>
</tr>
<tr>
<td>7.3</td>
<td>Total production shifts for 26 logging contractors from 2000 to 2004.</td>
</tr>
<tr>
<td>7.4</td>
<td>Total production shifts by region for 26 logging contractors from 2000 to 2004.</td>
</tr>
<tr>
<td>7.5</td>
<td>Total yearly production shifts for 16 coastal plain logging contractors from 2000 to 2004.</td>
</tr>
<tr>
<td>7.6</td>
<td>Total yearly production shifts for eight piedmont logging contractors from 2000 to 2004.</td>
</tr>
<tr>
<td>7.7</td>
<td>Total yearly production shifts for two Appalachian Mountain logging contractors from 2000 to 2004.</td>
</tr>
</tbody>
</table>
CHAPTER I
INTRODUCTION

1.1 Background Information

Logging contractors are vital to the operation of the wood supply system. They provide a service that the average landowner would not have the time or resources to perform, and one that the forest products industry has found economically inefficient (Ulmer and others 2004). Loggers are the central link in the process of converting raw materials into finished forest products. Therefore the health of the logging industry not only impacts, but can be an indicator of the overall health of the forest products industry.

Logging firms are an often overlooked component of the wood industry. They are usually found deep inside a tract of timber or along a secondary or tertiary rural road out of view from the major throughways. The only component of logging most individuals notice is a "log-truck" either going to or returning from a processing mill. These trucks are all basically the same; the names on the doors are hard to read at highway speed, masking the true number of contractors working in a given area. The public, for the most part, does not realize the contribution these businesses offer to their local and state economies. Depending on the region, logging contractors can provide thousands of jobs which contribute millions to state economies (Munn and Henderson 2002). These firms also require an intricate assortment of support businesses. Equipment dealers, parts
suppliers, accountants, fuel dealers, hydraulic specialists, welders, and other professionals, merchants, and trades as well as the people employed by these ancillary businesses depend on loggers for at least a portion of their income.

Logging is often perceived as a labor intensive career with minimal need for intelligence, however nothing could be further from the truth. The day to day operations of a logging business require the contractor to have at least a basic knowledge in several disciplines. The contractor has to be part accountant, part mechanic, and part economist. They must be skillful at managing labor, time, mill relations, and landowner concerns. He also has to be part lawyer; there are business laws, tax laws, labor laws, and environmental regulations to which he must adhere as well.

The initial capital invested can easily be in the hundreds of thousands of dollars with periodic reinvestment and upgrades required. Servicing the short term credit used to purchase equipment requires that the contractor be able to secure enough timber or contracts for cutting timber owned by others at the proper logging rate to cover the monthly payments and return a profit. This requires some loggers to take on the role of procurement officer as well.

The contractor must be able to adapt quickly to change in order to survive. A variety of factors can affect the efficiency and profitability of a logging business. Machinery breakdowns can cause the loss of production. The absence of one employee due to sickness or personal leave can impact the productivity of a small to mid-sized operation. Poor weather can force expensive machinery to sit idle. Long runs of good weather can create an overflow of wood inventory at the mills forcing long turn around
time for trucks, or worse, quota restrictions on production. New and existing environmental regulations can slow progress on certain sites. The effect of these factors and others are often double sided, decreasing production potential while increasing costs.

Like most professions, the logging industry has a minority of participants who cut corners wherever possible with little regard to legal or safety issues. The logging contractors chosen for this study were selected because of their values and compliance with all regulations. They are suggested by state logging associations, mill representatives, and other contractors whom regard these firms to be the best in their business.

1.2 Study Objectives

The main objective of the study is to evaluate the dynamics of the business health and productivity of logging contractors in the Eastern United States over time. This study is a part of a long term study addressing the cost and productivity of logging contractors initiated in 1988 at Virginia Tech. Mississippi State joined as a cooperator in 1996, and following a brief partnership between the two universities, the study is now held exclusively at Mississippi State University since 1999.

The larger study collects actual cost information from financial records and tax filings, production information from settlement records and includes a provision for the contractors involved express their concerns with issues facing the logging industry. It also brings these issues and logger - mill relationships to the forefront for further discussion. Because the data and research are presented by a non-biased third party, it can be used by the entire forest products industry.
Contractors in the study are spread across 17 states from Michigan south to Florida and west to Texas. Contractor firms of varying sizes, products, and business structure are represented.

The objectives of this study are as follows:

1. To monitor the cost and productivity shifts which have taken place over the study period of 2000 through 2004.

2. To maintain logging cost and productivity study database and enroll new contractors.

3. To monitor changes in equipment and equipment strategies and the logging force in the eastern United States through on-site interviews.

4. To document the changing business and personal demographics of participating contractors.
CHAPTER II
LITERATURE REVIEW

2.1 Early Research

Logging has been a labor intensive undertaking for most of its history. It is a mobile extractive industry with little opportunity or need to modify the workplace. It deals with a variable material in a variable, often remote, environment. The adaptability of human labor and animal power was necessary to deal with variable logging conditions (Bryant, 1913). As a consequence, forest operations mechanized later than other segments of the economy. But labor was expensive, and most research concerning the cost, productivity, and improvement of operations and firms focused on improving labor performance - volume output per unit time.

Early mechanization introduced in the late 1800s and early 1900s added capital, in the form of logging railroads and steam yarders to the mix for those operations where this advanced technology could be used (Hoffman 1999). But the productivity, and hence unit cost of these devices, were largely dependant on the ability of labor to cut and prepare material for them. Logging, in these cases, was usually directly associated with the mill as a cost center. Smaller, entrepreneurial firms were used in many areas to compliment these company operations or to harvest timber from tracts too small or scattered to support capitalized operations (Saikku 2005)
Things began to change in the 1930s and 1940s. Internal combustion engines replaced steam, farm tractors became robust enough to work in the woods, and the public road network, trucks, and tires developed to the point that forest to market transport broke away from the rail and water transport methods of the earlier era (Drushka and Konttinen 1997). Logging contractors began to rely less on animal power, and more on new machinery for both moving wood from stump to roadside and roadside to mill. Mules and horses were being replaced with tractors, log trucks and common carrier railroads replaced narrow gage rail and log drives (Stewart 2004). The new technologies allowed contractors to move more material with less effort and labor, but the felling and preparation of the material for transport was still labor intensive.

These early efforts of mechanization made it possible to de-couple logging from the consuming mill leading to the rise of the independent contractor system (Matthews 1942). Matthews devised mathematical models using machine expense rates to project costs for logging operations and began to apply general economic principals, such as break - even analyses and cost minimization of operations combining fixed costs of capital, variable costs of operation and labor. Matthews' work was one of the first complete studies on logging costs and it is still used as the basis for much of the work done today (Stuart 2003). Coming as it did on the cusp of a restructuring of the logging industry in the South and East, it perpetuated an approach of cost reduction, appropriate for a process within a larger firm, and largely ignored profit and profit maximization, the requirements of an entrepreneurial undertaking.
Social changes came rapidly in the post WWII era. Prosperity resulted in increased opportunities for urban, industrial employment with better wage and benefit packages greater than logging could provide, Agricultural mechanization displaced the seasonal work force that had served the logging industry. Racial and cultural barriers were lowered, and the workforce became mobile at a time when the demand for forest products was increasing (Holley 2000). Mechanization, the substitution of capital for labor, moved from being a strategy for improvement to a necessity for survival of the industry in North America and Europe. Advances in small engine technology and carburetion lead to light-weight, affordable chainsaws. The saw still had to be carried by a man, but increased his productivity. The combination of diesel engines, mobile hydraulics, improved drive trains and steering systems made it possible to do more and more of the necessary tasks by mechanical means.

The research performed during this time usually fell into one of three categories: Intermittent surveys to capture demographic information of respondent logging contractors which were important tools for assessing the availability and health of the contractor pool necessary for logging the mills. Tayloristic work study approaches for developing standard times and standard costs for rate setting were common in those countries and states where the logging force was unionized. The advent of computers and multiple regression techniques lead to a flurry of biometrics based approaches attempting to predict logging productivity and cost as a function of tree and tract characteristics such as -tree size, stocking, tract layout, soils, and topography that affected job productivity. These were an elaboration on the standard time/standard cost approach
for company operations and were seen as a tool for establishing contract rates for independent suppliers.

The fundamentals of the system had changed since Matthew’s work was published. The objective was no longer cost control for a process within a larger enterprise. The concern was establishing a contract rate for harvest and delivery that was adequate enough to encourage continued participation by the contractor, allowed a reasonable return to the landowner, and low enough to allow for profitable operation of the manufacturing facility. This gave rise to attempts to apply a variety of industrial engineering/operations research tools to an industry working in an environment for which they were only marginally suited (Stutzman 2001).

Schnell (1958) of the Tennessee Valley Authority (TVA), performed a field survey of pulpwood dealers and logging contractors within the 125 counties on the Tennessee Valley. The survey found that pulpwood production doubled from 1947 to 1956. The typical crew at the time consisted of three men with chainsaws, a one and a half ton truck, and a horse or mule. An estimated 4000 part-time contractors delivered half of the wood purchased. Only 800 full time contractors accounted for the other half of production. The study also provides a look at transportation systems of the time. Railways accounted for 82% of the wood received by consuming mills, 10% were transported by barge and only 8% by truck. Ninety two percent of the wood received was moved from one mode of transport to another between the stump and mill. Mechanizing the handling on the reloading yards was one of the first efforts.
Jiles and Lehman (1960) released another study for the TVA concerning hardwood logging production and costs. The study found that high costs were due to under skilled and inefficient labor. The typical logging crew was identical to the earlier Schnell study with the exception of crew size being reduced to two men from three. Half of the contractors used animal labor and the other half used crawler tractors for log skidding. Loading was still mostly done by hand. Cost of equipment – availability of capital - prevented most contractors from using loading equipment. Bottlenecks in efficiency were loading which was slow and cumbersome, trucking with an average roundtrip rate of four miles per hour, and labor which was often hard to find and keep year-round.

These early studies relied on statistical models which inadequately explained variability. The remaining variability had to be attributed to something, and labor skill and aggressiveness was beyond the measurement techniques of the time, so it must be the causal agent. (Personal communication – Stuart).

The American Pulpwood Association (APA), in 1960 contracted with the Battelle Memorial Institute for a study of the status of the wood supply system (Hamilton 1961). The institute found that logging was falling far behind agriculture and other extractive industries in fully mechanizing its operations. The changing labor pool of rural America was putting the industry at risk. Labor was leaving rural America for industrial employment. National prosperity, favorable labor costs, right to work legislation, air conditioning, and the interstate highway system were altering the economies of rural America. Changes in agriculture were decreasing the pool of seasonal workers, and work
in the woods, especially pulpwooding, was seen as hard work for low pay with few
benefits. The report sent some in the industry scrambling to find new technologies, both
in the woods and on the woodyard (points of transfer between transportation modes and
unloading facilities) to replace unskilled labor. Mechanization was seen as a solution to
these impending problems.

It offered promise for reducing the number of workers required, providing those
who were retained with better wages and working conditions, and reducing the sensitivity
of the wood supply system to weather. The challenge was to find a route to
mechanization that was compatible with the capital available to rural independent logging
contractors and the skills available in the local labor force. It would also have to be one
that could be maintained with limited on site parts inventories and sufficiently flexible to
adapt to the range of species and stands found on private timberlands. This encouraged
mechanization strategies relying on farm equipment, light industrial equipment and
trucks.

The continued availability of entrepreneurs and labor remained a concern. The
APA conducted periodic surveys of the pulpwood contractors in the south throughout the
seventies and eighties. Surveys conducted at Mississippi State include Watson and others
(1977), Weaver and others (1981 and 1982) and Watson and others (1989). The APA
surveys gathered information on the characteristics of the logging workforce as well as
the types of equipment and systems being used at the time. These studies were later used
by Carter and Cubbage (1995) to estimate the changes in efficiency that were brought
about by the increased mechanization of the logging industry.
As technology progressed later in the century, so did research into logging methods. The APA Harvesting Research Project (HRP) incorporated computerized analyses in many of the projects undertaken in 1967. One of the first challenges given the research team was to evaluate the future of the shortwood harvesting approach (now called cut-to-length) then typified by the Bush combine, and the tree length system the typified by the Beloit system, and their appropriateness for the southern logging industry. The rapid developments in mechanization at the time resulted in the manifestation of a variety of machines and machine concepts that fit into one of the two broad length categories. While similar, these machines were sufficiently different in concept, construction, and operation that their appropriateness for an independent contractor force could not be assessed by a single, deterministic approach. The Harvesting Analysis Technique (HAT) was developed as tool for assessing and comparing mechanical, operational and economic performance (Stuart 1980).

A second initiative was triggered by labor unrest and union problems in Canada at that time. Some of the sponsoring firms had operations in Canada, and were concerned about the possible spread of unionization to the South. It was deemed prudent to develop a basic set of standard times and standard costs that could be used in negotiations if the need arose. Eighteen man years were spent in collecting data on conventional harvesting systems of the era as well as the factors thought to have a major effect on task productivity. This data was then used to develop regression equations and to develop a set of production tables (Cunia and Lanford 1972).
The Harvesting Research Project ended in 1974 and the computer simulation study was transferred to The Industrial Forestry Operations program at Virginia Tech staffed by Dr. Thomas Walbridge, the HRP project director, and one of the forest engineers, William Stuart. While at Virginia Tech the study was enhanced with a larger database of harvesting and terrain variables. The system had a library of harvesting machines and 90 mapped stand variations along with a loblolly pine plantation growth simulator (Stuart 1981). Harvesting systems could be simulated with up to 14 machines performing up to five activities operating on a tract with 14 stand types. The system could account for costs of downtime, labor costs, and fixed costs accrued during a specific operation. Finally the simulator would allow the user to enter stumpage and hauling costs as well as debits based on volume of product moved. The uses of simulations such as HAT are still useful tools for students, researchers, and the forest industry as long as the researcher understands that the simulation is best used as a comparison model and not a definite prediction (Stuart 1980).

The Forest Engineering program at Auburn University was started a few years later, and staffed by Bobby Lanford who had guided the production tables project for HRP. That effort provided the basis for the Auburn Analyzer, a deterministic model for the analyses of harvesting systems (Tufts et. al. 1985).

The logging and forest products industry transitioned through the social and economic change of the 1960s, 1970s and 1980s with the help of the research described above. The move toward mechanization started in the 1960s advanced quickly enough to keep harvest and delivery costs within tolerable bounds. Advances in mobile hydraulics
made it possible to mechanize the last labor intensive harvesting function: felling, limbing, and bucking. The tree length system, which eliminated bucking (cross cutting the stem into logs and bolts) or transferred the function to the mill site, allowed the industry to survive and develop despite a diminishing labor pool.

Cost analysis studies during this era of evolving technologies were often focused on comparisons of alternative mechanized systems for performing the same task. The methodology for cost evaluation was still tied heavily to Matthews’ machine rate of 1942. This tool was useful for comparisons, but not recommended for developing business costs. Miyata (1980) worked on informing logging contractors with useful tools in accessing the “real”, (the economic, not necessarily the business), costs involved in harvesting using modern equipment. Miyata warned that while the machine rate approach had long been a useful tool, it is basically a set of rules of thumb and that no standard cost can be applied for estimating individual equipment costs. Each contractor was cautioned to use his own judgment to determine the costs to apply to his company.

2.2 Recent Studies

In the past twenty years, much more focus has been placed on the impacts of insurance rates, mill quotas, SFI training, and others on the productivity and costs incurred by logging firms. Mechanization caused the industry to develop differently in different regions because of the necessity of adapting machines, methods and business practices to local conditions (Laestadius 1990). The mechanized world was quite different than the one of simple tools, manual labor and animal power. It is for this reason some researchers explored these issues in their region and compared the results with the
overall industry. These studies would focus on the process and physical environment of harvesting and transport and ignore the business of harvesting and transport and the social and business environment.

One common concern raised in many studies is the changing demographic of the "average" logger. The average age of participating loggers has been on the rise. With 1,103 responses to a survey in the New England area, it was estimated that the mean age of logging contractors in the area was 45.5 with 23.3 years experience. The respondents stated concerns that very few young people wanted to "work in the woods". Furthermore, 69 percent of the contractors discouraged their children from entering the business (Egan and Taggart 2004). A similar study in Georgia estimated the average contractor age in the area to be 43 with 19 years experience (Greene et. al. 1998). The Georgia study also found that 42 percent of the participants planned to retire or sell the firm in the near future. The question is what are the possible causes of this trend in logging firms?

The most popular complaint of contractors is the increasing costs of owning and operating logging operations have been met with only marginal increases in compensation. With the change from manual to mechanized logging, there came increasingly higher capital investments as well as a need for more highly skilled labor (Greene et. al. 1998). In the beginning, these cost increases were mitigated by increased productivity. However, as mechanization matured, each step advance came at a higher cost, and the marginal gains per unit of expenditure decreased.

Laestadius (1990) noted that the difference between the Scandinavian and the southern wood supply system was that the Swedish system traditionally stored wood to
keep their contractors employed; the south maintained a surplus of contractors to keep
inventories low. There were valid reasons for this. Wood was easier to store in northern
climes, especially when water storage was available. Logging in northern climates
developed as a seasonal activity, farming labor was available in the winter, snow aided in
transport, and frozen ground was less susceptible to damage. Southern agriculture
traditionally had no extended idle period. The need for workers tended to peak for
relatively short periods spread across the calendar. Transplanting out tobacco plants from
the seedbed to the field, and later in the fall during priming and curing were the labor
intensive periods. Cotton farming required men and mules during seed bed preparation
and planting, and again during picking. In the pre-mechanization era, labor – and animal
power- could move easily from one occupation to another. Timber harvesting could
maintain reserve capacity, often at another sector’s expense. If wood inventories got low,
increased wood orders would entice more suppliers to move from the sidelines to
production. Reduced wood orders would cause them to fall back on other forms of
employment.

The switch to mechanized logging changed the underlying structure of this
relationship. But the tradition of adding additional capacity during times of increased
demand continued. “New capacity” would be added by asking existing contractors to add
machines or start a new crew, or the encouragement of new contractors to enter the
industry, often with used equipment. Disturbances in the wood supply system, real or
anticipated are met with an influx of new contractors which creates a surplus of capacity
when the system stabilizes, or the threat does not develop. This excess capacity is useful
to landowners and consuming mills in the short term, competition for survival keeps logging rates low (Ulmer et. al. 2004). A 1999 study published by the American Pulpwood Association found the production for its participants rose 11.7 percent with an increase in cost of 29.4 percent for the period of January 1994 to December 1997. Equipment and labor costs were a large part of this increase (Stuart and Grace 1999).

Skilled, reliable labor has proven difficult to find and even more difficult to keep. The skills set required on a modern, mechanized logging operation are very similar to those of other industries. Mobile equipment operators can move between logging and trucking, construction, primary manufacturing, and other more consistent, higher paying jobs. These jobs, once relatively rare in rural America, have become more common as the economy has developed and commerce has spread to smaller communities. There is major concern that the labor force and the contractor population is aging, and that the industry in not capable of attracting the replacements required to sustain the industry in the long term.

Logging has long been a family business, but many of the sons and daughters of current owners are going elsewhere for work. Contractors have found that they have needed to invest greater amounts of time and money in finding and training operators for their firms with no promise of retaining them (Egan and Taggart 2004). This commonly triggers calls for educational programs at the trade or technical school level to attract new labor to the industry. The best attractant is the promise of a competitive wage, competitive benefits package, and consistent employment. The same factors that cause workers to leave the industry are the same that keep new workers from entering.
The industry has been under considerable cost pressure for the last decade. Landowners have attempted to keep stumpage costs up to recoup their investments in land and timber while mills have tried to keep harvest and delivery costs low to support profitable operation of aging mills in the face of global competition. Unfortunately, when costs for a firm increase, and the rate paid for services falls, employee benefits and wages are the first things cut which leads to a decline in employees. The remaining employees are often forced to work harder with less pay and benefits which usually leads them to leave as well. Participants in various studies have stated a lack or fear of losing benefits among reasons for leaving the logging profession. This uncertainty of employee faithfulness coupled with an expanding learning curve on new machinery, continues to have negative effects on production rates and costs (Greene et. al. 1998).

Insurance rates, particularly Workers Compensation Insurance (WCI), have also been an increasing burden on contractors. While equipment insurance rates have risen on par with other industries, WCI rates have declined slightly in recent years. This decline is due mainly to the efforts of logging contractors to provide a safer work environment as well as the movement away from manual felling and into mechanized logging (Altizer et. al. 2004). Mechanized logging, in regions which will allow it, have a significantly lower injury rate. One study suggests an accident rate drop of 43 percent from 1996 to 1999 (Shaffer 2002). Even though a safer jobsite has kept the WCI rate in these areas within reason, this cost is still a major contributor to the overall cost per ton incurred. The mountain states carry a much greater burden than others due to WCI. The WCI rates in West Virginia, for example, are some of the highest in the country due to the WCI claims
of the states mining industry. Fearing bankruptcy of the state run Worker’s Compensation program, WCI rates for all industries in the state were raised in order to bail the system out (Personal communication – Stuart). Demographic studies in these areas have found trouble collecting accurate employee numbers due in part that contractors hire part-time or independent labor to avoid increasing WCI rates (Luppold et. al. 1998). The cost significance of WCI depends greatly on the size of the firm. Some contractors purposely keep the number of employees under the mandatory WCI limit in order to avoid paying for insurance. These firms have decided to sacrifice production in order to maintain lower costs, which has allowed some firms to remain in business (Luppold et. al. 1998).

A growing concern with the number of forest product corporations which are consolidating and downsizing is forestland fragmentation. Companies are divesting themselves of vast tracts of timber in an attempt to increase profitability. Grace and Stuart (1998) found that tonnage harvested from private forestland owners increased approximately 50% over the period from 1986 to 1996. These larger industrial tracts are being sold into smaller company or private ownerships who maintain much smaller parcels of land. The effect on loggers has been that moving to and harvesting these smaller tracts is less economical than were the larger tracts. Contractors lose days of production while having to move equipment from tract to tract (Stuart 2001). Along with this fragmentation comes a move of private landowners to a stand system where only portions of a property are harvested. Greene and others (1997) found that in
Georgia, timber sales of less than ten acres rose seven percent while sales over 200 acres dropped 18 percent.

Changing trends in public acceptance of logging and tightening environmental laws have forced contractors to spend more on training and logging methods. In accordance with the Clean Water Act, all forested states instituted water quality programs using Best Management Practices (BMP's). While BMP's are voluntary, the Clean Water Act is not. Contractors are penalized for excessive pollution of streams or logging sites, usually by the withholding of performance bonds until the problem is rectified which in turn costs them lost time and profit. These practices include creating proper haul roads, loading decks and stream crossings as well as designating and preserving streamside management zones (SMZ's). While these practices are ecologically important, they decrease production due to the loss of acreage in SMZ's, and increase cost by taking away man and machine hours constructing decks, roads and crossings. In most cases the logger is responsible for the brunt of the initial cost (Sun 2006).

The need for these environmental practices, along with programs for logger certification and the has brought a greater need for logger education programs. Contractors are now being required, in many states, to attend continuing logger education programs as part of the certification process (Grace 2003). Loggers attending these programs alongside representatives of the forest products industry can help to improve what are sometimes fragile relationships as well as open lines of communication (Keefer et. al. 2002). The programs offered to Mississippi contractors, for example, include SFI introduction and training, BMPs, timber harvesting and transportation safety, and
business management. These programs are offered to aid contractors in adapting to changing issues which may affect businesses and ways of doing business. Grace (2003) conducted a survey of attendees at 59 business management workshops to determine what the contractors felt they needed help with. The survey returned more than 1000 responses which were categorized by frequency and by business size. Firms, regardless of size, felt that tax issues, money management, and the changing wood supply system were the top three issues. Other issues included contractor - mill relations, business planning, production management and negotiating skills.

2.3 Cost and Productivity Studies

The contractor cost and productivity study began in 1988 at Virginia Tech. This study approached the problem by using real world data provided by logging contractors throughout the region. Loving (1991) started with 24 logging contractors throughout the Southeastern United States. He used the initial cost and productivity data to assess the efficiency and cost structure of participating contractors. The logging costs were separated into six major categories: 1) labor costs, 2) Equipment, 3) consumables and supplies, 4) contracted services, 5) insurance, and 6) administrative overhead. Loving found that labor, consumables and supplies, and equipment accounted for 75% of the average total operating costs. Excess production capacity was analyzed for the contractors as well. He found that most firms were operating below their possible efficiency level possibly because of an excess of suppliers in the region during this time.

LeBel (1993) continued the study with data supplied by 22 contractors in the southeast building on Loving’s work to determine reasons for inefficient production.
LeBel requested that contractors and their procurement foresters provide estimates of the firm's maximum daily production. He then compared their maximum production with the actual production figures provided and calculated efficiency ratings by region. The Piedmont region had 81% average contractor efficiency, Coastal Plain contractors averaged 70%, and the Mountain region averaged 63%. The most common reasons for lost production were bad weather, mill quotas, equipment failures, changing tracts, and labor problems.

LeBel (1996) used Data Envelopment Analysis (DEA), a nonparametric analysis method for measuring productive efficiency, on the data set of 23 contractors of the study. Contractor efficiency was determined as the ability of a firm to convert inputs (dollars) into outputs (timber harvested). LeBel determined major causes for lost efficiency were changing tracts and poor logging conditions. The contractors with the most efficient operations were those with production output in the 60,000 to 80,000 tons per year range.

Walter (1998) furthered the work of LeBel using cost and production data from 23 contractors along with participant demographic information. He measured the efficiency ratings of both small and large firms to determine what, if any benefits arose from firm size. He found that all firms regardless of size could produce wood at approximately the same cost per ton, meaning there were no economies of scale per se. Walter also found that adding equipment in an attempt to increase production usually lowered the firm's efficiency.

Shannon (1998) studied 35 contractors between 1990 and 1996 using DEA methods. Using demographic information concerning the contractors as predictors of
contractor efficiency he found age, experience, and education level to be poor predictors of efficiency, while business, operational, and environmental factors were much better. Shannon found that both production and production costs rose throughout the study period. Although both were on the rise, efficiency dropped because cost had risen faster than production.

Altizer (1999) expanded the study into the mountainous regions with his study of 15 Appalachian logging contractors from 1995 to 1997. Logging in this region operates much differently than in other regions. The timber harvested was predominantly hardwood from small tracts of land often requiring merchandizing which is more complicated and time consuming. Equipment spreads are often smaller and less mechanized than those in other regions. Haul distances could be much greater than other regions depending on the product hauled while haul times could be extended by road quality, slope, and alignment. Worker's Compensation Insurance in the region was also much higher than elsewhere, up to $1.00 per ton in some areas.

Omohundro (1999) used a database of 22 contractors, many of whom had participated in the study from its inception. He extended the cost, productivity, and demographics information database through 1998. He found that production dropped in the winter months and leveled out in the warmer months, as quotas replaced weather as inhibitors of production. Omohundro also determined that precipitation statistically accounted for only 2% of weekly production variation. Contracted services expenditures increased in 1997 while costs for equipment, consumables and labor decreased. Over the
study period, total costs per ton increased by 3.7%, while total production increased by 3.9%.

Mississippi State University joined Virginia Tech in 1995 and the study expanded into the Lake States region and added contractors in the Southern States. Miller (1999) added cost, production and demographic information for 27 loggers from the two regions to the database. Labor had the most affect on logging costs during the late 1990s. Equipment costs during the period dropped due to reinvestment. Administrative overhead had the greatest increase from 1995 to 1997 due in part to increased record keeping and accounting requirements. These factors together impacted the total cost per ton for the period which increased $1.96 in two years.

Stutzman (2001) continued the logging cost study from Mississippi State. He found that the average age of logging contractors had increased over the period as some younger contractors left the industry. Contractors running multiple crews began to cut back and streamline their operations, as did some contractors with large single crews. Equipment age for most contractors was going beyond the depreciation period. Labor concerns were still present with contractors keeping incentives around to attract skilled labor. Production decreased early in his study period but had begun to gradually increase in the last year.

Jackson (2003) analyzed 38 contractors while maintaining continuity of the study database. Many of the younger contractors in the study including the children of older contractors who had taken over the business had left the business by 2002. Skilled labor problems persisted with some loggers losing help that had been with them for many
years. Equipment purchases remained stagnant with many firms opting to purchase used equipment when necessary. Production for the group increased slightly during the study but at a lower rate than did the average cost per ton.
CHAPTER III
METHODS AND PROCEDURES

This study is a continuation of the logging cost and productivity study initiated at Virginia Tech in 1988. Mississippi State University began work on the study in 1995 and in 1999 it was transferred to Mississippi State exclusively. The study initially focused on contractors in the piedmont and coastal plains regions of the Eastern United States, then in the latter part of the nineties research was expanded into the Appalachian and Lake States regions. This study is built on the earlier research of others including: Loving (1991), LeBel (1993), Shannon (1998), Walter (1998), Altizer (1999), Omohundro (1999), Miller (1999), Stutzman (2001), and Jackson (2003).

3.1 Contractor Selection

Contractors recruited for the study are those considered by their peers to be in the top echelon of their profession. They must be in compliance with all applicable laws and regulations while having a good reputation within the industry. Potential participants are suggested by logger's associations and councils, various forest resource organizations, wood consuming mills, and other participating contractors. In addition to a good reputation, contractors must also have kept an accurate record of production, expenditures, and revenues for their operation.
3.2 Coverage Area

The study now consists of 50 participants in 13 states throughout the Eastern United States. While not all were able to supply the full data set for the period from 2000 to 2004, all were able to contribute at least a portion of the data. The geographic distribution of participants throughout the Eastern U.S. is shown in Figure 3.1.

Figure 3.1  Location of logging contractors involved in the study.
3.3 Recruitment and Data Acquisition

Once a contractor is nominated for the study, they are contacted to schedule a meeting. During this time the contractor is provided with background information on the study including previous publications, results of the study, confidentiality agreements, and what types of information will be requested from them. At this point, if the contractor agrees to participate, a second meeting is scheduled at the contractor's office or jobsite to collect all necessary data.

During the second meeting, basic operation information is collected from the contractor. A procedure for the collection of cost and production information is organized to find the most convenient and accurate method of exchange. For some contractors, this requires that the researcher contact accountants, bookkeepers, CPAs, and wood purchasers in order to schedule data transfer.

3.4 Demographic and Business Information

During the early meetings demographic information was collected from the contractor. If the contractors choose to, they are asked to share personal information such as age, education level, and whether or not they are involved in other businesses or employ family members. Business characteristics such as equipment in use, trucking strategy, employee information, stumpage acquisition and type, and business organizational structure were also collected.
This time is also used to discuss factors and issues affecting the logging industry. The contractor can request what information they would like to see further explored in the study. These discussions can also be used to determine how that contractor has responded to a particular problem and can that strategy be useful to other participants in the study.

3.5 Production Information

Production data from the contractors was obtained on a weekly, quarterly, or annual basis depending on the contractor. The information was either provided by the logger or their wood purchaser in a variety of formats such as loads, cords, thousand board feet (MBF), cunits, or tons. In order to obtain a more accurate record of costs vs. production, local conversion factors were then used to convert all production into tonnage.

3.6 Cost Information

Only costs directly associated with the harvesting and transportation of wood from the stump to the market were considered in the study. Costs associated with stumpage acquisition and other activities were excluded. Although some contractors provided income data, this information was excluded as well.

Cost information was provided during annual visits or mailed by either the contractor or their accountants and bookkeepers. The data were then analyzed and separated into one of six cost categories first arranged by Loving (1991). An overview of these categories is provided in table 3.1 along with subcategories.
Table 3.1 Cost Category Descriptions Adapted from Loving (1991).

1. **Equipment**
   - A. Note Payments
   - B. Depreciation
   - C. Equipment Rentals
   - D. Taxes (Highway use, property tax)

2. **Labor**
   - A. Payroll (wages and salaries)
   - B. Payroll taxes (FUTA, FICA, Medicare)
   - C. Workers Compensation Insurance (rate and experience modification factor)
   - D. Employee Benefits

3. **Consumables**
   - A. Tires
   - B. Fuel
   - C. Oil and Lubricants
   - D. Parts and Maintenance
   - E. Truck and Equipment washing
   - F. Non-depreciable tools (chain saws)
   - G. Gravel
   - H. Mats
   - I. Wrecker Service

4. **Administrative Overhead**
   - A. Secretary Wages
   - B. Bookkeeping or Accounting fees
   - C. Office expenses
   - D. Licenses
   - E. Fines
   - F. Legal and Professional Dues
   - G. Travel Expenses
   - H. Phone and CB Radio Expenses
   - I. Medical Expenses

5. **Insurance**
   - A. General Liability
   - B. Equipment (Fire/Theft/Vandalism)
   - C. Umbrella Policy

6. **Contracted Services**
   - A. Contract Hauling
   - B. Cut & Skid, Moving Expenses, other
Worker's compensation insurance (WCI) for this study has been separated from the insurance category and added to the labor expenses. This was done because WCI is proportional to employee payroll which makes it more of a function of labor than insurance.

Another issue concerning the costs was an equal compensation for the contractors themselves. The contractors have many variations on how they pay themselves. To remove this variation, Walter (1998) devised an officer's salary equation which would serve as a replacement cost of hiring an extra employee to perform the duties of the owner. The equation uses a base salary of $20,000 with an additional $0.30 per delivered ton.

3.7 Data Analysis

Fifty contractors were able to supply at least partial data for the entire research period of 2000 – 2004, with 26 firms providing complete data for the period. The data provided by these contractors were analyzed using Exploratory Data Analysis (EDA) to obtain statistical and graphical outcomes which compare and contrast changing trends in logging costs and production over time. The analyses were performed to determine what changes had taken place within the study group rather than predict future outcomes.

The following techniques were used to determine changes in cost, production and demographic trends: medians, quartile shifts, inter-quartile ranges, cumulative relative frequency charts, and regressions.
CHAPTER IV
LOGGING CONTRACTOR BUSINESS DEMOGRAPHICS

This chapter consists of the business demographics of 50 currently participating logging contractors operating 87 logging crews throughout the Eastern United States. Comparisons were made as well between these contractors for the short term study between 2000 and 2004. Contractors were asked to supply personal and business data on indicators of the overall health of the timber harvesting industry. Personal information such as the age and education level of the business owner provides insight into the characteristics of the “average” logging professional operating today. Changes in business characteristics such as equipment renewal rates, employment levels and benefits, and business strategies reflect the methods contractors use to increase the efficiency and profitability of their firms.

4.1 Contractor Location

The contractors represent 13 states and four physiographic regions throughout the east. Alabama and Virginia had the most participants in the study with nine contractors apiece followed by Mississippi and Georgia, each with seven firms.
Other states represented on the study include Louisiana, Michigan, Arkansas, Florida, North Carolina, South Carolina, Maryland, New York, and Texas. Figure 4.1 illustrates the state by state distribution of participating contractors.

Figure 4.1 Participation by state of logging contractors throughout the Eastern United States.

The majority of the logging firms are located in the Coastal Plain and Piedmont regions with 24 and 17 contractors respectively (Figure 4.2). The remaining contractors involved in the study are in the Appalachian Mountain and Great Lake States regions.
4.2 Contractor Demographics

The demographic information for 27 contractors involved in the study in 2000 was used to gauge changes which took place over the five year period from 2000 to 2004. While many of the contractor’s families are heavily involved in the business, few have plans to take the business over when the current owner retires. Because of this, many contractors work far beyond a normal retirement time frame before shutting the firm down or selling it as a whole.
Figure 4.3 illustrates the change in the age distribution of the participants. Some new, younger contractors were added but, the percentage of contractors in the 30 to 40 year old age group rose from 11% to 16%, and those over the age of 55 rose from 15% to 32%. The contractors in the “middle-aged” group declined from 74% to 52% over the period.

Figure 4.3 Age distribution of participating logging contractors in 2004 as compared to 2000.

Logging contractors are often stereotyped as undereducated individuals performing mindless blue collar work. However, modern logging operations often require millions of dollars in capital and an almost never ending dedication to proper
management of resources, labor, and equipment in order to be profitable. Figure 4.4
demonstrates the education level of the 50 study participants in 2004. Although two of
the older contractors chose not to finish high school, the overwhelming majority have a
high school education with 46% completing at least some college and eight obtaining a
bachelor’s degree from a four year university.

Figure 4.4  Education level and training obtained by participating logging
contractors.
4.3 Business Characteristics

The logging contractors that participate in this study provide a good example of the varying business strategies employed by the industry. Logging firms differ depending on variables such as topography, region, timber markets, contractual relationships, and land ownership patterns. These variables and others affect the organizational structure of the firms.

The general business structures used were; sole proprietorships, Limited Liability Companies (LLCs), Full C corporations, and S (also called closely held or family) corporations (Figure 4.5). “C” corporations were most common throughout the study, with the percentage increasing over the five year interval. Sub S corporations were the next most common form, but decreased in between samples. Corporate forms are more complex than the other structures.
“C” and “S” corporations offer the contractor the most protection of personal assets and allow separation of businesses interests. Both Full C and Sub S corporations offer similar protection and benefits. The difference being a Sub S corporation is taxed similar to a sole proprietorship where the owners report income or loss on their individual tax return and the corporation itself is not taxed.

The simplest form, sole proprietorship, is still used by smaller operations but is declining in popularity. This business structure lacks the degree of protection of personal assets and liability offered by incorporating, but it does offer simplicity and total control of the business.
Limited liability companies were relatively rare among contractors in the study. They may offer a degree of liability protection and flexibility similar to sole proprietorships in the types of undertakings the business can include within a single structure, but in addition they require the same organizational effort as a corporation while offering less legal protection for an operating company.

4.4 Timber Procurement

The three main timber procurement methods employed were: contracting with a wood dealer who acquired stumpage and located markets, contracting directly with a consuming mill, and buying stumpage and merchandizing the product themselves. While many contractors use a combination of these methods, thirty of the fifty in the 2004 population used one or the other exclusively (Figure 4.6).
Figure 4.6  Stumpage acquisition methods by percentage used by logging firms 2004.

Eighteen of the contractors harvested only timber procured by or owned by a consuming mill. Nine firms chose to purchase timber for themselves and three worked only through a wood dealer.

4.5 Species Harvested

Only eight percent of the firms in the 2004 population harvested only from one species group, only pine or only hardwood, (Figure 4.7) The others worked a mix of the two, and the mix depended on the region and topography. The heaviest concentration of hardwood logging was in the Appalachian Mountain and Lake States regions. The
greatest amount of pine harvesting was performed by contractors located in the coastal plain region throughout the south and east.

Figure 4.7 Combinations of species harvested by logging firms 2004.

4.6 Labor Demographics

The logging firms in the study varied in size from one to five crews. Twenty eight firms operated only one logging crew in 2004 (Figure 4.8). Thirteen firms operated two crews and five firms ran three crews. The three largest Coastal Plain contractors ran three of the four largest operations. A Lake States contractor ran one of the five crew operations.
Figure 4.8  Number of harvesting crews operated by logging firms 2004.

Figure 4.9 illustrates the number of in-woods employees and truck drivers employed by the contractors. While most firms employ truck drivers, many use only a few of their own trucks and outsource a share of their trucking to contract haulers due to difficulties finding and retaining experienced drivers. Only four of the fifty firms chose to use only contract trucking.
Some of the firms shown with only a few or no drivers have separate trucking firms operating in tandem with the logging business. The drivers included in Figure 4.9 represent only those listed as exclusive employees of the logging business.

Contractors use a variety of methods for paying labor depending on the number of employees and duties performed. Fifteen of the participating contractors paid their employees on a daily basis and another fifteen firms used an hourly pay scale for all employees (Figure 4.10).
Eight firms used a production based pay system with the hope that it provided an extra incentive to increase production. One contractor in the study chose to pay his crew by the week and also offered them a guaranteed payment in case of weather or shutdowns and other work stoppages. Other contractors offered guaranteed pay to their employees depending on the situation. The remaining 11 contractors used a combination of payment methods depending on the duty being performed and the worker. Many chose to use the salary option as payment for crew foremen and key personnel while drivers are paid on a production basis and the crew on a daily or hourly scale. Most contractors have decided
on a pay scale that they feel will entice qualified labor to their crew and persuade them to stay once their hired.

Contractors use a variety of fringe benefits to attract and retain skilled employees for their firm. The most common benefit provided by firms is transportation to and from work (Figure 4.11).

![Figure 4.11 Fringe benefits offered by logging firms 2004.](image)

Forty one firms either provide their employees with vehicles or picked them up at their home or a common meeting place and took them to the job site. Christmas bonuses, (74% of the firms), and paid vacations / holidays, (72%of the firms), were the next
common benefit. Eight contractors offered uniforms to their workers, two provided lunch, and one bought each employee one pair of boots each year. Eleven firms provided their employees with loans and financing when necessary. Twelve owners offered production bonuses to workers when they exceed a set level of output, two offered a safety bonus, and one sponsored an employee lottery in the form of an additional bonus to an employee at the end of the year. Some contractors provided insurance coverage to their workers: dental insurance (1), health insurance (21), and life insurance (1). Three firms offer pension plans and one firm provides IRA’s for long term employees.

The fringe benefits offered by loggers in the 2004 study are compared to the benefits offered in the 2000 study in Figure 4.12.

![Figure 4.12 Fringe benefits offered by logging firms in 2004 as compared to 2000.](image-url)
Many of the benefits offered have decreased over the five year period. The only major benefits that increased were offering uniforms and offering health insurance; both increased less than 5%. While most employers wanted to provide their employees with benefits, it was becoming financially impossible. Benefits can be indicators of overall business health. Loggers have been forced to cut any spending not tied directly to production in order to remain in business.

4.7 Equipment Demographics

Equipment purchases were relatively stable in 2004 (Figure 4.13).

![Graph showing equipment demographics](image)

Figure 4.13 Number and age of logging contractor’s production equipment 2004.
Most feller-bunchers were less than five years old with the most (26) being one year old or less. The situation was similar for skidders as well. Forty of the 146 skidders in the study were less than one year old and 64% were less than five years old. Loader age, on the other hand, was across the board. Roughly 50% of the loaders in the study were older than five years, only 10% were less than one year old. The trend suggests that contractors are trying to extend the loaders lifespan, while regularly replacing feller-bunchers and skidders to avoid lost production.

The age of the support equipment used by the logging firms is illustrated in figure 4.14. The overwhelming majority of all support equipment was greater than five years old in 2004.
Figure 4.14 Number and age of contractor’s logging support equipment 2004.

Thirty two percent of the trucks in the study were less than five years old with 33% greater than ten years old. The service vehicles had 37% less than five years old and 32% greater than ten years old. Thirty seven percent of the bulldozers in the data set were more than ten years old with the rest spread mostly over the five to ten year old range. While support equipment has traditionally been allowed to age much more than production equipment, the amount of equipment over ten years old could indicate a reluctance to replace non-vital equipment.

Table 4.1 demonstrates the median age of all equipment used in the 2004 data set as it compares to the 2000 data set. The feller-bunchers median age rose from two years
to 4 years over the period. The skidders and loaders median age only increased one year from three to four for the same time. The median age for all support equipment increased as well. Bulldozers in the data set doubled the median age from four to eight years. Service vehicles increased four years as well going from three to seven years old. The median age of trucks increased by two years from four in 2000 to six in 2004.

Table 4.1 Median age of equipment in 2004 as compared to 2000.

<table>
<thead>
<tr>
<th>Equipment</th>
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<td>4</td>
</tr>
<tr>
<td>Skidders</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Loaders</td>
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</tr>
<tr>
<td>Bulldozers</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Service Vehicles</td>
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</tr>
<tr>
<td>Semis</td>
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</tbody>
</table>

Given that the tax depreciation schedule for all equipment other than truck tractors is five years (trucks depreciate in three), just under half of the equipment population has been depreciated out or is within a year of being fully depreciated.

Figure 4.15 compares the age of feller-bunchers in the 2004 study to the age of feller-bunchers in the 2000 study.
Figure 4.15  Percentage and age of feller-bunchers in 2004 as compared to 2000.

The number of machines three years old or less fell from 82% in 2000 to 50% in 2004. The machines in the middle age class of four to six years old rose from 9% to 33%. This suggests that although more than 80% of the machinery is less than six years old, contractors are holding machines longer than before. The investment in tools of production is declining.

Skidder age did not increase as much during the same period. Figure 4.16 illustrates near identical aging in the two studies with 50% of the machinery less than three years old in 2000 and 48% in 2004. The four to six year old age class expanded slightly from 28% to 32% with ages five and six cancelling each other out as did ages one
and two. The periodic renewal of skidders suggests contractors are concerned with
downtime from breakdowns of machinery greater than six years old.

![Skidder Age (Years) vs. Percentage (%)](image)

**Figure 4.16** Percentage and age of skidders in 2004 as compared to 2000.

Some of the pattern may be explained by business patterns. Many firms invested
in new equipment in the “good times” of 1998 and 1999. That equipment was aging out
in 2004, requiring firms to re-invest, although at a lower level.

The loaders aged the most in the 2000 – 2004 period. The percentage of loaders
three years old or less fell from 64% to 39 % (Figure 4.17). The loaders in the four to six
year old category rose slightly from 27% to 29%. The amount of machinery allowed to
age beyond six years rose sharply from only 9% in 2000 to 32% in 2004 with the
majority in the six and seven year old categories.

Figure 4.17  Percentage and age of loaders in 2004 as compared to 2000.

The aging was apparent in the trucking fleets as well. The percentage of trucks
less than three years old fell from 43% to 23% while the four to six year old class fell
from 36% to 29% (Figure 4.18).
The seven year old and older class increased sharply from 21% to 48%. The increase in truck age is due in part to the practice of keeping or buying older trucks to use as set-out trucks to haul timber from the bunching ground to the main roadway for pick-up or for short haul distances while contracting out longer runs.

The contractor’s service vehicles are part of an aging fleet as well (Figure 4.19). The percentage of three year old or less vehicles fell from 63% to 28% over five years. The four to six year old vehicles dropped from 27% to 19% while the percentage of vehicles over the age of ten jumped from 3% to 26%. As with the semis, this could be a result of keeping and purchasing older trucks to do the work rather than buying new.
Although the bulldozers aged during the period, the change was not as great as the semis and service vehicles. The percentage of newer bulldozers fell 33% to 17% while the four to six year old category stayed the same at 19% (Figure 4.20).
Figure 4.20 Percentage and age of bulldozers in 2004 as compared to 2000.

The older category of equipment, (over seven), rose from 48% to 65% mainly due to an increase in the number of machines seven to ten years old. Older machines may serve well for building landings and occasional road work, but the increased age does reflect a decrease in equipment investment.
CHAPTER V
LOGGING COST ANALYSIS

The annual business expenses of study participants were summarized into the six previously mentioned cost categories to determine possible trends over time. Twenty six logging firms were able to provide complete logging cost data for the study period spanning from 2000 – 2004. A long term cost analysis consisting of all available data from the 50 current participating firms, with some dating back to the origination of the study in 1988, is also included to determine changes over an extended period.

5.1 Expense Categorization

Annual expenditures were summarized using the category system described in Table 3.1. Median percentage values of each category are shown in Figure 5.1 for the five year period 2000 - 2004. Costs associated with labor continued to be the largest cost center for these firms, peaking at 36% in 2001 then gradually declining. Consumables remained around 20% although the cost has increased steadily since 2001.
Contracted services have overtaken equipment as the third largest annual expense. Costs for contract services increased throughout the entire period peaking in 2003 with nearly a 10% increase in only three years. Many firms are outsourcing trucking and other services in an attempt to reduce costs and reduce capital investment. Equipment expenses fluctuated over the five year period. Firms reinvest when the market for their services seems promising, and choose to run older equipment, purchasing new or replacement machines only when absolutely necessary, when the market is uncertain. Insurance costs have increased only marginally over five years, from 3.01% (2000) to 3.96% (2004) of total cost. Administrative overhead expenses have remained relatively
unchanged over the five year period as well with change remaining less than 1% of total cost.

5.2 Quartile Analysis

Table 5.1 is the result of ranking the total expenditures by firm for 26 firms by year from smallest to largest and then dividing it into four quartiles. Total outlays increased for all quartiles and the two measures of dispersion, the range (the spread between the largest and smallest contractor) and the IQR (inter quartile range) – the difference between the breakpoint of the first and third quartile) widened over the period. The rate of increase was greater for the larger firms.

Table 5.1 Quartile statistics for 26 firms' total expenses from 2000 to 2004.
5.3 Expense Categories

For the study group as a whole, equipment spending, as a percent of total direct cost has been slowly decreasing since peaking in 1998 (Figure 5.2).

Figure 5.2  Equipment as a percentage of total costs for all study participants 1988 to 2004.

The uncertain future of the industry coupled to stringent cost control measures by purchasers of logging and hauling services have led many contractors to run older equipment longer than usual. Many have chosen to “outsource” trucking to reduce capital invested in the operation. The expanding market of the late 1990s encouraged a
few contractors to invest heavily in equipment, but the tendency evaporated in the business climate of the early 21st century. The distribution of data for 2004 is quite similar to that of 1994. The upper outliers of the data in recent years represent firms that have either added equipment or re-invested when financially prudent. The decrease in equipment investment could indicate an increased reliance on contracted services in recent years as well.

5.3.1 Consumable Supply Costs

Consumable supplies cost is dominated by fuel costs. As a percentage of total cost, consumables slowly decreased from the onset of the study to a low in 1998 when fuel prices were at a minimum and then increased as fuel prices rose (Figure 5.3).
Figure 5.3 Consumable supplies as a percentage of total costs for all study participants 1988 to 2004.

There are two forces at work here, the direct costs of fuel, and contractors trying to operate in a period of rising costs and pressure to reduce or hold logging rates constant, compensate by delaying equipment replacement. Older equipment means increased tire and repair costs which increases supply costs. Since that point there has been steady increase due largely to the significant increases in fuel prices and petroleum products.

The rising cost of petroleum products is of great concern to logging contractors. Consumable supplies are currently the third largest spending category in the study and are likely move into second place as a result of rising of both on-road and non-road diesel fuel prices (USDOE 2006) (Figure 5.4).
Figure 5.4  Diesel fuel price trends for on-road and off-road use from 2000 through 2004.

5.3.2 Labor Costs

Total labor expenditures as a percentage of total cost have remained in a gradual decline throughout the study period (Figure 5.5). There appear to be three forces driving this change:

1. Larger, more efficient equipment reduces the need for labor, but the major gains from capital substitution for labor occurred well before the time covered by this study.

2. The increase in contract trucking has reduced the payroll of logging firms. The cost of the employees to the contracting firms is still included in the total costs, but now appears as contract services rather than labor.
3. Pressures to keep contract rates down in the face of rising operation costs have forced many contractors to cut crews to the minimum required, with the owner filling in by spending more time as a working member of the crew or working weekends and to reduce the benefits offered to their workers to the minimum required to keep a workforce.

![Figure 5.5 Total labor as a percentage of total costs for all study participants 1988 to 2004.](image)

Worker's Compensation Insurance (WCI) can be a substantial cost to logging contractors. Figure 5.6 illustrates the downward trend in WCI rates from 1988 to 2004. While the rates have remained relatively high throughout the period, the decrease
indicates the move to more mechanized operations and an increased emphasis on safety has reduced the cost of workplace accidents (Altizer, 2004).

Figure 5.6 Worker's Compensation Insurance (W.C.I.) as a percentage of total costs for all study participants 1988 to 2004.

Insurance premiums are indirectly influenced by the performance of the larger economy. Insurance is a heavily regulated industry, and investment income can supplement premium income in meeting insurers financial goals, so rates may adjust downward during periods of economic expansion and rise during economic contractions.

Most firms have been able to keep their rates below $10.00 per $100.00 of payroll, however there are several outliers. Some of these firms by choice or because of
their operating environment (e.g. cutting hardwoods in Appalachia) rely heavily on manual harvesting methods; others may have had a recent accident that affected their rates.

5.3.3 Contract Services Costs

Contracted services cost is a cost a logging firm can choose to take on or avoid by performing the function in house. Only one third of the participants in 1998 contracted for any services, by 2004 the percentage rose from 33% to 92.5% (Figure 5.7).

Figure 5.7  Contracted services as a percentage of total costs for all study participants 1988 to 2004.
The extent of contracting also varies among firms. Some contract all their trucking, others contract hauling only when additional capacity is needed. Other services may be contracted as well. A few operations use contractors to build roads, move equipment, or do BMP work. The dollar amount of contracted services ranged from $267 to $1.4 million across the forty firms that provided data. Consequently, the interpretation of the plot of contract services as a percentage of total costs is somewhat difficult to interpret. All those with no contract costs in a given year appear as a single zero point (Figure 5.7). A pattern has emerged as more firms have opted to contract some services in recent years. Contracted services have become the second largest cost in dollar terms to logging firms in the study. More contractors have outsourced their trucking in order to distance themselves from liability of on-road accidents and to reduce the costs ownership and upkeep of a trucking fleet. Some contractors have begun to use contract logging crews and seasonal labor as well.

5.3.4 Administrative Overhead Costs

Administrative overhead costs include only the direct costs of operating the business, there is no allowance for state and federal income taxes, return on investment, or other indirect costs incurred (Figure 5.8).
Figure 5.8 Overhead costs as a percentage of total costs for all study participants 1988 to 2004.

Only one third of the firms in the 1988 population claimed any overhead costs. The contractors or their wives handled the bookkeeping duties such as filing taxes and other required reports. In contrast, only one reported no costs in 2004. The complexity of operating a business associated with increased regulation, changing tax laws, and potential litigation have caused many to enlist the support of bookkeepers, accountants, lawyers, and other professionals. Computers, cell phones, internet connections and other business tools have become much more common as well.

Many are recognizing that even if a wife or other family member are willing to help in the operation and administration of the business at no cost, it is in the family’s and
business’s best interest to put them on the payroll to assure they qualify fully for social
security and Medicare benefits in the future. Even with these accommodations, the
administrative overhead costs have remained around 3% for most contractors in recent
years. This component has also been affected by pressures to reduce costs. The increase
in administrative overhead services leveled off in 1999 and began a gradual decline as
some contractors and their family members reverted back to performing these tasks
themselves.

5.3.5 Insurance Costs

The costs associated with general liability, fire, theft, vandalism, and other
business insurance have fluctuated over the study period, rising from 1990 though 1995,
falling between 1998 and 2000, and rising again from 2000 to 2004. The trend is not
definitive, it is vexed by high and low outliers. It has also been affected by decisions to
carry only the insurance that was required and could be afforded as a cost control
measure, rather than contracting for what was needed (Figure 5.9).
Figure 5.9 Insurance costs as a percentage of total costs for all study participants 1988 to 2004

There has been incremental increase overtime as rates have increased, however most firms have searched for the most efficient coverage possible to reduce costs. (This category does not include worker's compensation insurance (WCI), which is included in the labor cost category.)

5.4 Shifts in Production and Costs

The expense and production information for 26 contractors for the period of 2000 to 2004 was used to assess the shifts in the cost of production by firm. Figures 5.10 – 5.13 illustrate year to year trends of relationship between production and costs.
Figure 5.10 indicates that 8 firms increased their production while at the same time increasing their yearly expenses. Conversely, 10 contractors reduced their production as well as their costs of production. Four contractors were able to increase their production while decreasing their costs. At the same time 4 contractors decreased production while incurring an increase in production costs.

![Figure 5.10 Total production and expense shifts for 26 logging firms from 2000 to 2001.](image)

While it is tempting to try to fit a line to the points to develop a ratio that would measure the effects of increasing or decreasing production on total outlays and, by extension, the cost per ton, the urge has been resisted. First the population is small for
such an undertaking. Secondly, it appears that two lines would be required. The rate of reduction in total expenses with reduced output is less than the rate of increase in expenditures with increased output.

Ten contractors, in the period from 2001 to 2002 reduced their production while reducing their costs (Figure 5.11), but the reductions for all but one were minimal.

Figure 5.11  Total production and expense shifts for 26 logging firms from 2001 to 2002.

Six experienced increased costs with reduced production, two had relative large increases. Eight firms increased production as well as expenses. Six firms reduced their
production and experienced increased costs per ton. Five firms were able to increase production while reducing costs.

Figure 5.12 illustrates a tightening of the data set as the spread of increases and decreases was narrowed.

Figure 5.12  Total production and expense shifts for 26 logging firms from 2002 to 2003.

From 2002 to 2003 only 3 firms were able to increase production while decreasing expenditures. At the same time 9 producers reduced production but increased costs. Eleven contractors increased production and increased their total costs. Three firms reduced production while also reducing costs.
The data for the 2003 - 2004 period reflected a further tightening of data. Contractors were streamlining their operations more and more which reduced the number of unexpected outcomes (Figure 5.13).

Figure 5.13  Total production and expense shifts for 26 logging firms from 2003 to 2004.

No firms were able to reduce costs and increase production during this period. Only three contractors reduced production while incurring cost increases. Six contractors had a reduction in both production and costs. The majority of contractors, 17, had the expected outcome of increased costs and their production.
The relationship between the total and categorized costs for each firm and that firm’s production are expressed as cost per ton as a means of demonstrating the variability in distributing component costs. These cost per ton figures can be used to compare total costs and expenditure categories for firms across business sizes, location, and structure. The short term analyses are based on data from 26 firms from three geographic regions during the 2000 – 2004 period. Long term analyses use the available data provided from all 50 current study participants from 1988 through 2004.

6.1 Cost Per Ton Quartile Analysis

The total cost per ton data by year for the 26 firm data set over the 2000 – 2004 period was ranked from highest to lowest and separated into quartile data. The minimum and maximum values, the internal quartile bounds, the overall range (from highest to lowest, and the inter quartile range (from the lower bound of the first quartile to the upper bound of the third ) are shown in Table 6.1. The first (lowest) and fourth (highest) quartiles must be considered cautiously. Several of the firms included in the study are structured with multiple owners of record, family members, or partners. In some cases minority owners take a mix of wages and profits from the firm. To assure privacy, no
information is collected on owners’ wages or profits, a formulaic substitute of $20,000 per year plus an allowance of $0.30 per ton for the principal owner is added. The fourth quartile is a mix of conventional firms and those performing harvests where the cost per ton is a second order concern, such as harvesting grade hardwood logs, specialized real estate or development cuts and the like for at least a portion of the year.

Table 6.1  Cost per ton quartile statistics and changes for 26 firms' total expenses from 2000 to 2004.

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
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<tbody>
<tr>
<td>Minimum</td>
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<td>$9.04</td>
<td>$9.02</td>
<td>$7.80</td>
<td>$8.50</td>
</tr>
<tr>
<td>Median</td>
<td>$14.61</td>
<td>$14.53</td>
<td>$14.81</td>
<td>$14.89</td>
<td>$15.50</td>
</tr>
<tr>
<td>Third Quartile</td>
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<td>$17.69</td>
<td>$17.56</td>
<td>$18.87</td>
<td>$21.27</td>
</tr>
<tr>
<td>Maximum</td>
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<td>$26.55</td>
<td>$30.74</td>
<td>$40.56</td>
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<td>$17.53</td>
<td>$22.94</td>
<td>$32.06</td>
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<tr>
<td>IQR</td>
<td>$2.89</td>
<td>$4.04</td>
<td>$4.44</td>
<td>$5.72</td>
<td>$7.03</td>
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</table>

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<tbody>
<tr>
<td>Minimum</td>
<td>9.44%</td>
<td>-0.18%</td>
<td>-13.57%</td>
<td>8.99%</td>
<td>2.91%</td>
</tr>
<tr>
<td>First Quartile</td>
<td>3.79%</td>
<td>-3.92%</td>
<td>0.26%</td>
<td>8.28%</td>
<td>8.26%</td>
</tr>
<tr>
<td>Median</td>
<td>-0.58%</td>
<td>1.93%</td>
<td>0.54%</td>
<td>4.13%</td>
<td>6.08%</td>
</tr>
<tr>
<td>Third Quartile</td>
<td>10.30%</td>
<td>-0.77%</td>
<td>7.47%</td>
<td>12.72%</td>
<td>32.60%</td>
</tr>
<tr>
<td>Maximum</td>
<td>-15.06%</td>
<td>-49.01%</td>
<td>15.78%</td>
<td>31.93%</td>
<td>-33.84%</td>
</tr>
<tr>
<td>Range</td>
<td>-18.87%</td>
<td>-59.26%</td>
<td>30.88%</td>
<td>39.72%</td>
<td>-39.56%</td>
</tr>
<tr>
<td>IQR</td>
<td>39.99%</td>
<td>9.86%</td>
<td>28.79%</td>
<td>22.94%</td>
<td>143.52%</td>
</tr>
</tbody>
</table>

The minimum cost increased slightly, fluctuating in a $1.25 range over the five years. The maximum value dropped sharply over the period, bottoming in 2002 and rising again in 2003 and 2004. The overall range shrunk by approximately 40% over five
years. In contrast, the inner quartile range spanning the second and third quartiles increased from $2.89 to $7.03 or nearly 144% for the period. Much of this increased spread can be attributed to a 33% increase in cost per ton for larger firms.

6.2 Year to Year Changes in Average Cost per Ton

Members of the population remained the same, but individuals responded to the markets, opportunities, and challenges of their production environment differently. Figures 6.1 through 6.4 show indices developed for production and expenditures by dividing the annual values for 2001, 2002, 2003, and 2004 by the value for 2000 and then plotted against each other. The scales of the axes for each figure were held constant for all years. Each figure is divided into quadrants by horizontal and vertical lines passing through the intersection of 1.00, 1.00 indices.

Points in the upper right quadrant are firms that increased both production and expenditures. Points in the lower right quadrant identify firms that increased production and reduced expenditures, the lower left quadrant contains firms that reduced production and reduced expenditures, and those in the upper left reduced output and increased expenditures. The dotted line through the plot indicates proportional growth, expenditures increasing at the same rate as production. Data points above the line indicate firms whose expenditures rose faster or fell slower than did their production causing the average cost per ton to increase. Points below the line indicate that expenditures rose slower or fell faster than production and average cost per ton decreased.
The data points for the firms that were in the smallest, median, and largest productivity in 2000 are identified by the letters S, M, and L. The data points for the firm that grew the fastest across the five years are tagged with an F. The production of the smallest firm was below 2000 levels for all four years, but costs did not decrease proportionately. The largest firm of 2000 experienced similar problems, output did increase by 5% in 2001 and 2% 2002, but fell to 85% of the 2000 level in 2003 and ended 2004 at 84% of starting output, The mid-sized firm moved along the proportional line, falling back in production and expenditures in 2001 and 2002 and increasing output faster than spending in 2004. The fastest growing operation was a stellar example of increasing output while attending to expenditures. Growth closely followed the proportional line.

Figure 6.1 Production and expenditure indices of 26 logging firms for the period of 2000 – 2001.
Figure 6.2  Production and expenditure indices of 26 logging firms for the period of 2000 – 2002.

Figure 6.3  Production and expenditure indices of 26 logging firms for the period of 2000 – 2003.
Figure 6.4  Production and expenditure indices of 26 logging firms for the period of 2000 – 2004.

Year to year, by firm, changes in average cost per ton provide interesting insights to individual business reactions to short term changes in costs and opportunities, and overall trends in the sector. A year with a mix of increased and decreased costs per ton indicates the overall sector was relatively stable and individual firms were accommodating changes occasioned by local conditions. A year with a majority of firms experiencing increased average costs per ton indicates a shift in the component costs, or an overall constraint in the ability to produce. An increased average cost per ton for a firm is not necessarily bad, for example increased expenditures that occur with equipment replacement as a result of increased depreciation and interest expenses, may be and usually are a favorable outcome. By the same token, reduced expenditures resulting from
the failure to replace older equipment may be favorable for the year in question, but be counter to the long term viability of the system

During the 2000 – 2001 period median cost per ton (Figure 6.5) remained relatively unchanged.

![Figure 6.5 Changes in costs per ton by logging contractor for the period 2000 – 2001.](image)

This belies the changes in several firms shown in Figure 6.5. A significant change (+/-$2.00 or more) for a contractor was usually associated with restructuring their operation in response to market conditions or changes in their labor force, equipment renewal, or a greater reliance on contract services. Of the two contractors which
experienced the greatest shift, one cut the crew size dramatically and the other outsourced trucking completely.

Median logging cost increased marginally during the 2001 – 2002 period due in part to an increase in fuel cost, but cost per ton increased for two thirds of the firms, some minimally, but six had increases of $2.00 or more (Figure 6.6).

<table>
<thead>
<tr>
<th>Contractor</th>
<th>Cost / Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$28.00</td>
</tr>
<tr>
<td></td>
<td>$26.00</td>
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<tr>
<td></td>
<td>$24.00</td>
</tr>
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<td>$2.00</td>
</tr>
<tr>
<td></td>
<td>$0.00</td>
</tr>
</tbody>
</table>

Figure 6.6 Changes in costs per ton by logging contractor for the period 2001 – 2002.

Two firms had an increase in costs of more than $4.00 per ton. One had a major rise in insurance costs and the other reinvested in new equipment during this time. Of the
three firms that greatly reduced spending, two did so by cutting their operation size greatly and the other by eliminating his contract labor.

Figure 6.7 shows the relatively small increase in the median logging costs between 2002 and 2003. Most minimal increases in spending can be attributed to increasing fuel and lubricant costs during the period.

![Figure 6.7 Changes in costs per ton by logging contractor for the period 2002 – 2003.](image)

Major increases for three contractors were due to the addition of equipment and labor to the firms. Two firms experienced an increase in costs during their transition into exclusive contract trucking. Of the seven firms decreasing costs by more than a dollar
per ton during the period, four did so by fully depreciating their current equipment setups while avoiding buying new equipment. The other three firms decreased costs by reducing their crew size and selling unneeded equipment.

Fuel prices were the major contributing factor to the increase in spending for most contractors in the 2003 – 2004 period (Figure 6.8).

![Figure 6.8](image)

Figure 6.8 Changes in costs per ton by logging contractor for the period 2003 –2004.

Three of the five firms with significant cost increases were experiencing fuel cost increases of $2.00 or more per ton. Other factors contributing to significant increases were a rise in contract trucking fees and two firms purchasing new equipment. The only
firm to achieve a considerable decrease in costs did so by allowing his equipment to fully depreciate during this time while opting to wait on new equipment.

Figure 6.9 shows the overall change in cost per ton for the entire five year period from 2000 to 2004.

Six operations had costs per ton in 2004 that were +/- <$2.50 of their 2000 costs. Four experienced cost increases of $5.00/ton or more. Significant cost increases came from a heavier reliance on contracted trucking, increased fuel and consumable supplies prices and, for a few firms, the addition of new crew and equipment. The two firms that
were able to reduce their costs by $5.00 per ton or more did so by significantly reducing their business size down to half or less than in previous years.

6.3 Cost per Ton Regression Analyses

Regression analysis was used to test the relationship between production and component costs for these logging firms. This was accomplished using the complete cost and production information for 26 logging firms over the five year period 2000 to 2004. Figures 6.10 to 6.16 illustrate the regression analysis for the total expenditures versus production for each of the five years. The regressions were run as simple linear analyses of the form \( y = a + bx \) (with intercept) and as \( y = bx \) (forcing an intercept of 0,0). The intercepts for each year were small, and inclusion did little to improve the correlation coefficient.

The distribution of points about the set of lines on figures 6.10 to 6.16 are worth noting. The scatter for all years is fairly well balanced for operations producing less than 80-90,000 tons per year, nearly as many points are above the lines as below, and the spread is about equal. The concentration of observations shifts to within or below the set of lines at 90,000 tons and remains there through 200,000 tons per year and then tends to drift to above the set of lines from that point on. This indicates that economies of size do not exist with these operations; larger operations are no more, or less likely, cost efficient than medium and some small operations. This implies that logging firms have very few “fixed” costs on a yearly basis.

As expected, annual outlays are closely related to annual production, the \( R^2 \)-values for the regressions for each of the five years lie between .8300 and .9250 which
indicate that 83 to 93 percent of the variation in logging costs can be attributed to production.

Comparing the annual average cost per ton from the regression analysis with the median annual cost per ton from Table 6.2 demonstrates the effect of operation size on cost per unit.

Table 6.2  Comparison of average and median logging cost per ton by year.

<table>
<thead>
<tr>
<th>Year</th>
<th>Average Cost/Ton</th>
<th>Median Cost/Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>$13.99</td>
<td>$14.61</td>
</tr>
<tr>
<td>2001</td>
<td>$15.29</td>
<td>$14.53</td>
</tr>
<tr>
<td>2002</td>
<td>$14.82</td>
<td>$14.81</td>
</tr>
<tr>
<td>2003</td>
<td>$15.16</td>
<td>$14.89</td>
</tr>
<tr>
<td>2004</td>
<td>$16.11</td>
<td>$15.50</td>
</tr>
</tbody>
</table>

There was a tendency over the study period for larger operations to get even larger, while small and mid-sized operations remained stable. The average cost per ton is more heavily influenced by the costs experienced by the larger operations, for they contribute more to the total expenditures and the total production. The median cost per ton is determined by the cost per ton for the operations ranked 13th and 14th in production. The average cost per ton proved to be the more volatile statistic, with year to year
changes greater than those of the median. Both showed the same overall trend. They diverged somewhat in 2001 and 2002, where the average increased in 2001, while the median remained essentially stable, and then the average fell back in 2003, bringing both measures into convergence.

The average cost per ton was lowest in 2000 with a value of $13.99, and highest in 2004 at $16.11 (Figure 6.10). Costs did decline briefly in 2002 but again rose to the period high through 2003 and 2004, possibly because of the higher expenditures by the larger operation in the later years (the five observations lying furtherest from the lines all occurred in 2003 and 2004.)

![Figure 6.10 Total cost versus annual production for 26 logging firms 2000 – 2004.](image)
The equipment component of logging costs (Figure 6.11) is less well correlated with production than total costs but still displayed strong $R^2$-values-in the .61 to .73 range.

Figure 6.11  Equipment cost versus annual production for 26 logging firms 2000 – 2004.

The spread of points around the set of lines demonstrates the difference in equipment strategies employed by these firms. The differences are especially obvious for the smaller firms producing 100,000 tons per year or less. Some had virtually no equipment costs while others delivering the same amount of wood were paying $8 to $10 per ton. The slope indicates the cost per ton was at its lowest in 2003 at $1.80.
Equipment costs fluctuated in the mid to upper $2.00 range for the rest of the period, peaking in 2001 at $2.82 per ton. The high and low points represent years when contractors were either sacrificing profits by re-investing in newer equipment (2001), or risking lost time for repair by letting older equipment remain active (2003).

The $R^2$-values for relationship between consumable supplies and production weakened steadily from .79 (2000) to .61 (2004). Fuel costs remained high throughout the study period although they dropped significantly in 2004 (Figure 6.12). The peak in consumable costs occurred in 2000 most likely due to a sharp increase in fuel prices which occurred that summer.

![Figure 6.12 Consumable cost versus annual production for 26 logging firms 2000 – 2004.](image)

89
Production rates proved to have the strongest effect on total annual labor costs. The $R^2$-values ranged from .81 in 2000 to .94 in 2002. The yearly costs per ton for total labor were the lowest in 2000 at $4.37 and were the highest in 2001 at $5.11 (Figure 6.13).

![Figure 6.13 Total labor cost versus annual production for 26 logging firms 2000 – 2004.](image)

After peaking in 2001, labor costs dropped incrementally throughout the remainder of the study period. This is a possible result of many firms choosing to reduce the size of their logging operation or outsourcing their trucking needs.
Figure 6.14 illustrates the correlation between production rates and insurance costs. This cost category includes all insurance costs associated with timber harvesting excluding worker’s compensation insurance.

![Graph showing insurance costs versus annual production for 26 logging firms 2000–2004.](image)

The $R^2$-values for the period were weaker than previous categories but remained above .60 with the exception of the 2004 low (.49). The cost per ton for the period remained relatively steady throughout five years with the peak in 2002 ($0.42) and the lowest rate occurring in 2004 ($0.33). Again, the drop in insurance costs could be a product of reduced equipment insurance due to smaller crew sizes.
Worker’s compensation insurance rates demonstrate a strong correlation with production rates (Figure 6.15). The $R^2$-values remained in the low to mid .70’s through five years with a low of .70 (2000) and a high of .78 (2001). The cost per ton rate was on a steady rise throughout the period with the exception of a two cent drop in 2004. Cost per ton ranged from $0.19 in 2000 to $0.30 in 2003.

Figure 6.15  Workers Compensation Insurance cost versus annual production for 26 logging firms 2000 – 2004.

Contracted services presented a problem using regression analysis. Some firms involved in the study use very little if any contract labor or services. Therefore their production increased while investing little or no money into the category. This being
considered the R²-values remained stable between .47 (2000) and .52 (2003). The contract services cost per ton did rise significantly over five years (Figure 6.16).

Figure 6.16  Contracted services cost versus annual production for 26 logging firms 2000 – 2004.

Costs rose approximately 81%, from a low of $3.12 in 2000 to $5.64 in 2003. The rise in costs reflect a trend of outsourcing more and more trucking to independent firms in an attempt to avoid legal problems and reduce costs.
6.4 Regional Annual Cost per Ton Shifts

Regionalized analysis of changes in cost per ton averages was performed using complete cost and production data from 26 logging firms over the five year period from 2000 to 2004. Harvesting data from the coastal plains, piedmont, and Appalachian mountain regions are represented in Figures 6.17 – 6.19.

Sixteen loggers from the coastal plains region are represented in Figure 6.17. Nine of these firms experienced a rise in average cost per ton over the period with the increase ranging from $1.51 to $8.82 per ton.

Figure 6.17  Shifts in total annual cost per ton for sixteen logging firms located within the coastal plains region 2000 – 2004.
Contractors C7 and C15 had the greatest increase for the study period. Firm C7 experienced growing pains from adding an additional crew and supplying them with new equipment. Contractor C15’s operation in a specialty market required that he use additional labor and contract services to harvest higher quality material. Four contractors were able to decrease their costs but by a much smaller margin than those whose costs increased. The cost decrease ranged from $0.55 to $1.71 per ton. Three firms were able to keep their average cost per ton relatively unchanged at $0.50 or less over the period.

Of the eight logging firms from the piedmont region of the eastern U.S., five had increased costs from 2000 to 2004. The cost increase ranged from $2.94 to $10.98 per ton (Figure 6.18).
Figure 6.18  Shifts in total annual cost per ton for eight logging firms located within the Piedmont region 2000 – 2004.

The upper range increase came from a contractor whose contract service expenses rose 362% after adding a chipping operation requiring the addition of new equipment and manpower. Three contractors were able to lower their costs per ton in the region. The decrease ranged from $0.10 to $6.40 per ton. Although contractor P6 decreased his overall cost $0.10, he went through a $15.76 increase in 2001 following an attempt at outsourcing logging operations as well as trucking.

There were two contractors from the Appalachian region which were able to provide complete data for the five year study (Figure 6.19).
Contractor A1 increased his cost per ton by $1.64 with mild fluctuation throughout the timeframe. Contractor A2 however endured drastic swings of rising and falling costs each year. The swings were due to the high grade hardwood product which the contractor harvested at various times throughout the study while also operating a thinning operation. While the higher grade products are significantly more expensive to harvest, they often provide a much higher market value as well.

Fourteen of the 26 contractors had an increase in their logging costs per ton greater than $0.50. The greatest of these increases came from three logging firms which added new logging or log chipping crews during the study period. Eight firms were able
to decrease costs per ton by greater than $0.50 with only two decreasing costs more than $2.00 per ton. The remaining four contractors remained relatively unchanged during the study period.

The greatest changes in cost per ton were a result of drastic changes in crew size and equipment changes. The fact that only three companies were confident enough during the period to expand their business, and that two contractors reduced their crew sizes, could indicate the uncertainty these contractors, like many others, had for the future of the logging industry.
CHAPTER VII
PRODUCTION ANALYSIS

This chapter uses the complete production histories provided by 26 logging contractors from the eastern U.S. for the 2000 – 2004 period. The production data provided was used to analyze changes in production trends by the individual contractor and by region on a yearly basis.

7.1 Production Quartile Analysis

Quartile statistics were used to assess changes in the group’s production from year to year and over the five year study period. The median annual production for the data set increased nearly 20% over the five year period in spite of a 10% decline from 2000 to 2001 (Table 7.1). This increase is the result of a 37% increase in the third quartile’s (the larger firms) production over the period which offset compensated for a 25% decrease in the first quartile (smaller) firms’ production over the same time. The range remained relatively constant increasing only 3,000 tons between 2000 and 2004. There was a contraction in 2003, followed by a recovery in 2004.
Table 7.1 Production quartile statistics for 26 logging firms from 2000 to 2004.

<table>
<thead>
<tr>
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<th>2000</th>
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<th>2002</th>
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<td>Minimum</td>
<td>16,641.70</td>
<td>15,118.94</td>
<td>13,563.12</td>
<td>12,492.82</td>
<td>13,294.81</td>
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<td>55,117.05</td>
<td>45,250.34</td>
<td>43,875.09</td>
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<td>Median</td>
<td>71,398.21</td>
<td>64,679.70</td>
<td>76,967.38</td>
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<td>85,409.72</td>
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<td>Third Quartile</td>
<td>136,689.35</td>
<td>141,790.94</td>
<td>153,486.06</td>
<td>182,645.08</td>
<td>186,913.71</td>
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<tr>
<td>Maximum</td>
<td>275,000.00</td>
<td>290,000.00</td>
<td>279,829.76</td>
<td>233,142.57</td>
<td>274,646.08</td>
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<td>220,649.75</td>
<td>261,351.27</td>
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<td>IQR</td>
<td>81,572.30</td>
<td>96,540.60</td>
<td>109,610.98</td>
<td>142,970.08</td>
<td>145,759.46</td>
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Year to Year Change

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<td>Minimum</td>
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<tr>
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<td>19.0%</td>
<td>10.1%</td>
<td>0.8%</td>
<td>19.6%</td>
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<tr>
<td>Third Quartile</td>
<td>3.7%</td>
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<td>Maximum</td>
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<tr>
<td>IQR</td>
<td>18.3%</td>
<td>13.5%</td>
<td>30.4%</td>
<td>2.0%</td>
<td>78.7%</td>
</tr>
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</table>

The inter-quartile range (IQR), the spread between the lower bound of the second quartile and the upper bound to the third quartile increased by 79% over five years suggesting a widening of the production differences within the population. The upper bound of the first quartile dropped by 16,000 tons or 25% between 2000 and 2003 while the upper bound of the third quartile increased by 46,000 tons or 37%.

Figure 7.1 illustrates the changes over the five year period. The smaller operations got smaller. The output of the firms in the second and third quartile increased while the larger contractors remained relatively stable. The dip in the maximum production in 2003 was caused by one contractor downsizing that year.
Figure 7.1 Production quartiles for 26 logging contractors from 2000 to 2004.

Another contractor increased his output in 2004 returning the population bound to near 2000 levels. This simply demonstrates that the summary does not reveal the changes taking place within and among the quartiles. Just as the quartile bounds are not static, the firms within the quartiles change year to year depending on weather, markets, and business decisions.
7.2 Yearly Production Shifts

The year to year production shifts and the summary shift for the period 2000 through 2004 for the 26 firms are shown in Figure 7.2.

![Figure 7.2 Production shifts for 26 logging contractors from 2000 to 2004.](image)

The periods from 2000 to 2001 and 2001 to 2002 had a fairly narrow range of variation with a balance between those that expanded and those that contracted. The spread began to widen between 2002 and 2003, with “break-out” expansions and contractions, and continued with another set of expansions between 2003 and 2004. The eye is attracted to the set of expansions, but the summary or periodic (2000 – 2004) set
show that while five of the operations experienced considerable growth, the majority lost production.

The increases in production from the larger firms offset the reduction of output from some other firms resulting in a net increase of nearly 450,000 tons over five years (Figure 7.3) with most of the increase occurring in 2003 and 2004.

Figure 7.3  Total production shifts for 26 logging contractors from 2000 to 2004.

7.3 Regional Production Analysis

The production data for the five year period was segregated into regional data sets representing the three home regions of the 26 contractors (Figure 7.4).
Figure 7.4 Total production shifts by region for 26 logging contractors from 2000 to 2004.

These data sets are not of equal size. The coastal plain region was home to the larger contractors, and the largest number of contractors (16). The Piedmont region occupied its usual “in between” position, in between in both the number of contractors (8) and the size of the firms. There were only two Appalachian Mountain contractors that had complete data for the period, and these firms tend to be smaller than those of the piedmont or coastal plain, but their contribution is important for the integrity of the study. Their production was virtually unchanged for the first two years followed by an incremental increase in 2002 and 2003 and decreased slightly in 2004. Overall their production increased by approximately 11,000 tons over five years. Total output of the
group increased by roughly 450,000 tons over the period, with much of the increase (370,000 tons) coming from the coastal plain businesses.

The data from the coastal plain firms demonstrates the impact of a minority on the performance of a group. The group’s wholesale increase was mainly a product of four contractors increasing their business size. Firms C4, C7, and C14 were able to increase their production by adding harvesting crews and equipment (Figure 7.5).

![Figure 7.5 Total yearly production shifts for 16 coastal plain logging contractors from 2000 to 2004.](image)
Firm C5 produced additional tonnage by adding equipment and labor to an existing crew. Conversely, other crews reduced the size of their operations in an attempt to increase their margin by streamlining their harvesting operations. Firm C6 still used a single crew but reduced their equipment spread to increase the utilization of the retained equipment, gaining in efficiency but losing production. Firms C9 and C10 cut back to two and one crews respectively in order to reduce costs. Although other firms in the group experienced highs and lows in production during the period, the changes were marginal and most likely due to variables such as weather, mill production quotas, and changing markets.

Contractors within the piedmont region experienced similar variability in production and challenges to their production goals. Figure 7.6 illustrates the changes in yearly production of eight regional logging firms.
Figure 7.6 Total yearly production shifts for eight piedmont logging contractors from 2000 to 2004.

Four of the firms remained relatively stable throughout the period, staying within bounds of less than 10,000 tons over the length of the study. Two contractors, P7 and P8, were able to increase production. Firm P7 accomplished this by increasing the size of his harvesting crew. Contractor P8 more than tripled his production by taking on additional thinning and harvesting crews. The remaining two contractors, P3 and P4, both reduced production to match market conditions.

Both loggers from the Appalachian mountain region (Figure 7.7) operate in the volatile hardwood market with swings in product value and market demand.
The climate and topography of the region has an effect on production of these contractors, as demonstrated in the performance of firm M1. Contractor M2, however, was able to double production between 2001 and 2002 by adding a softwood thinning crew. After trying this for two years he shut that crew down and returned to a single crew hardwood operation.

This analysis demonstrates interesting characteristics of the logging force. First, while the output from the entire population increased over the period, the majority of the gain came from a minority of the firms. More firms decreased production than increased it, but the sum of the reductions were less than the sum of the gains. The smaller firms
were relatively consistent across the period. Each size and regional population included some firms that managed for stability, and some that were willing to try new modes of operation. Dealing with the variability in opportunity, weather, markets, and costs is a constant challenge for these firms. While production reflects their response to that challenge, it provides only limited insight concerning the strategies and management skills necessary and the effects of increases and decreases on business health. The data reflects a willingness of contractors across the Eastern United States to change and grow, to try something new, and build on the method if it works, or to return to traditional operation when the change promised more than it delivered.
CHAPTER VIII
SUMMARY AND CONCLUSIONS

8.1 Overview

A data set was compiled from detailed information provided from 26 independent logging contractors from throughout the Eastern United States over a five year period from 2000 to 2004. Logging contractors participating in this study were spread throughout 13 states and four distinct physiographic regions: the coastal plain, piedmont, Appalachian Mountain, and Great Lake States regions. Collected data including logger demographics, operational expenses, and production totals obtained through personal interviews with participating firms. The data provided by these firms were analyzed using Exploratory Data Analysis (EDA) to obtain statistical and graphical outcomes which compare and contrast changing trends in logging costs and production over time.

8.2 Logging Contractor Business Demographics

A larger sample size was available for the contractor and logging firm demographic portion of the study. There were 50 firms which operate 83 logging crews throughout the Eastern United States which were able to provide detailed personal and business demographic data. Data from the 50 firms currently participating in the study
were compared and contrasted with demographic information provided in previous studies in order to observe any changes which may have occurred.

Contractors were asked to provide a variety of personal and business demographic data during regular interview periods. Personal data included the location of the logging firms work area, the age of the contractor, and the education level of the contractor. Business demographic data were collected including business structure, timber procurement and harvest strategies, labor characteristics, and equipment strategies.

8.2.1 Contractor Demographics

The age distribution of the logging contractors in the study has increased over time with the percentage of contractors over the age of 55 rising from 15% to 32%. This is due in part to the lack of younger members of the contractor’s families taking ownership in the business, forcing owners to work far beyond normal retirement time in order to keep the business from shutting down. The education level of these contractors varied from some high school to college graduates. Although two of the older contractors did not finish high school, the overwhelming majority graduated high school, with 46% completing at least some college and eight obtained a bachelor’s degree from a four year university.

8.2.2 Business Demographics

There were four basic business structures utilized by logging contractors during the study period. Full C and S corporations remained the most used options accounting for 76% of the firms studied. The majority of the remaining firms were sole
proprietorships (20%) along with 4% of the contractors opting for the added protection of a Limited Liability Company (LLC).

Three methods of timber acquisition were used by contractors during the study: contracting with a wood dealer who acquired stumpage and located markets, contracting directly with a consuming mill, and buying stumpage themselves and merchandizing the product. Twenty of the 50 contractors used some combination of these strategies. Eighteen firms contracted directly with a consuming mill exclusively, three only used wood dealers, and nine harvested only timber they procured themselves.

The type of timber harvested depended on the region and topography in which the contractor operated. Two contractors working in the Appalachian region harvest only hardwood species and two other coastal plain contractors harvested only pine. The majority of the firms harvested some mix of species, the ratio of which depending on the region.

The 50 contractors studied operated 83 logging crews employing 614 individuals. The number of crews per business ranged from one to five. Twenty eight firms operated only one crew; 13 firms operated two crews; five firms operated three crews; two firms operated four crews; and two firms ran five crews. The number of individuals employed ranged from one firm which ran only a two man operation to one firm employing 43 workers.

Most contractors chose to pay their employees either hourly or daily with each accounting for 30% of the population. Eight contractors (16%) paid their employees based on their production and seven firms (14%) used a combination of hourly pay for
general labor and salary pay for key personnel. The remaining five firms used varying combinations of hourly, daily, weekly, salary, and production methods.

Fringe benefits offered to employees included: transportation, uniforms, paid vacation and holidays, Christmas bonuses, employee loans, production bonuses, health insurance, life insurance, meals, safety bonuses, pension plans, and dental insurance. The most popular benefits provided were transportation (82%), Christmas bonuses (74%), paid vacations and holidays (72%), uniforms (44%), health insurance (42%), production bonuses (24%), and employee loans (22%). As logging firms attempted to reduce costs over the study period, many of these firms reduced the amount of benefits they offered. Transportation fell from 100% in 2000 to 82% in 2004. Employee loans fell sharply from 59% to 22% during the five year period. Production bonuses, Christmas bonuses, and paid vacations and holidays saw significant decreases as well. Of the most popular benefits offered, only health insurance and provided uniforms encountered a minimal increase.

The age of equipment used by contractors over the study period was recorded as an indicator of the financial health of the firms. The median age of all equipment including feller-bunchers, skidders, loaders, bulldozers, service vehicles, and haul trucks increased over the period. While the median age of all equipment increased, the age of service and support equipment saw the greatest increase. The percentage of service vehicles three year old or less vehicles fell from 63% to 28% over five years and vehicles over the age of ten jumped from 3% to 26%. The percentage of haul trucks less than
three years old fell from 43% to 23% and the seven year old and older class increased sharply from 21% to 48%.

The age of production equipment during this period increased as well although not as sharply. The age of feller-bunchers in the three year old or less class fell from 82% in 2000 to 50% in 2004 with the three to six year old class rising from 9% to 33%. Skidder age remained relatively unchanged throughout the period suggesting that contractors are concerned with downtime from breakdowns of machinery greater than six years old. The age of loading equipment encountered the greatest increase over the period with the percentage of loaders three years old or less falling from 64% to 39% and the group greater than six years old increasing from 9% to 32%. The increases in equipment age reflect a lack of confidence in the timber market over the period and an attempt to reduce logging cost while incurring the risk of machine breakdowns and lost productivity.

8.3 Logging Cost Analysis

Logging expenditures from 26 logging firms from the 2000 to 2004 period were grouped into six basic categories: equipment, consumables, total labor, insurance, administrative overhead, and contract services. The changes in the median value of these cost categories reflect the adaptations contractors have used in an attempt to keep their businesses profitable.

Equipment values fluctuated over the period but remained around 16% for the five year period. The fluctuations are an indication of contractor’s attitude toward the future of their market and the choice to renew equipment or delay purchases. Median
values for consumables fell to a low of 18% in 2001 but has seen steady increase to 23% through 2004. This increase is a result of a near dollar increase of both on and off-road diesel between 2001 and 2004. While labor remained the highest cost category ranging between 31% and 36%, it has gradually decreased since 2001. The decrease coincided with 16% to 23% increase in contracted service costs. This swap in costs is a product of more contractors choosing to outsource trucking to private firms and a reduction in the number and size of logging crews. The remaining categories, administrative overhead and insurance, both saw marginal increases over the period but remain at around at around 3% and 4% respectively.

Quartile analysis of total costs for these contractors showed an increase for firms of all sizes. The minimum and first quartile firm’s costs increased 13.4% and 15.3% respectively between 2000 and 2004. The median firm’s total costs increased 22%. The larger firms encountered the highest percentage change in costs over the period. The third quartile increased 43.2% and the largest firm’s costs increased nearly two million dollars (43.9%).

Production and cost shifts were plotted from year to year throughout the period in order to analyze the relationship between changes in production and the effect this change has on changes in total costs. Throughout each year some contactors were able to increase their production while decreasing their costs. Conversely, each year there was a small group of firms which produced less with an increase in costs. The contractors in these groups were in the minority however with most firms having costs rise and fall along with their production levels.
8.4 Logging Cost per Ton Analysis

A cost per ton analysis was used to explore the relationship between a firm’s total and categorized costs against that firm’s production in order to demonstrate the variability in distribution of component costs. These cost per ton figures were used to compare total costs and expenditure categories for firms of varying business size, location, and structure. Because of market and regional variations, these figures may not necessarily be an indicator of a firm’s efficiency but more of an indicator of the adaptability of the contractors and the overall health of the industry.

Quartile statistics were used to examine shifts in cost per ton figures for 26 contractors from 2000 to 2004. The first quartile cost per ton rose eight percent over the period with the minimum firm rising only 3%. The median value dropped slightly during the first year but steadily rose through 2004 ending with a 6% increase. The third quartile bound rose significantly (33%) over the period due in part to spikes in fuel prices. The maximum firm decreased their cost per ton by 34% by significantly reducing their operation and crew size early in the period.

Year to year data were compared for each contractor over the period with the average cost per ton figures found using regression analyses contrasted against median value data from the quartile analysis. The average data proved to be more volatile than did the median value due to the growth and decline of the larger contractors in the study but both indicated the same steady rise in cost per ton over the five year period. The $R^2$ values for the regressions of the period were between .83 and .93 indicating that 83 to 93 percent of the logging costs were attributed to production.
The components of logging costs were regressed against annual production to test the strength of their linear relationship. The $R^2$ values for equipment costs were between .61 and .73 with average cost per ton ranging from $1.79 to $2.82. While strong, the fluctuation in these values represents the variability of equipment purchase strategies used by contractors during highs and lows in the market.

The $R^2$ values for consumables fell from .79 in 2000 to .61 in 2004 as did the average cost per ton. This drop was caused by an increase in contract trucking and fluctuation in fuel prices over the period. Production rates proved to have the strongest effect on total annual labor costs with $R^2$-values ranging from .81 in 2000 to .94 in 2002. The average cost per ton for labor peaked at $5.11 in 2001 and gradually declined to $4.55 in 2004 most likely as a result of firms decreasing crew sizes and outsourcing of trucking. Contract service rates presented a problem using regression analysis due to the fact that some firms use no contract labor while others outsource all trucking and use some seasonal labor. This being considered the $R^2$-values remained stable between .47 (2000) and .52 (2003). The average cost per ton rose 81% from a low of $3.12 in 2000 to $5.64 in 2003.

Contractors from the piedmont, coastal plains, and Appalachian Mountain regions were able to provide data for a regional study of changes in cost per ton. Nine of 16 coastal plain firms had an increase in coast ranging from $1.51 to $8.82 per ton; four firms decreased their costs from $0.55 to $1.71; and three firms remained relatively unchanged. Five of the eight piedmont contractors experienced the largest cost increase ranging from $2.94 to $10.98 per ton. The remaining three piedmont firms decreased
their cost per ton ranging from $0.10 to $6.40. One of the two Appalachian logger’s cost per ton increased $1.64 over the period, the other displayed significant fluctuations from year to year as he switched between thinning operations and harvesting high grade hardwood.

8.5 Production Analysis

Complete production records were analyzed from 26 logging firms located throughout the Eastern United States from 2000 through 2004. Quartile statistics were gathered from this data in order to assess yearly changes over the five year period. The median production value increased 19.6% over five years despite a ten percent drop in 2000. The minimum and first quartile firms decreased 20% and 25% respectively over this period due to significant yearly drops from 2000 through 2003 before rebounding in 2004. The bound of the third quartile increased over 46,000 tons (37%) during this time while the largest firm regained the approximately 20% of production it lost between 2001 and 2003 to finish relatively unchanged. The quartile analysis indicates that the smaller firms continued to get smaller during the study as mid-sized and larger firms increased production and the larger firms remained stable.

The gains of the mid-sized and larger contractors overcame the losses of the smaller contractors to give the population a net increase of nearly 500,000 tons over five years. Net production for the group rebounded from a low of 2.4 million tons in 2001 to just less than 3 million tons in 2004. These late gains were a result of median and third quartile firms increasing production steadily since 2001.
The production information for the population was split into regional data to determine what effect geographic location had on production shifts. The 16 coastal plain contractors increased their output by 370,000 tons over the period. The majority of the increase was a result of 5 firms increasing their operation and crew sizes over the period. Conversely, three firms eliminated crews or cut crew size during this time in order to streamline their business in to cut costs. Other firms in the region remained relatively stable throughout the period. Contractors from the piedmont region experienced similar results as well. Four of the eight contractors in this region remained stable while two cut production in order match market conditions. Two contractors from this region were able to increase production vastly, one by increasing the size of his harvesting crew, and the other by adding a thinning crew to his operation. One of the two Appalachian crews fluctuated between 20,000 and 30,000 tons over five years harvesting only high grade hardwood. The other doubled his production from 20,000 to 40,000 tons during 2002 and 2003 by adding a softwood thinning crew during this period. However in 2004 this contractor shut the thinning crew down and returned to a single crew hardwood operation lowering his production back to previous levels.

8.6 Conclusion

The logging industry has remained in a constant state of change since the new millennium. Independent logging contractors must be able to adjust to these changes in order to survive. The contractors in this study have used many different methods in an attempt to adapt and survive in an increasingly tighter market.
Some have found success in increasing the size of their business and increasing production, others have felt the need to downsize in order to reach the same goal of increasing profits. Most contractors in the study have retained their support equipment and service vehicles much longer than they have in the past, with more than 50% of loaders, semis, service vehicles, and bulldozers having more than five years of service. More and more vital equipment such as feller-bunchers and skidders are now being kept in use past four years as well. This reluctance to upgrade equipment indicates a lack of confidence in the current status of the logging industry.

The spending on contracted services has been an increasing trend during the study period also. The cost of contract services has moved from the fourth to the second largest expense category by percentage between 2000 and 2004. While a few firms have contracted out logging services and BMP work, the majority have contracted at least part of their trucking. These firms are outsourced their trucking in order to distance themselves from liability of on-road accidents and to reduce the costs of ownership and upkeep of a trucking fleet. This also removes the challenge that many contractors have had in finding experienced, well qualified drivers and providing them with enough work to keep them from hauling for other industries throughout the year.

The difficulty in finding and keeping skilled labor does not end with drivers. Partially a result of the increase in contract services, the spending on total labor decreased gradually during the study period as well. Many firms have had to cut employment back to only what was vital to the operation in order to remain competitive. Finding quality workers for these positions has become increasingly difficult. Logging firms are facing
the same challenges in finding and retaining skilled labor that they faced at the beginning of the last century. As logging budgets have gotten tighter, contractors have had to cut many of the benefits that workers could obtain in other industries. This coupled with strenuous labor, mill quotas, and lost time due to weather has made it near impossible to entice workers to the logging industry.

The beginning of the rapid growth in consumable spending occurred during this study period. After reaching a low in 2001, consumable spending steadily increased throughout the end of the period in 2004. While important, the increasing price of fuel is not the only concern in this category. The cost of petroleum products as a whole can become crippling to a logging firm. As fuel prices increased, so did products such as hydraulic fluid, engine oil, gear oil, machine lubricants, and even tires. The longer a contractor uses his equipment the more maintenance it requires and the increasing price of these products and others have driven maintenance costs much higher. These costs along with fuel have been enough to drive some firms out of business in recent years.

As finding work becomes more challenging and the profits grow slimmer, fewer new contractors have been willing to enter the workforce. This has forced many contractors to stay on the job far beyond the time they would have liked to have retired and some businesses to shut down completely. The loss of some of the second and third generation logging firms is of great concern to the industry as a whole. These firms have encountered the hard times of the past, yet managed to survive. The unwillingness of the younger generations of these families to enter the logging business now could imply a lack of hope for their industries future.
Studies such as this give insight into the overall health of logging industry. The data provided by real world contractors covering a wide variety of economic and demographic categories can provide us with view of the status of the wood supply system as a whole. As changes occur new data from new and existing contractors will enable researchers to gauge the viability of a key component in one of the largest manufacturing industries in the nation.

8.7 Suggestions for Further Research

1. The contractor database should be maintained and expanded to include firms from states not currently represented in the study.

2. The effects of the rising cost of fuel should be further explored in order to understand what changes contractors have incorporated in order to maintain profits.

3. More quarterly data should be collected as the contractors are able to provide it as a means of exploring changes in the industry over a shorter study period.

4. Data should be collected concerning what affects the emerging bio-fuel market could have on the wood supply system as well as the logging contractors included in it.


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