Impacts of Land and Ownership Characteristics
on the Stumpage Prices for Virginia's Nonindustrial Forests

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(ABSTRACT)

The character of Virginia's nonindustrial private forests is changing primarily for two reasons. First, many large, continuous forested tracts are being sub-divided, into with the resulting smaller tracts purchased for amenity values and recreation instead of as a timber investment (Hodge 1993). Second, the demographics of non-industrial private forest (NIPF) landowners are shifting away from an agricultural, rural focus to an urban oriented lifestyle and absentee ownership. These changes may mean less timber available for purchase by the forest industry. Timber that is sold will be on smaller parcels that is bound to have an impact on the procurement activities of forest industries. However, little research has been performed on the impacts of site and landowner characteristic on stumpage prices.

The objective of this research project is to identify how the stumpage price of timber is altered by the characteristics associated with the changing forest: decreasing tract size, decreasing harvested volumes, landowner residence, and landowner harvesting preferences. In addition to the price of timber, the competitiveness of timber sales is analyzed to determine what impact the fragmented forest could have on the competitiveness of timber markets.

To perform the study, site and landowner information was collected for 138 recent NIPF timber sales that occurred within central Virginia. This region is identified as a critical area for the study of forestry activities because of the growing urban and suburban residential populations and the large amount of forest industry activities taking place there.

Results show that access to the site is the most important characteristic determining the selling price of timber. Sites that are easy for logging crews and vehicles to approach dramatically increase the price paid per ton. Tract size is less important in determining bid prices for timber either once the total volume harvested passes a minimum of 500 tons, or there is mature hardwood sawtimber on the site and the acreage is greater than 50 acres. Landowners preference for select cut harvests results in a lower price per ton being paid by the purchaser due to the increased logging costs associated with this type of harvesting.

Acknowledgments

I would like to thank my committee, which included Jay Sullivan (chair), Greg Amacher and Robert Shaffer. Their insight, patience and experience contributed greatly to this project. I would also like to thank the various participants in this study whose field experience provided the data for this research.

As always, my parents provided the motivation and means for me to expand my education.

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Chapter 1

Introduction

The character of Virginia's nonindustrial private forests is changing with many forested tracts being purchased for amenity values and recreation purposes (Hodge 1993) by non-industrial private forest owners (NIPF) oriented to an urban lifestyle while often holding the land as absentee owners. These changes may mean less timber could be available for purchase by the forest industry and the timber that is sold will be on smaller parcels whose landowners desire harvesting methods that have an emphasis on amenity values. The changing makeup of NIPFs is bound to have an impact on the procurement activities of forest industries

The objective of this research project is to identify how the stumpage price of timber is altered by the characteristics associated with the changing forest: decreasing tract size, decreasing harvested volumes, landowner residence, and landowner harvesting preferences. In addition to the price of timber, the competitiveness of timber sales is analyzed to determine what impact the fragmented forest could have on the competitiveness of timber markets.

Literature Review

Population growth

The U.S. population, possibly the cause of all of the problems, is increasing. Over the next 50 years, a population increase of 90 million is expected (Alig and Wear 1992). The Wharton population projection series shows the total U.S. population reaching 275 million in 2000 (from 249 million in 1990) and continuing to grow to almost 320 million in 2030 (South's Fourth Forest 1988). In Virginia, the most recent census (1994) records a population of 6,552,000 which is a net increase of 5.9% since 1990 (Weldon Cooper Center for Public Service 1998).

Loss of Forestland

Forestland has been diminishing since the 1950's. In 1952, 193 million acres, 3/5 of the land in the South (Virginia, North Carolina, South Carolina, Alabama, Georgia, Florida, Tennessee, Mississippi, Louisiana, Arkansas, Oklahoma, and Texas), was classified as forestland. Turn of the 21st Century forest for the United States is 201 million acres. Between 1970 and 1987, forestland area (nationwide) declined by 17 million acres (Alig and Wear 1992). Models predict that 12 million acres will be lost to urbanization between 1992 and 2020 (Weir and Greis 2002). Since 1976, the amount of forested land in Virginia has been relatively stable at 15.4 million acres.

Predictions for forestland continue the declining trend. Alig and Wear (1992) project a loss of 21 million acres by the year 2040 which will amount to 4% of the forestlands in the US in 1987. Zipperer and Birch (1993) predicted a larger decrease in US forestlands; 754 million acres in 1970 to 699 million acres in 2040 which is a net decrease of 55 million acres. By the year 2030, the South Central region (Texas, Oklahoma, Arkansas, Mississippi, Alabama, Louisiana, and Tennessee) and the Southeast (Virginia, North Carolina, South Carolina, Georgia, and Florida) are both projected to sustain a 4 million acre reduction in forestland area (South's Fourth Forest 1988).

Urbanization

Growth of urban areas and the movement of populations to rural areas results in a demand for more housing and infrastructure, which translates into demand for forestland to urbanize. Hart (1991) also found that as agricultural land is converted to urban use, new cropland is developed from forestland. The area of cropland in the South is projected to remain essentially constant, while urban and related uses increases from 51 million to 64 million acres annually (South's Fourth Forest 1988). Vesterby and Kruppa (1988) report that about three quarter of a million acres per year in the US are urbanized with 170,000 acres in the South being urbanized annually (South's Fourth Forest 1988). In 1950, the U.S. population was 151 million people, 64 percent of which lived in urban areas. By 1990, U.S. population was 249 million persons, 75% lived in urban areas (USDC 1992). Periodic forest surveys have indicated that urban and developed areas in the South have expanded by 20 million acres since 1952 (South's Fourth Forest 1988). In Virginia in 1997, only an estimated 22 percent of Virginia's citizens live in non-metropolitan localities. In fact, over half of Virginia's population lives in just two Metropolitan Statistical Areas (MSAs), the Virginia portions of Washington DC and the Norfolk-Virginia Beach-Newport News area (Spotlight on Virginia, January 1998).

Between 1970 and 1980, non-metropolitan areas grew faster than metropolitan areas as 4 million people moved from metropolitan areas. By the year 2040, the urban build-up will cover between 9-13% of the country's surface area (Zipperer 1993). Mean urban acreage per person has also increased, rising from .20 acres per person (app) in 1960 to .23 app in 1970 and .28 app in 1980. This indicates the growth of suburbs as they allow more acreage per person. Reasons for the growth of urbanization in the South include interregional population shifts and migration of industry to the Sun Belt states (South's Fourth Forest 1988).

Pattern of Urbanization

Urban areas expand into surrounding rural areas and develop forest and agricultural use lands. Dillman (1993) studied the growth of urbanization in two regions (South Carolina and Florida) over three decades. The South Carolina study (three counties within the Charleston Metropolitan area) showed an increase in the urban area from 1/5 of the surface area to over 1/2 of the surface area. Conversely, the area of forestland, wetlands, and cropland each declined by 40-50% over the three-decade period. The Florida region (five counties within the Tampa Bay Metropolitan area) had urban areas increasing from 2/5 to 2/3 of the study region, with cropland decreasing by 35% and forestland decreasing by almost 75% over the three decade time period of study (Dillman 1993).

Fleury and Blinn (1996) made key observations concerning urbanization of areas surrounding the Twin Cities (Minneapolis and St. Paul, MN) area: fragmentation of forestland was more active closer to the Twin Cities and along transportation corridors where easy access was afforded to population centers, building construction was frequently associated with NIPF subdivision, and there were relatively high levels of absentee owners in the "high growth" counties (1996). In Virginia, a similar trend is occurring, with population growth greatest along the transportation corridors of Interstates 95 and 64 (Roanoke Times, January 15, 1998), which serves metropolitan areas of Charlottesville, Washington D.C., Richmond, and Virginia Beach.

Urbanization has occurred so fast in some areas that a new classification term, fast growth, had to be created to accommodate them. Counties are classified as fast growth counties if the population grew by more than 25,000 people and increased in population by at least 25% within a decade. In 1970, 135 counties in the US were classified as fast growth and 42 of these counties (31%) (USDC 1992) were in the Southeast. It is estimated that 1/3 of land developed in these counties comes from cropland while the rest of the land comes from forestland and pasture (Vestervy and Krupa 1988). All 10 of the fastest growing counties [nationwide] are on the outer edge of cities. Demographers call this population trend the “doughnut” phenomenon. Central cities and their nearby older suburbs are the holes. Suburbs on the outskirts, where there is more room for new homes, corporate headquarters and shopping centers, are the doughnut ring. The more remote suburbs grew almost 3 times faster than developed counties (USA Today, January 24, 1998). Alig, Adams, and Haynes (1983) summarize the effects of urbanization:

> The rate of conversion of rural land to nonagricultural uses increased during the last two decades [60’s and 70’s], coinciding with some major socio-demographic trends. These trends include the decentralization of population and economic activities from metropolitan to non-metropolitan areas, increased number of household formations, shifts of population from the North to the South and West, and development of major infrastructure programs-for example, the interstate highway.

Parcelization Studies

Rates of Parcelization

Rates of the parcelization of forestland were determined in the forests of Northern Minnesota between 1965 and 1990 by Fleury and Blinn (1996). Four counties were monitored, two slow population growth counties and two fast population growth counties, to determine the effects of urbanization on the size of forest landholdings. The two fast growth counties exhibited a higher degree of forest parcelization than did the two slow growth counties. Both fast growth counties had an increased number of parcels created and an increased amount of forest was subdivided.   The average acreage of a parcel in the fast growth counties was 15.4 acres while the acreage in the slow growth counties averaged 53.0 acres

In addition to urbanization, forestland that is adjacent to metropolitan areas is increasingly fragmented. MSAs, which includes cities and suburban counties, possessed 17% of Georgia's total forestland in 1989 and 22% of Georgia's standing sawtimber (Deforest et al. 1990). Rural areas adjoining MSAs are classified as exurban if their population is increasing and if they are within 50 miles of a city. Exurban areas are often the outer commuter zone beyond the built-up suburbs. Deforest et al. (1990) report that 48% of Georgia's forestland (11.5 million acres) is in exurban counties, as is 51% of Georgia's standing sawtimber. These authors also report that 26% of all forestland in the Southeast falls within MSAs.

Virginia forestland data shows that the state has 15.4 million acres of forestland, with 12.3 million acres, or 81% classified as rural forestland (Scrivani and Rei Liu 1998). Of the rural forestland, about 3.9 million acres are considered by some as unsuitable for forest management due to slope, small acreage, or spatial arrangement. Considering population density, slope restrictions, and forest fragmentation, about 8.5 million acres, or 55 percent of Virginia's forestland, can be considered as suitable for long term forest resource utilization. Taking into account the 38% of Virginia's forestland that is in agriculture or urban usage, only 33% of Virginia's lands can be considered suitable for long-term forest resource utilization (Scrivani and Rei Liu 1998). Table 1.1 lists the acreage per survey unit of suitable rural forestland in Virginia.

Table 1.1

Acreage of timberland, rural timberland and suitable rural timberland in Virginia (in thousands of acres)

		All Timberland		Rural Timberland		Suitable Rural Timberland	
Survey unit	All Land	Acres	Percent	Acres	Percent	Acres	Percent
Coastal Plain	6351	3702	58.3	2837	44.7	2387	37.6
Southern Piedmont	5588	3778	67.6	2965	53	2315	41.4
Northern Piedmont	4381	2427	55.4	1630	37.2	1208	27.6
Northern Mountains	4300	2537	59	2238	52	1344	31.3
Southern Mountains	4773	3004	62.9	2661	55.8	1204	25.2
Statewide Total	25393	15448	60.8	12331	48.6	8458	33.3

Source: Scrivani and Rei Liu 1998

Impacts of Parcelization on Forestry Activities

The significance of forestlands adjoining urban areas is that timber in urban-influenced areas may be withheld from harvesting and replanting because of increased real estate values and changing landowner objectives. MSAs lost 126,000 acres of forestland between 1982 and 1988 (Deforest et al. 1991) to urban areas. Greene (1997) reports that if these forestlands are harvested, they are unlikely to produce another crop of trees. The effect of urbanization on forestlands and agriculture is to raise land values and property taxes that are too expensive for the management of forests for forest products. In market value per acre, built up uses tend to easily dominate other uses. Prices for built-up land are nearly always considerably higher than the $1,000 - $3,000 per acre generally commanded by crop production or the $200 - $800 per acre associated with timber production (Alig et al. 1990).

Causes of Parcelization

Tax policies

Forest parcelization is also caused by tax policies that discriminate against investing in long-term maintenance and tenure of forests. These policies include the high cost of death taxes and the inability to deduct forest management expenses. In response to death taxes, forests are being divided among multiple heirs or subdivided and sold to pay high estate taxes when the owner dies. The inability to deduct forest management expenses, such as expert advice and intermediate silvicultural operations, impedes sound forest management and provides an opportunity for development. Hauenstein and Siegel (1980) point out several relationships between rural land-use trends and tax structure, including the observation that forestland is generally less able to absorb tax increases than are most other types of properties, as many tracts offer little prospect of early income from which to meet annual taxes.

Numerous documented cases of forest estates being subdivided suggest that federal and state death tax burdens cause disruption in management and may cause heirs to abandon timber production programs. Many estates are forced to harvest prematurely in order to pay death taxes, especially when unplanned (Peters, Haney, and Greene 1996). Most forest owners (about 6 million ownerships) are not in a full-time business of growing trees and they receive income from their forests infrequently. The infrequent activity and irregular income typical of most forest ownerships is viewed by tax authorities as a passive investment and is subjected to rules making it difficult to recapture expenses such as consulting and conservation and maintenance practices (Decoster 1998).

Decoster (1998) summarizes the negative effects of tax policies:

> For example, most forest owners have a big harvest once in decades and then, splat!...the tax windshield pops up and smacks 28% [decreased to 20% in 1997] of the profit out of their pockets. That may sound fair (it's a standard rate), but if the resource sold has been held for 20 years, 71% of the gain being taxed is inflation. That's a real tax rate of 95%-plus on the real gain, and doesn't even consider other burdens, such as annual property taxes on the land. There's a way to survive this and this is to get big and business-like...there's just a little problem with this strategy: most nonindustrial private forest owners are not big, are not business like, and aren't going to be. So we have tax policies that definitely do not encourage most people to invest in holding land and growing forest long-term.

Conservation Easements

A management tool designed to protect NIPFs from the pressures of urbanization is the conservation easement. Conservation easements are appealing to NIPF landowners because they can help protect carefully stewarded forest capital from liquidation through unwanted over-harvesting and parceling of the property (Best and Wayburn 1996). Easements can be a means to overcome tax barriers by removing speculative rights (such as future housing development rights) that raise the tax burden but provide no income for the NIPF landowner. Conservation easements are legally binding agreements between private landowners and non-profit or government agencies which restrict future activities that can take place on a parcel of land. While most conservation easements have been utilized to maintain open space (especially with farmland), create habitat set-asides, or to protect scenic views, the use of conservation easements on working forestland is a relatively recent and growing phenomenon (Best and Wayburn 1996).

Most forestry professionals approve of conservation easements as a tool to slow down the forest fragmentation process. However, restrictions limiting the type of forest management possible on easement forests are a concern for forestry professionals (Alig, Adams, and Haynes 1992). Restrictions often include: clearcutting restrictions, selective cutting requirements, canopy closure requirements, and prohibition of parceling of the property for real estate development. Boelhower and Van Ryn (1996) studied forest conservation easements in New England (Maine, New Hampshire, Vermont) and reported on the variety of timber harvesting provisions placed on easements. Table 1.2 lists the various types of harvesting provisions placed on lands under conservation easements in New England. Many Maine easements contain provisions requiring selective cutting, limiting cutting near natural features, or prohibiting clearcutting. Over half of New Hampshire easements (60%) contain no specific provision regarding timber harvesting, compared to 43% in Vermont and 4% in Maine (Boelhower and Van Ryn 1996).

Table 1.2

Timber harvesting provisions on conservation easements by state

	Maine	New Hampshire	Vermont	All States
Clearcutting restrictions	67%	18%	39%	31%
Cutting near natural features	71%	12%	20%	22%
Selective cutting requirements	83%	17%	36%	30%
Road building standards	25%	6%	7%	9%
Canopy closure requirements	21%	4%	7%	7%
Other	17%	9%	2%	8%
No specific harvesting provisions	4%	60%	43%	49%

Source: Boelhower and Van Ryn 1996

NIPF landowner characteristics

The increasing migration of urban landowners to rural areas has created a change in the traditional NIPF landowner. Identifying the changing landowner characteristics is essential to a study of the impact that these landowners have on stumpage prices. The percentage of non-farm NIPF ownerships has increased from 27% in 1952 to 42% in 1977 (Birch, Lewis, and Kaiser 1978). Multiple surveys have shown that an increasing percentage of NIPF landowners are college educated, employed in professional fields, and wealthier than traditional NIPF landowners. Birch (1995) reports that the new NIPF landowner is younger, better educated, and earns more than the owner of a decade ago. McCurdy and Vitello (1980) report that NIPF landowners had more education than was the average in the southern Illinois region. More than one-third had completed college and a fifth had pursued some graduate studies.

Hodge (1993) provides the breakdown on the age of Virginia NIPF landowners in Table 1.3a and the break down of NIPF landholdings by acreage in Table 1.3b. Fifty percent or more of Virginia NIPF owners are age 61 or older. With such a large proportion of landowners in this bracket, it is possible that the land owned by this group will change ownership in the near future. With the increasing trend towards fragmentation of NIPFs due to death taxes, the larger parcels most likely will be divided, adding to the number of NIPF owners in Virginia with small, forested parcels.

The composition of the nonindustrial private owner class appears to have shifted in the 70's and 80's toward non-farmers. Barclough and Rettie (1984) studied the change

Table 1.3a

Age of Virginia NIPF owners

Age	%
0 to 45 years	17
46 to 60 years	33
61 to 70 years	28
71 years and older	22

Table 1.3b

Virginia NIPF ownership by parcel size

Virginia NIPF ownership by parcel size.

Size	%
20 to 50 acres	32
51 to 100 acres	23
101-250 acres	25
251-500 acres	12
more than 500 acres	8

Source: Hodge 1993

in the demographic distribution of NIPF landowners in New England from 1948 to 1973. Business and professional NIPF landowners increased from 21.5% in 1948 to 44.5% in 1973 while farmer NIPF landowners decreased from 22.2% in 1948 to 4.5% in 1973. Business and professional employees are a large segment of the non-farmer groups, have higher incomes, and are more likely to invest in forestry than other nonindustrial owners (Alig, Adams, and Haynes 1992). Alig and Healy (1987) report that individuals in business and professional occupations showed the largest increase in aggregate area as well as in number of owners.

Marcin and Skog (1984) suggest that the values of baby boomers, who are increasingly college educated and environmentally aware should support increased interest in good forest management. Their intentions to harvest should decrease during their empty nest years (years 2000-2015) with increasing tendencies to harvest during their retirement years (after 2015). On the other hand, these authors state that the environmental awareness that these new residents maintain might limit the amount of clear cutting, road building, and aerial spraying of herbicides that is performed. Maass (1991) states that these landowners are becoming more sophisticated and will not permit widespread liquidation of their timber to feed mills. Only 32% of the Kentucky NIPF landowner population indicated that timber [for harvesting] was an important reason for owning forestland (Gracey and Pelkki 1996).

Birch (1995) outlined the reasons for owning forestland by NIPFs in Virginia for primary and secondary reasons. The two highest ranking primary reasons were “part of residence” (37%) and “aesthetic enjoyment” (17%) while “timber production” was third with 10%. Hodge (1993) performed a similar study of Virginia NIPF landowners by surveying both landowners who had harvested timber and those who had not. They were asked to rank 11 reasons for owning their forest. The top three reasons cited by the non-harvesting group were aesthetics (preserving nature, maintaining scenic beauty, and viewing wildlife) while commercial timber production ranked ninth out of 12. For the NIPF landowner group who had harvested timber, their top three reasons were the same as the non-harvested group though timber production ranked fifth out of 12. The list for reasons for owning forestland is found in Table 1.4.

NIPF landowners may have recreation, aesthetics, wildlife, land stewardship, enhancement of land value, and amenity values among other needs and wants to be satisfied through ownership of forestland (Nagubandi et. al 1996). Zipperer (1993) supports a similar opinion of NIPF landowner social demographics:

> Compared to rural or local residents, the newcomers bring with them a different set of cultural values, lifestyles, attitudes, and demands of the forest landscape. These values and attitudes affect the newcomer's perception of how the forest should be managed and for what purposes. Most newcomers have spent their entire lives in metropolitan areas, are accustomed to high-quality services, and want these services in their new rural setting. Often they have no grasp of the relationship among trees, wildlife, and water; little understanding of multiple-use management; and little comprehension of the relationship between timber operations and forest products. By contrast, rural or local residents look to forestlands for their livelihood and view the forest as an economic asset to be used and managed.

Table 1.4

Importance of reasons for ownership for Virginia NIPF owners

Rank: Non-harvesting Group	Rank: Harvesting group	Reason	Very Important	Somewhat Important	Not Important
1	1	Preserving nature	63%	28%	9%
2	2	Maintaining scenic beauty	59%	29%	11%
3	3	Viewing wildlife	47%	34%	19%
4	4	Real estate investment	40%	36%	24%
5	6	Wildlife for hunting	35%	30%	35%
6	7	Second homesite	32%	39%	39%
7	10	Buffer from adjacent property	30%	25%	45%
8	9	Nonwildlife recreation	29%	28%	43%
9	5	Producing commercial timber	27%	34%	39%
10	8	Firewood for personal use	26%	35%	38%
11	11	Conservation easement	21%	30%	49%
12	12	Leasing land for hunting	5%	10%	85%

Source: Hodge 1993

Absenteeism of NIPF Landowners

There has been considerable discussion of whether there is a difference in forest management behaviors between NIPF landowners who reside on their property and those who do not (commonly referred to as absentee landowners). Forestry professionals are concerned that the percentage of absentee forest landowners has increased and these landowners may be more difficult to reach with forest management information and assistance than resident forest landowners (Alig, Adams, and Haynes 1992). In addition to being harder to reach, it is believed that many new absentee NIPF landowners purchased their properties for secondary, vacation homes with an emphasis on amenity values and are not interested in harvest operations.

Numerous studies have been conducted on recording absentee NIPF ownership. In 1978, Birch, Lewis, and Kaiser (1978) reported that 82% of NIPF landowners in the South resided in the same county as their forest ownership. Kingsley and Birch (1980), using the definition of an absentee landowner as one who lives more than 50 miles from his or her forest ownership, found that 11% of Maryland's NIPF landowners lived more than 50 miles from their forestland while in Kentucky, Powell and Birch (1978) found that only 3% of NIPF landowners lived more than 50 miles from their forest ownership. In Crow Wing County, Minnesota, a rapidly developing county, the percentage of absentee owners rose from 31% in 1965 to 57% in 1990 (Fleury and Blinn 1996).

In Virginia, Hodge and Birch (1993) used a mail survey and determined that 32% of respondents lived more than 50 miles from their forestland. Shaffer and Meade (1997), using tax records, determined a 16% absenteeism rate for Virginia. Of these absentee landowners, 60% lived within the major metropolitan area of Richmond, Washington, DC, Norfolk/Hampton Roads, or the Tri-Cities of North Carolina (Greensboro, Winston-Salem, High Point).

There has been considerable discussion of the attitudes of absentee NIPF landowners towards forest management. Morgan and Martin (1995) found that absentee NIPF landowners, defined as those who did not reside in the same county as their forestland, were twice as likely to respond to a mail offer to provide forest management information as resident NIPF landowners. In the same study, non-resident landowners were also twice as likely to request direct contact with a professional forester. Hickman and Gelhausen (1981) found that interest in landowner assistance programs was greater among absentee NIPF landowners than among residing NIPF landowners.

Effects of Change on the Forestry Industry

The changing character of NIPF forests has the potential for both direct and indirect effects on timber availability. Direct effects of parcelization could be that less forestland is available and that the remaining forestland is harder to access by industry. The indirect effects could be the increased difficulty found in procuring timber on these tracts, the increased management costs in managing smaller units, and the increased potential for non-timber uses of the land. Parcelization could impact the forest industry because of changes in forest area, connectivity, distribution, and accessibility to forestland. Also, NIPF landowners often do not manage their land for timber products because of insufficient economic incentives, a lack of knowledge concerning management systems, or a preference for other management options (Zipperer 1993).

Parcelization has the potential to have an immense impact on the forest industry due to its reliance on a timber supply from NIPFs. In the United States, 73% of forestland is privately owned with 59% being owned by NIPF landowners and 14% owned by the forestry industry (Birch 1995). Public forests comprise the remaining 27% of the U.S. forestland base (Birch 1995). With 70% of forestland in the South, southern forest industries rely greatly on NIPF landowners as a source of open-market timber to provide raw material for their mills (South's Fourth Forest 1988). Specifically, NIPFs accounted for 49% of the volume of growing stock removals in 1991 while industrial forestlands provided 33% of the volume harvested and public forests accounted for 18% of 1991 U.S. harvest volumes (Powell 1995).

Timber harvests on NIPFs have increased by 17% since 1952 (Powell 1995). Few statistics are kept by state in tracking the harvest volumes on NIPFs. Pennsylvania reports that 72% of commercial forestland is in NIPFs and these lands provide most of the raw materials (80%) to the states $4.5 billion a year hardwood industry (Washburn 1996). Though Virginia does not track this statistic, it can be assumed that with Virginia's 450,000 NIPF landowners, controlling 77 percent of the state's forested land, or almost 12 million acres (Birch 1994), Virginia NIPFs comprise a considerable share of the state's harvest.

Many studies have reported the effects of changing acreage size on the forestry industry through recording the changing acreages of timber harvests (Greene 1996, Greene 1997) and the average landholdings of NIPF landowners (Birch 1994, Zipperer and Birch 1993). Average timber sale acreages in Georgia declined by 36% from 118 acres in 1988 to 75 acres in 1994 (Greene 1996).

Surveys have noted that the average NIPF acreage has been slowly decreasing since the 1960's. Nationwide, Decoster (1998) tracked the percentage of NIPF landowners whose landholdings were less than 100 acres. In 1978, 92.2% of total NIPF landowners owned less than 100 acres while in 1994, 93.7% of total NIPF landowners owned less than 100 acres. Concurrently, in 1978, 72,000,000 acres were in tracts less than 100 acres while in 1994, 126,000,000 acres were in tracts of less than 100 acres. Birch (1995) supports this claim in the South. He found that the number of NIPF acreages within the 1-9 acre size class increased by 51% between 1978 and 1994 and within the same time period the 10-49 acre size class increased by 83%. Conversely, Birch found within the same time period that the 100-499 acre size class ownership by NIPFs decreased by 15% and the 500-999 acre size class ownership decreased by 9%.

Zipperer and Birch (1993) report that between 1972-1988, the size of forest ownerships within the New Jersey highlands declined from an average of 22 to 12 acres. NIPF landowners in Georgia experienced an increase in the acreage of the three smallest stand categories with a marked increase in the less than 10 acre stand size. Accordingly, NIPF ownerships saw declines in each of the three largest stand size classes (Greene 1997). Birch (1995) performed an intensive survey of NIPF landowners in the South with the number of private ownerships with fewer than 10 acres of forestland increasing from 2.7 million in 1978 to 3.2 million in 1994.

Economic role of forest industry

The repercussions of forest fragmentation could be serious in the South where forestry is such a large component of the economy due to the abundance of pine forests, gentle topography, and transportation corridors. Zhang, Warren and Bailey (1998) state that as timber supplies from public forests in the Pacific Northwest decline, forests in the South will assume an ever larger role in timber supply. In the South, one out of every five manufacturing establishments is timber-based and in 1984, 12 southern states accounted for 1/3 of the softwood lumber and 2/5 of the hardwood lumber produced nationally (South's Fourth Forest 1988). The forest industry ranks first or second in importance among major industry groups in most states in the South.

Employment and income in the forest industries in the South exceeds those in other major manufacturing industries (textiles, apparel, and processed food). In 1982, southern forest industries employed one out of every 9 workers, paid $1 out of every $10 in wages, produced $1 out of every $11 of value added to the economy by manufacturing (exceeding textiles, apparel, and processed food). In the mid-1980's, some 45% of the U.S. employment in primary and secondary wood processing was in the North and 35% in the South. In 2040, these two eastern regions will continue to have about 80% of the total wood processing industry employment even though employment will only be 72% of the employment in 1985 as capital is substituted for labor (USDA 1990).

Forest industries in Virginia have a significant impact on the economy of Virginia. Foreman et al. state "Virginia's forest products industry provides a vital source of income and jobs for many rural areas and smaller cities. The harvesting, processing, and marketing of wood products adds $9.8 billion annually to Virginia's economy and accounts for over 228,370 jobs." (Virginia's Forests Our Common Wealth 1995). Forestry in Virginia is one of the largest manufacturing industries in the state ranking first in employment, second in wages and salaries, and fourth in value added products (Virginia's Forests Our Common Wealth 1995).

More than 228,730 Virginians are employed by the forest products industry with an annual average wage for a worker in the forest products industry being $14,452 or

$278 per week. A worker providing forest services (tree planting, timber marking, land management, etc.) has an annual average wage of $20,213 or $389 per week (Weldon Cooper Center For Public Service 1998). For each forest product manufacturing job, an additional two support/service jobs are created (Virginia's Forests Our Common Wealth 1995). The median value for State-level income multipliers in both lumber and wood products manufacturing and in pulp and paper manufacturing is approximately 2.4. These multipliers indicate that a $1 increase in wages and salaries in the lumber and wood products sector or the pulp and paper products sector would result in an expansion of wages and salaries for all sectors statewide of $2.40 (South's Fourth Forest 1988).

Forest parcelization could increase harvesting costs by decreasing the amount harvestable timber available at each site. This shortens the length of time in which loggers can work an individual site and increases the frequency of expensive equipment moves. Thienpont (1976) surveyed completed logging operations in the Southeast to determine whether small tract sizes had sufficient volume to amortize both fixed and variable costs for different harvest systems and still provide a profit. Results showed that mechanized systems required at least 50 acres or 500 cords to harvest a tract and be financially solvent. Walbridge (1976) found that for highly capitalized harvest systems, careful attention must be paid to the frequency and length of the move. Move distances in excess of 10 miles into tracts of less than 200 cords total volume were found to be a significant factor in the total cost of harvesting for mechanized systems.

Greene (1997) states that most NIPF sales probably provide less than 2 weeks of operation for the typical logging operation in Georgia. Concerning costs for loggers, Row (1978) determined that area of the harvesting job proved to be the most significant and consistent factor in cost per acre as well as total cost figures. Greene (1997) summarizes that while logging system production rates have increased dramatically, timber sale sizes have been declining. Hunter (1982) found decreasing tract size statistically significant in decreasing stumpage prices for pulpwood, supporting the hypothesis of higher harvest costs on small tracts.

In addition to logging costs, small NIPF landholdings increase forest management costs. Forestry literature documents that small tracts have higher forest management costs. Gardner (1981) found that large tracts (50 or more acres) have lower average reforestation costs than small tracts (2 to 20 acres). Wikstrom and Ally (1967) concluded that for most forest management practices, cost per acre increased rapidly with decreases in the size of area, particularly on areas smaller than 40 to 50 acres. Average costs seem to be at least 25 percent higher for tracts below 10 to 20 acres in size. Overall larger tracts, of 50-125 acres, have larger economic advantages over small tracts. Average costs increased rapidly on tracts below 50 acres and are prohibitive on tracts below 10 to 20 acres in size (Wikstrom and Ally 1967, Gardner 1981).

Chapter 2

Methods and Materials

Introduction

The purpose of this study is to determine how prices of wood procured in open markets depends on site and landowner characteristics. Actual data from timber sales that occurred between 1997 and 1998 will be used to determine how the price offered (and accepted) depends on characteristics of the site, such as access, tract size, and landowner characteristics. The sale price of timber was the accepted, actual price on a per ton basis paid for a standing tract of timber. The numbers of bids for each tract also will be used with this data to determine how characteristics of the site and the industrial firm affect bidding intensities.

Bid price formulation has been examined in the timber sale appraisal literature for some time (e.g., Jackson and McQuillan 1979, Buongiorno and Young 1984, Jackson 1987, Puttock et al. 1990, Munn and Rucker 1995). However, these earlier studies focus primarily on the attributes of only the timber on a particular site. This analysis includes a broader range of variables that could affect stumpage prices, such as variables related to forest fragmentation.

Several hypotheses will also be tested to determine the significance of tract size, landowner harvesting preference, landowner residence, and volume harvested on the price of timber. This analysis will determine what characteristics of the site and landowner are capitalized into the price that forest industry is willing to pay for timber sales. Once this is known, a more complete picture for how tract characteristics and absenteeism affect the forest industry and the costs of wood procurement will be known.

Data sources and study area

Timber procurement personnel at industrial forest operations and sawmills who purchase timber from within central Virginia provided sale information, along with consulting foresters who sold timber from within this region. Participants who provided this information either procured or sold timber within this region as their primary geographical source of timber.

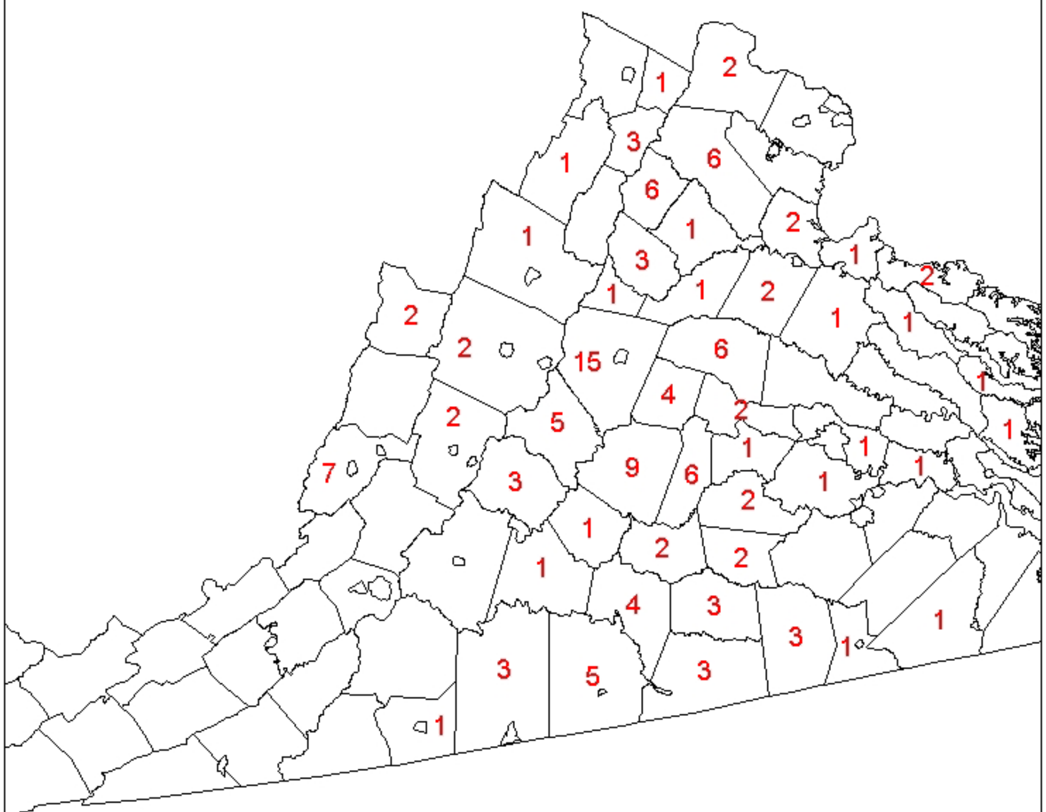
Central Virginia was defined as the area formed between the triangle of Fauquier county (northern intersection), the city of Roanoke (southwestern intersection) and the city of Richmond (southeastern intersection) and is represented in Table 2.1. This region of Virginia was identified as a critical area for a study of forest fragmentation for two reasonss. First, the geographical triangle of the study area has three major cities at each corner: the Washington D.C./Northern Virginia Metropolitan area, Richmond and Roanoke. Also, the cities of Lynchburg and Charlottesville are located within the study area. These metropolitan areas are often the source of factors that are associated with forest fragmentation: growing populations that require housing and infrastructure, professionals and other wealthy urbanites who desire to live in a rural setting outside of the cities, and forested and agricultural lands that are cheaper than already developed lands to purchase.

The second reason for selecting the sampling area is the amount of forest operations occurring in this part of Virginia, and trends in utilization that are thought to be a result of increased population pressures. Statewide, between 1992 and 1995, the number of primary roundwood consuming plants in Virginia declined from 311 to 289 even though the amount of harvested timber consumed by these mills rose by 3% to 485 million cubic feet of harvested timber (Johnson et al. 1995). Including all forest industries located within the study area or within 50 miles of the study area, there are approximately 150 sawmills and four pulp mills (Johnson et al. 1995). Although the data are primarily industry-based, information was also collected on the type of landowners with which the sales were undertaken.

Complete information on 138 timber sales that were conducted between 1997 and 1998 was collected by recording information from actual timber sale prospectuses and bid sale results. Field notes from the foresters involved in the sales were also included. Due to the large procurement areas of the participants, the study area for timber sales included 44 counties. The number of sales recorded per county listed is identified in Table 2.1. Complete sale information can be found in the Appendix. Interviews were also conducted with representatives of those firms and consulting companies that provided sales data to obtain their opinions concerning forest fragmentation.

Site characteristics sampled included all of the typical information recorded on a timber sale prospectus, along with information that would determine other important harvesting conditions for a timber sale. Specifically, site characteristics variables included: estimated acres of the tract to be harvested, estimated tons of hardwood sawtimber to be harvested, a dummy variable indicating whether access is rated as good to excellent (as identified either by the consulting forester or procurement forester), the estimated cost of road construction to complete the harvest, distance from harvest site to haul road, a dummy variable indicating whether or not BMPs needed to be applied to the

Table2.1 Reported Timber Sale by County



site during harvesting operations, and a dummy variable indicating whether or not the site could support year round logging.

A weakness of the site information recorded is the hardwood sawtimber variable. In recording the data from sale prospectuses, it was not possible to record the quality of sawtimber at each site. Some prospectuses recorded the quality of hardwood sawtimber while others did not. As the prospectuses are letters attracting buyers, this information was very subjective. In fact, many prospectuses opened with the same information "…xx Forestry Consultants invite you to bid on xx acres of high quality sawtimber…"

Site variables that need additional explanation include the access variable and BMP variable. Access was identified as good or excellent when the logger did not have any obstacles to gaining entry to the tract. Examples of obstacles identified in the sales were a logger having to cross another landowner's property to get to the tract to be harvested or a tract that adjoined a railroad siding in which access to the tract was limited while railcars were parked on the tracks. The application of BMPs was only included (dummy variable = 1) when the treatment included a cost to the purchaser, such as installing water bars or creating an appropriate stream crossing.

Purchaser characteristics included a dummy variable identifying if the primary purchaser was a hardwood sawmill, a variable recording the haul distance to the primary mill, and percent of wood harvested from site estimated to be delivered to primary mill. Seller variables included a dummy variable indicating whether the landowner intervened in the harvest haul distance to the primary mill. This variable was identified by timber sale prospectuses and field notes. Examples of landowner intervention were: requiring additional logging decks to be established and the landowner deciding upon the hauling road to be used.

The estimated average harvested acreage was 65.3 acres with an average volume of 2193 tons per sale. Access was interpreted from information present on the sale prospectus for each buyer, with 75% of the sales being recorded with either excellent or good access. The average cost of road construction to complete the harvest was $792, while distance from harvest site to haul road averaged 984 feet. Best management practices (BMPs) were deemed necessary for 73% of the sales, and 80% of the sales were capable of being harvested any time in the year.

Seller characteristics were collected to determine essential features of landowners that might impact the firm's sale bidding behavior. For most (66%) of the sales, the primary purchaser was an agent of a sawmill that primarily purchases saw logs.
The distance from location of the sale to primary mill of the purchaser averaged 74.6 miles, and finally, an average of 67% of the wood harvested went to the primary purchaser.

Specification of base models

The construction of base models was necessary for a statistical evaluation of the data. Rationale for estimating the basic model comes from the theory of bidding behavior. In particular, this literature argues that the marginal utility of a sale characteristic can be defined by a regression of the bid price on the characteristics of the sale. Since for a timber firm marginal utility equals the marginal profit of the procurement activity, the estimated marginal prices will tell us how the profitability of procurement activities depends on land and landowner characteristics, and on fragmentation and absenteeism. Identifying these relationships will tell us the extent that fragmentation or shifting landowner preferences impacts the forest industry.

The basic model to estimate is:[1] $P_j = P_j(S,A,C,\Omega;\beta,\varepsilon)$, (1)

Where Pj is the price of sale j, S is a vector of resource stock measures, A is a vector of variables measuring access, C is a vector of variables measuring logging cost indicators, Ω are characteristics of landowners or the market that might impact sale prices (thus, these include variables important to the firm such as mill constraints), β is a vector of parameters to estimate, and ε is an error term. The specification allows a study of how the characteristics of timber sales are realized through the bid prices without the influence of a constant being introduced into equation.

Because firms bid for timber sales, it is useful to understand how characteristics of the tract and the landowner contribute to the bidding strategies of the firms. The model to estimate in this case would relate the number of bids received for a sale to characteristics of the sale, market, and landowner:

$$B_j = B_j(S,A,C,\Omega;\beta,\varepsilon), \quad (2)$$

where Bj is now the number of bid prices observed for each sale.

Estimating equation (2) will provide insight into which characteristics of the market or tract increase or decrease the competitiveness of the timber sales. In fragmented areas, or those with a high proportion of absentee landowners, there are opposing effects on competitiveness. First, as tracts become broken up, competitiveness

[1] Although we did not have specific seller characteristics, we do include in (1) variables that are controlled by the seller, such as type of harvest, what types of BMPs are used, and time of year for harvesting. Thus, we expect that possible endogeneity (recognized to exist in hedonic price models that include only on purchaser characteristics) are minimized.

might increase since the number of tracts which are suitable for harvesting decreases, yet the high fixed cost mills that are supplied by these areas face continued need to supply wood to the mills. Conversely, as raw material prices increase due to fragmented supply sources, larger scale companies might find it worthwhile to extend their procurement ranges and bid in less fragmented areas. Although the extended portion of the procurement region may previously have been considered the low rent margin of timber sales, it is possible that bidding pressures could increase on the larger tracts further out from the mill center, given the increased scarcity of large, contiguous volumes of wood near to the mills. In turn, this might reduce the competitiveness of bidding on tracts in fragmented areas. If this is indeed the case, and if prices remain higher in fragmented areas, then we suspect it is the smaller firms that will continue bidding on land close to the mills. Interestingly, in the past this area was never thought of as the economic margin, but in fact rents to harvesting wood would be smallest there.

Estimating (1) and (2) will give us an understanding of the marginal value that industrial firms place on certain characteristics of sales, and we will be able to determine how fragmentation and absenteeism affect the marginal values of these characteristics and the competitiveness of timber sale bidding. As mentioned above, we will also be able to determine how the competitiveness of timber sales depends on fragmentation and increasing absenteeism among landowners. Ultimately, changes in the forest sector may reduce the probability that industry bids on a sale, which would imply reduced supply potential or increased pressure to satisfy mill constraints in the region.

Another useful result from estimating (1) and (2) will be a comparison between types of firms. It is well known that both small, labor intensive firms and large capital intensive firms procure from the same areas. Typically the smaller firms are sawmill-based, while the larger ones are paper and finished product based operations. There has been little study of the organization of industry into procurement areas. Yet these issues will become important as fragmentation either increases the competition for sales, or reduces the possibilities that small tracts will be bid upon by larger firms. We will therefore complement our estimation of these functions by examining the differences for both large and small procurement operations.

Chapter 3
Results of the price equation base model

Table 3.1 presents results from applying equation (1) to the data. The dependent variable is the selling price of the timber divided by the total tons of timber volume harvested from the site, i.e., the price per ton of harvested material. All non-dummy variables are presented in log form. [2]

The following independent variables were significant in the base model: acres harvested, primary purchaser, access, application of BMPs, distance to primary mill, and percent of harvested volume delivered to the primary mill. The three most significant variables were the access variable, the variable indicating the primary purchaser, and the percent of material delivered to the primary mill, with access having the largest magnitude. Access to the site is essential to making a tract of timber saleable, and purchasers will pay more when the site is easy for logging crews to get to.

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[2] Specifically, the dummy variables were created as follows. For the primary purchaser variable, the dummy variable was classified as one if the purchaser was a sawmill and a zero if the purchaser was an industrial forestry firm. The variable, Access, was defined as ease in which entrance to the tract could be obtained. Access to the tract was ranked on a scale ranging from excellent, good, fair, or poor, with the dummy variable equaling one when access to the tract was excellent or good and zero otherwise. When a site required BMPs, the dummy variable was ranked as one and zero otherwise. For sites in which the landowner determined the method of harvesting, this dummy variable received a one and zero otherwise. Certain sites afforded year round logging and these sites were given a one in the data. Sites which could only be harvested during dry seasons received a zero.

Table 3.1
Stumpage price regression

Dependent variable is price per ton
* indicates significance at the .10 level or less
(*L*) indicates that the variable is represented in the log form

Independent variable	Coefficient (n=129)
Estimated Acres (*L*) Harvested, (acres)	-.19618[3] (0.03921)*[4] -.1952[5]
Estimated Hardwood (*L*) Sawtimber Removed, (tons)	5.97E-02 (.50760)
Primary Purchaser, 1 = Hardwood Sawmill	2.1347 (0.00000)*
Access, 1 = Good or Excellent	4.0336 (0.00000)*
Road Cost (*L*), (dollars)	-.936e-2 (0.71574)
BMP's Applied, 1 = Yes	.31732 (0.04335)*
Landowner Determined Harvest, 1= Yes	.424e-1 (0.74792)
Distance to Haul Road (*L*), (feet)	-.170e-2 (0.93194)
Year Round Logging 1 = 12 month harvest	.15288 (0.32316)
Distance to Primary Mill (*L*), (miles)	-.17012 (0.05994)* -.1100
Percent Delivered to Primary Mill (*L*) (% of total tons harvested)	1.0659 (0.00000)* -.0310
Population Density (*L*) (Pop./acreage of county)	2.48E-02 (0.76464)

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[3] Regression coefficient
[4] Significance probability
[5] Elasticity = percent change in dependent variable for a 1% change in an independent variable

When the primary purchaser is supplying a sawmill, the selling price is higher primarily for one reason. Sawmills primarily purchase tracts that contain either pine or hardwood sawtimber, which receive a higher per unit price than pulpwood.

The size of the tract harvested was significant at the 0.05 level and had a negative coefficient (its computed elasticity is -0.20). This variable, though it did not have as high a coefficient as access, is very important to the purchasing price of timber. Basically, the sign and significance of the acres harvested implies that as acreage increases the price paid per unit decreases. This may be arising out of a combination of factors, including a higher variability wood quality and species mix across the tract, location of larger tracts relative to competitive market centers, and limited ability of smaller mills to handle larger tracts (for cash flow or mill capacity reasons). Another theory is that smaller tracts, in order to be sold, require a minimum "benchmark price" which results in these smaller tracts having a higher price paid per ton than larger tracts.

The significance and positive sign for the percent of product delivered to the primary mill indicate that as the amount of harvested volume delivered to the purchasing mill increases, the purchaser is willing to pay more for the tract (the elasticity of this variable is considerably less than the tract size elasticity, at 0.03). The application of BMPs on timber sale also has significant effects. The dummy variable indicating if BMPs were required on the site has a significance of .04 and a positive coefficient of 0.32. While it is easy to infer that sites requiring BMPs would significantly impact the price of the timber, the positive coefficient implies that price for timber on tracts requiring BMPS actually increases, which is not expected and can be deemed a spurious result.

In the base model, a number of variables were not significant at the .10 level and do not affect the price offered. These include volume of hardwood sawtimber (which does not have the expected sign), cost of road construction (although this may be related to the BMP variable as mentioned above), and a dummy variable indicating whether the landowner played a role in the harvesting operation design. The distance to haul road variable was also nonsignificant, as was a dummy variable indicating whether year round logging was possible, although the signs of these variables were correct. Finally, the population density variable was not found to be significant, but tract size is significant and probably is a better indicator of the role of parcelization in timber purchasing behavior. Population density was only measured as the average density across the county.

Chapter 4

Extensions and hypothesis tests utilizing the price model

Tables 4.1-4.4 present results of several sample groupings used to study additional issues within the price model. These included considering further the effects of acreage, volume harvested, type of harvest, and landowner absenteeism on the price offered for a timber sale. Acreage and volume are important variables related to fragmentation, while type of harvest and landowner absenteeism are related and measure landowner type.

Tract Size

One distinct characteristic of the fragmented forest as determined by Bates and Cooksey (1998) and Birch (1995) focuses on the increasing parcelization of tracts into smaller acreages. However, little research has been done to consider the implications of these smaller parcels of land on the selling price of timber and the competitiveness of the sale. In addition, the impact that various site and purchaser characteristics have on the selling price of the timber as acreage diminishes is not well understood. Timber sale information collected for this study allowed a model to be created that examined the effects of diminishing harvested area on the sale price of the timber. The objective of this model was to determine what impact the various individual components of the timber sale (site and purchaser characteristics) have on the price per ton of timber harvested as tract size decreases.

To further analyze the impact of tract size on timber sales, the data were grouped in categories according to the size of the tract that was harvested (Table 4.1). This included tracts having less than or equal to 25 acres, less than or equal to 50 acres, and

Table 4.1
Tract acreage and stumpage price

Dependent variable is price per ton
* indicates significance at the .10 level or less
(*L*) indicates that the variable is represented in the log form

Independent variable	Tract size less than 25 acres (n=26)	Tract size less than 50 acres (n = 67)	Tract size greater than 50 acres (n = 61)
Estimated Acres (*L*) Harvested, (acres)	-.30954[6] (.38098)[7]	-.51971 (0.00917)* -.4007[8]	.27409 (.32610)
Estimated Hardwood (*L*) Sawtimber Removed, (tons)	4.49E-01 (.03806)* .0942	9.15E-03 (.917)	2.79E-01 (.06321)* .0688
Primary Purchaser 1= Hardwood Sawmill	1.6732 (.01113)*	1.6216 (0.00003)*	2.4603 (.00000)*
Access 1 = Good or Excellent	3.4993 (0.10947)*	5.9409 (0.00002)*	1.2578 (0.36914)*
Road cost (*L*), (dollars)	423e-2 (0.95323)	-.495e-1 (0.17204)	.746e-1 (0.04401) .0813
BMP's Applied, 1 = Yes	.64502 (0.06396)*	.34225 (0.13006)	.11546 (0.47377)
Landowner Determined Harvest, 1 = Yes	.34305 (0.34976)	-.21038 (0.34140)	.17824 (0.27366)
Distance to Haul road (*L*), (feet)	-.625e-1 (0.44619)	.210e-2 (0.93331)	-.238e-1 (0.16827)
Year Round Logging, 1 = 12 month harvest	1.7642 (0.01175)*	.22680 (0.33503)	.18725 (0.27436)
Distance to Primary Mill (*L*), (miles)	-.50909 (0.20452)	-.24879 (0.12728)	-.19186 (0.03655)* -.2188
Percent Delivered to Primary Mill (*L*), (% of total tons harv.)	.90625 (0.00097)* .2088	.98767 (0.00000)* .1144	.93731 (0.00000)* .1802
Population Density (*L*) (Pop./ acreage of county)	2.18E-01 (0.58733)	4.31E-03 (0.97679)	.155E-01 (0.86547)

6 Regression coefficient
7 Significance probability
8 Elasticity = percent change in dependent variable for a 1% change in an independent variable

greater than 50 acres. Of the timber sales reported, 55% of the sales had harvested areas of less than or equal to 50 acres, while only 11% of the sales had harvested areas of 25 acres or less.

In the base model the acres harvested variable had a significance level of 0.04 and a negative coefficient of -0.20, and a corresponding elasticity of -0.20. In the regressions over the acreage groups, the harvested acres variable was only significant at the .05 level for harvested acreages of 50 acres or less. The elasticity of the coefficient equaled -0.40. The implication of this variable being significant is that for harvested acreages less than 50 acres, acreage size is significant in causing the price paid per ton to decrease as tract size increases. The non-significance of this variable for harvested sizes greater than 50 acres implies that the size of larger harvested tracts does not negatively impact the price. Perhaps at the 50 acre level tracts already contain a great deal of variability in quality and species mix, much of the small mill competition that could bid up the price of timber on smaller tracts is already eliminated, or tracts greater than this size tend to be located away from the more competitive market centers.

Using the same approach, the variable representing volume of hardwood sawtimber changed in significance and magnitude over the acreage groups. In the base model, the hardwood sawtimber variable was insignificant, while it was significant at the .05 level for harvested acreages less than 25 acres (with a computed elasticity of .09). The hardwood sawtimber volume was insignificant for harvested acreages less than 50 acres while it was significant at the .10 level for harvested tracts greater than 50 acres (here the elasticity was 0.07).

The impact of this variable implies that price paid per ton increases for smaller tracts (less than 25 acres) if hardwood sawtimber is present on the tract or for tracts greater than 50 acres in size. Small tracts that contain hardwood sawtimber are attractive and within the purchasing power of both small sawmills and industrial procurement foresters. An explanation for this is best explained in the following paragraph on the primary purchaser.

The primary purchaser dummy variable (1 = purchaser represented a sawmill) was significant at the .05 confidence level in the base acreage model and in each of the acreage group models, as well. The base model had a significance level of zero and a coefficient of 2.13, less than 25 acres at .01 and 1.67, less than 50 acres at zero and 1.62, and greater than 50 acres at zero and 2.46, respectively. The increasing value of this coefficient may be explained by the fact that the value of hardwood sawtimber is higher than pulpwood on a per unit basis. The increasing value of the coefficient, especially the large coefficients of the greater than 50 acres regressions, indicates a possible per unit increase as tract size increases. However, interviews with the participants in this study stated that price paid per ton on large tracts does not increase as tract size increases. Price paid per ton can decrease on larger tracts due to varying sawtimber quality or possible difficulties in harvesting a large tract (due to contract length restrictions).

The ease with which a purchaser can harvest the timber is evaluated in the access variable. As we showed with the base model, when this variable is significant and positive, the explanation is that when access is either excellent or good, price paid per ton increases. In the regressions of less than 25 acres and less than 50 acres, the variable remained highly significant with large positive coefficients, although the coefficient was highest for the larger tracts. Interestingly, for tracts greater than 50 acres, the access variable was not significant, however. This may indicate that access is a more important variable for smaller tracts (as a barrier to entry into the market) than larger tracts. Small tracts must have good access to be sellable due to the limited total volumes of timber on site, which increases logging costs.

The road cost construction variable was insignificant at the .10 level for the base model and the tract size grouped models of 25 acres or less and 50 acres or less. For tracts greater than 50 acres, the road cost construction variable was significant at the .10 level and had a coefficient of .07 and a positive elasticity of .08. Similar to the access explanation, small tracts, due to the importance of accessibility, usually do not require roads and if they do, road costs are minimal or if road construction costs are substantial, the tract might not be sold at all. Purchasers are willing to pay a higher price for road costs when tract size is greater than 50 acres because of the higher volume of timber on the site.

Other variables worth mentioning for the regressions grouped in different tract sizes include percent of product delivered to the primary mill and haul distance to the primary mill. The percent product delivered to primary mill variable is significant and has a positive effect at the 0.05 level for both the base model and over all of the tract size groups. This may be explained by purchasing strategies of potential buyers. When a substantial component of the tract volume will be delivered to the primary mill of the purchaser, and not marketed and sold as different product classes to other mills (often delivered as gatewood which brings a lower price), the purchaser will pay more per volume harvested.

The haul distance to the primary mill is both significant at the .05 level in the base model and the greater than 50 acres regression (both have negative coefficients and elasticities of -.11 and -.2188, respectively). It is insignificant in the less than 25 acres and less than 50 acres regressions. The explanation for this is that the numerous haul trips to the mill that occur on larger tracts (in this case 50 acres or more), that typically have larger harvest volumes, results in less being paid per ton due to the increased transportation costs. The same pattern appears in the volume hypothesis tests with tracts having greater than 500 tons of volume harvested having less paid per ton due to the increased costs of paying for multiple haul trips to the mill. Thus, volume of harvested material is more critical than actual size of the harvested area.

Volume Harvested

Another concern with increased fragmentation is that, as harvested tract size diminishes, so does the volume of material harvested from each individual tract. However, the volume of material harvested from the site does not follow a linear decrease as acreage decreases. Though a variety of natural factors can account for this, such as species present and stand stocking, other factors such as type of harvest performed can significantly decrease the amount of volume sold in a sale. As we showed previously, an additional aspect of fragmentation is the changing type of landowner who owns tracts in high-growth areas. Fleury and Blinn (1996) and Hodge (1993) suggests that NIPF landowners are interested in forest management for amenity values rather than financial gain, and thus the timber volume on these tracts might be understocked. In this section we examine whether these smaller volumes of harvested timber have an impact on the selling price of the timber.

Using a method similar to that conducted for tract size, models were estimated in which sales that had harvested timber volumes less than or equal to 500 tons were distinguished from those with greater than 500 tons harvested (Table 4.2). The 500 ton level was chosen as the average weekly production level for a harvesting operation in central Virginia (Personal Communication, Dr. Bob Shaffer, Virginia Tech). Participants providing sale data for this study also agreed that this level was a critical point, providing approximately one week of work for the typical logging crew. Participants also commented that any sale which had a volume below this level usually received a lower price due to the costs of having to move logging crews to a new site more frequently.

To allow this regression to be performed, the variable representing the tons of hardwood sawtimber removed had to be dropped due to collinearity. In both the regression of less than 500 tons harvested and greater than 500 tons harvested, the tract size variable was not found to be significant. This suggests that meeting a minimum volume target may be more critical than the total acreage of the tract. It also supports the concept that other factors which limit the volume of timber removed can play a significant role.

These results support the notion that competition may be greatest for tracts with smaller volumes. This is consistent with the smaller mill capacity and less available capital possessed by these firms relative to the large paper mills. It also suggests, perhaps surprisingly, that most of the competition that occurs over parcelized tracts is due primarily to smaller sawmill operators, despite the fact that many of these

Table 4.2
Total harvest volume and stumpage price
Dependent variable is price per ton
* indicates significance at the .10 level or less
(*L*) indicates that the variable is represented in the log form

Independent variable	Tons harvested less than 500 tons (n=32)	Tons harvested greater than 500 tons (n=96)
Estimated Acres (*L*) Harvested, (acres)	-0.10943[9] (0.51956)[10]	0.11608 (0.46605)
Primary Purchaser, 1 = Hardwood Sawmill	3.6405 (0.00000)*	1.8726 (0.00000)*
Access, 1 = Good or Excellent	.97826 (0.43039)	3.2035 (0.00002)*
Road Cost (*L*), (dollars)	.1009e-1 (0.73711)	-203E-03 (0.93043)
BMP's Applied (*L*) 1 = Yes	0.54443 (0.07530)*	0.27084 (0.09023)*
Landowner Determined Harvest, 1 = Yes	0.19821 (0.37398)	-.5788E-02 (0.96827)
Distance to Haul Road (*L*), (feet)	.643E-01 (0.23840)	-4.05E-02 (0.07057)*
Year Round Logging, 1 = 12 Month Harvest	0.66802 (0.04580)*	-2.42E-02 (0.87693)
Distance to Primary Mill (*L*), (miles)	3.13E-02 (0.89402)	-0.15403 (0.04006)* -.1606[11]
Percent Delivered (*L*) to Primary Mill (% of total tons harvested)	0.52682 (0.16309)	0.82125 (0.00000)* -.1717
Population Density (*L*), (Pop./Acreage of County)	-0.998e-2 (0.95870)	-5.76E-02 (0.56764)

[9] Regression coefficient
[10] Significance probability

tracts are closer to mills and population centers. This contradicts the accepted notion that smaller firms operate further out in the procurement range.

The access variable is not significant in the regression based on sales less than 500 tons, but it is significant when data is grouped for greater than 500 tons. Recall that in the grouped tract size models, access was significant and had a positive coefficient for tracts with acreages less than 25 acres and less than 50 acres. The results from the volume models imply that purchasers will pay more for good access when there is more than 500 tons of timber to be removed from the sale. If a purchaser knows that there is a large volume to be removed from the tract, good access is essential for removing the large amount of timber in a cost effective manner. Tracts with large harvest volumes will have more wear and tear on the road surface, thus tracts with good access will reduce the need for the purchaser to spend any capital on road construction. These two different results reinforce the theory that the impact of harvest size on price is a different, potentially independent factor than volume harvested.

The distance to haul road variable, which was insignificant in the acreage model, is insignificant at the .10 level in the less than 500 tons regression. However, in the greater than 500 tons regression, the haul road variable is significant at the .10 level. This variable may be important when the volume being harvested is greater than 500 tons, because there are a larger number of trips from harvesting site to haul road. Thus, the negative coefficient and elasticity implies that as distance to the haul road increases for sites with tons of harvested volume greater than 500 tons, price paid per ton decreases.

In the greater than 500 tons regression, the haul distance to primary mill variable is significant at the .10 level and has an elasticity of -0.16. This implies as the haul distance to the primary mill increases, the price paid for the tract decreases. These results are similar to those found in the acreage base model. In the acreage model, for tracts greater than 50 acres of harvested size, the haul distance to the primary mill variable has both a negative coefficient and negative elasticity. Thus, for this variable, the volume and acreage models behave similarly.

Finally, the variable for the percent of product delivered to primary mill variable is significant for both the base model and the greater than 500 tons regression. This sign and the significance implies that purchasers will pay more when a larger portion of the volume on the tract goes to their mill. Similar to the haul distance variable, the percent product delivered to primary variable behaves the same for the volume and acreage models.

Landowner absenteeism

Though there has been much discussion on the impact of landowner absenteeism on the forestry industry (Zipperer (1993), Fleury and Blinn (1996), Morgan and Martin (1995)), there has been little research on the impact of absenteeism on the selling price of timber. Our timber sale data collected included information concerning the residency of the landowner of the timber tract that was sold. The base model was run for the following groups: whether the landowner lived on the tract, resided within 50 miles of the tract, or resided farther than 50 miles from the tract. The fifty-mile limit was chosen based on other studies which have proposed this limit as the most useful definition of absenteeism. In this section we will both characterize how these limits affect price offers, and whether these limits result in significant differences in the price offered for a timber sale.

Of the sales examined, 45% had landowners who lived on the property while 35% had landowners who did not live directly on the harvested track but resided within 50 miles of the property. The remaining 20% of the landowners resided more than 50 miles from the harvested tract and were classified as absentee landowners. This 20% figure is slightly higher than the 16% absenteeism rate reported by Shaffer and Meade (1997) but is lower than the absenteeism rate of 32% recorded by Hodge and Birch (1996).

The results of the regressions by landowner residence group are given in Table 4.3. In this model, acres harvested was significant at the .05 level while it was insignificant for landowners living within 50 miles and landowners beyond 50 miles. Each significant variable had a negative coefficient. The negative coefficients are expected for the same reasons as negative signs found for the acres harvested variable in the acreage model discussed above.

The volume of hardwood sawtimber removed is significant at the .05 level for landowners not living within 50 miles. The positive coefficient, as already discussed, states that as the volume of hardwood sawtimber increases, the price paid per ton increases. The regression for landowners living within 50 miles was insignificant at the .10 level. However, the hardwood volume variable in the regression where landowners lived on the land was significant at the .10 level and had a negative coefficient.

Timber stands that have hardwood sawtimber on site are usually visually appealing to the landowner when they live on the site, and most likely a resident landowner has the opportunity to enjoy them more often. Also, when a timber sale is being marked and harvested, the resident landowner has the opportunity to have more control of the process. As expected, purchasers pay less for this situation than one where the landowner is either absentee or plays no role in the harvest plan.

For landowners residing greater than 50 miles away from the harvest site, a consulting forester is typically employed to conduct the sale. A consulting forester may generate a fee by receiving a percentage of the timber sale price. Consulting foresters did not seem important (or significant) in the price models, however. Access and primary purchasers being sawmills had effects consistent with the models discussed earlier.

The cost of road construction variable also had an impact similar to the tons of hardwood sawtimber removed variable. It is not significant at the .10 level in the base model while it is significant at the .05 level with a negative coefficient in the landowners living on the site model. The variable is insignificant at the .10 level in the landowners living within 50 miles model, while in the landowners not within 50 miles model the variable is significant at the .05 level with a positive coefficient. When a tract requires road construction costs and landowners live on the site, these residents might require additional road work to be performed to make the road either more visually appealing or suitable for long-term use (such as a landowner's driveway). Thus, it is not surprising that a purchaser would pay less for the stumpage (on a per ton basis) when facing road construction costs when the landowner is residing on the tract.

Although distance from harvest site to haul road variable is not significant in the base model, it is significant at the 0.05 level with a positive coefficient for landowners living on the site. However, the variable is insignificant at the 0.10 level for both the

Table 4.3 Absenteeism and stumpage price
Dependent variable is price per ton
* indicates significance at the .10 level or less
(*L*) indicates that the variable is represented in the log form

Independent variable	Landowners living on land (n=60)	Landowners within 50 miles (n=103)	Landowners not within 50 miles (n=25)
Estimated Acres (*L*) Harvested, (acres)	-3.77E-02 (0.77388)	-0.1702[12] (0.10781)*[13] -.1660[14]	-0.34461 (0.08578)* -.369
Estimated Hardwood (*L*) Sawtimber Removed, (tons)	-1.83E-01 (0.09741)* -.0445	0.0191 (0.81357)	0.40696 (0.00759)* .117
Primary Purchaser 1 = Hardwood Sawmill	2.1626 (0.00000)*	2.0441 (0.00000)*	2.95 (0.00011)*
Access 1 = Good or Excellent	3.1653 (0.00403)*	3.7150 (0.00000)*	3.8982 (0.02078)*
Road cost (*L*), (dollars)	-8.39E-02 (0.01020)* -.035	-0.0349 (0.17530)	0.16472 (0.00636)* .1325
BMP's Applied(*L*) 1 = Yes	0.15269 (0.34999)	0.1709 (0.24720)	0.47426 (0.12707)
Landowner Determined Harvest (*L*), 1 = Yes	0.21713 (0.22082)	-0.0462 (0.73575)	0.26135 (0.50134)
Distance to (*L*) Haul Road, (feet)	6.84E-02 (0.00535)* .0612	-0.0139 (0.51594)	0.0279 (0.64212)
Year Round Logging 1 = 12 months	0.1421 (0.37803)	0.1265 (0.25685)	0.86137 (0.06050)*
Distance to (*L*) Primary Mill, (miles)	-9.78E-02 (0.59249)	-0.0426 (0.48360)	-0.72378 (0.00216)* -.8789
Percent Delivered to Primary Mill (*L*) (% of total tons harv.)	1.2592 (0.00000)* .225	1.2072 (0.00000)* .175	0.90769 (0.00001)* .140
Population Density (*L*) (Pop./acreage of county)	8.59E-02 (0.39646)	8.28E-02 (0.33566)	0.16754 (0.29422

[12] Regression coefficient
[13] Significance probability
[14] Elasticity = percent change in dependent variable for a 1% change in an independent variable

landowners living within 50 miles, and for nonresident landowners not living within 50 miles variable. The reason that this variable is significant for landowners that live on the site may be that the landowner again has the opportunity to intervene in the location and thus the distance of the haul route for the harvested timber.

The dummy variable representing year round logging is insignificant at the 0.10 level in the base model, in the regressions when landowners lived on the site, and in the regression where landowners lived within 50 miles of the site. It is significant at the .05 level with a positive coefficient for when landowners lived greater than 50 miles from the site. The implication of this variable may be that purchasers will pay more for year round logging, but only when landowners are not likely to be able to inspect the harvesting operation on a continuing basis. Finally, the percent of volume harvested that is delivered to the primary mill was significant at the .05 level for each regression. The positive coefficient indicates, as stated in the acreage model, that as the percent of a product delivered to the primary mill of the purchaser increases, the purchaser pays more per ton on the unit.

Type of Harvest

The changing demographics of the NIPF landowner have caused a shift in the type of forest harvesting allowed on their forest lands. Marcin and Skogg (1984) state that the environmental awareness of these new landowners might limit the amount of clearcutting, road building, and other site intensive forestry operations. In Virginia, Hodge (1993) surveyed landowners and found that the most important reasons for owning forestland was for aesthetics, while commercial timber production ranked ninth out of twelfth. It is uncertain how the price paid for a timber sale is affected by the increased demand for select cuts. If the price paid for the timber decreases significantly for sales requiring select cuts, landowners may not be motivated to conduct a timber sale, which could impact timber availability.

A model was developed to study how the price paid for a timber sale changes with respect to the type of timber harvest prescribed for the sale (Table 4.4). Of the reported timber sales, over 52% were reported as clear cuts, 38% were reported as select cuts, and roughly 9% were thinnings. Select cuts were defined as any type of harvest in which a substantial portion of the timber basal area was left on the site primarily for aesthetic reasons. Unfortunately, the dummy variable indicating BMP application had to dropped from these regressions due to collinearity. The resulting specification includes the price paid per ton as the dependent variable with the following independent variables: acres harvested, volume of hardwood sawtimber removed, ease of access to the site, cost of road construction, landowner intervention in the harvest, distance to haul road, whether or not the site could support year round logging, type of purchasing agent, distance to the primary mill of the purchasing agent, percent of harvested volume delivered to the primary mill of the purchaser, and the population density of the county in which the sale occurred.

The sample was split into those landowners who agreed to a clearcut and those landowners who specified a selection cut. No testing was performed on sales that were identified as thinnings because of the limited number of thinnings reported in the sample. The acres harvested variable is significant at the 0.10 level with a negative coefficient in the base model, while it is not significant at the 0.10 level in the clearcuts-only model. For the select cuts-only model, it is significant at the .05 level. The elasticities for the base model and select cuts model are similar at -0.17 and -0.20, respectively. The negative coefficient indicates that purchasers pay less per ton for sites involving a select cut than they do for a clear cut. Intuitively, the select cut harvesting method requires the purchaser (and thus the harvesting crew) to be increasingly cautious when harvesting the timber to avoid damaging residual stems. This process is time intensive, and the associated cost appears to be passed onto the landowner in the form of a reduced price paid for their timber.

Access to the site was again significant for all models. All had similar coefficients of roughly 4.0. This variable demonstrates again that purchasers pay more for sites having good access regardless of type of harvest or the landowner type. The variable that measured whether the landowner had an involvement in the harvest is insignificant in the base model and the select cuts-only model. It is significant at the .05 level with a negative coefficient for the clear cut-only model. Finally, the primary purchaser variable is significant at the .05 level for the two harvest type groups.

The only remaining significant variable is the percent of product delivered to the primary mill, which is significant at the .05 level for the base model and both grouped models. Moreover, the base model, clear cuts only regression, and the select cuts regression all exhibited similar elasticities for this variable of 0.15, 0.14, and 0.17, respectively. Again, as more of the harvested timber is delivered to the primary mill of the purchaser, the purchaser pays more for the timber.

Table 4.4
Type of harvest and stumpage price

Dependent variable is price per ton
* indicates significance at the .10 level or less
(*L*) indicates that the variable is represented in the log form

Independent variable	Clearcut only (n=68)	Select cut only (n=48)
Estimated Acres Harvested (*L*), (acres)	-6.65E-02[15] (.69534)[16]	-0.25431 (.01529)* -.2009[17]
Estimated Hardwood (*L*) Sawtimber Removed (tons)	1.01E-01 (.28411)	6.08E-02 (.63242)
Primary Purchaser 1 = Hardwood Sawmill	1.2784 (0.00009)*	1.3889 (0.00000)*
Access 1 = Good or Excellent	4.5819 (0.00000)*	4.2951 (0.00000)*
Road Cost (*L*), (dollars)	-1.43E-02 (.60879)	-5.35E-03 (.89184)
Landowner Determined Harvest, 1 = Yes	-4.65E-01 (.04676)*	7.58E-03 (.97054)
Distance to Haul Road (*L*), (feet)	-1.96E-02 (.40496)	3.17E-02 (.36268)
Year Round Logging 1 = 12 months	3.87E-02 (.81638)	2.73E-02 (.87262)
Distance to Primary Mill (*L*), (miles)	-7.32E-02 (.29285)	5.23E-02 (.66979)
Percent Delivered to Primary Mill (*L*) (% of total tons harv.)	0.89549 (0.00000)* .142	1.1704 (0.00000)* .1710
Population Density (*L*), (Pop./acreage of county)	-9.08E-02 (0.34848)	9.83E-02 (0.38557)

[15] Regression coefficient
[16] Significance probability
[17] Elasticity = percent change in dependent variable for a 1% change in an independent variable

Chapter 5.
Results of the bids equation model

When timber is sold in a sealed bid sale, the number of bids received often depends on the mix of species and products on the tract. The competitiveness of the timber sale can be implied by the number of sealed bids received for a sale. This is the equation given in (2). Estimation of this equation should incorporate both landowner and site characteristics. The site characteristics incorporated included: acres harvested, tons of hardwood sawtimber removed, ease of access to the tract, cost of road construction, application of BMPs, the landowner's role in determining the harvest type, distance to haul road, capability of year round logging, and population density of the county in which the timber sale occurred. In our sample, out of the 138 timber sales collected 60 sales reported the number of bids for each sale. The median number of bids received for each sale was equal to four per sale. The model to predict the number of bids was constructed in a similar manner to the previous price hedonic model (eqn 1).[18]

Table 5.1 reports the results of the estimated bids model. Unfortunately, only acres harvested was a significant predictor of bids, and was positive and significant at the .05 level. None of the other variables in the base model were significant at the .10 level. However, estimating models using grouped data (based on acres harvested, tons harvested, absenteeism, and type of harvest) resulted in variables becoming significant at both the .05 and .10 level.

[18] Similar to the price model, a complete set of seller characteristics were unavailable to include in the model. This prevents some endogeneity problems, if the error in the number of bids is correlated with characteristics of the purchaser. However, given that we can include in the model some characteristics of the sale that the purchaser has some control over (such as BMPs, time of year to log, and type of harvest), we expect that this bias is minimal.

Table 5.1
Number of bids regression

Dependent variable is the number of bids received
* indicates a significance of .10 or less
(*L*) indicates that the variable is represented in the log form

Independent variable	Coefficient (n=60)
Estimated Acres Harvested (*L*), (acres)	0.21029[191] (.02798)*[20] .6089[321]
Estimated Hardwood Sawtimber Removed (*L*), (tons)	8.46E-02 (.11513)
Access 1 = Good or Excellent	0.1329 (.82890)
Road cost (*L*), (dollars)	-4.96E-03 (.84078)
BMP's Applied 1 = Yes	2.67E-02 (.85618)
Landowner Determined Harvest, 1 = Yes	-4.83E-02 (.70673)
Distance to Haul Road (*L*), (feet)	-1.77E-01 (.44688)
Year Round Logging 1 = 12 month harvest	1.14E-01 (.37931)
Population Density (*L*) (Pop./acreage of county)	0.08455 (.49775)

[19] Regression Coefficient

[20] Significance probability
[21] Elasticity = percent change in dependent variable for a 1% change in an independent variable

Chapter 6.
Extensions and hypothesis tests of the bids model

Similar to the price specification, we also conducted several extensions using the model for bids. These included investigating the effects of splitting the sample according to acreage, volume harvested from the site and type of harvest. Acreage and volume harvested provides some additional evidence on the importance of tract size, which is related to fragmentation, while harvest type is correlated with landowner type. Tables 6.1-6.3 present the results from all of these regressions.

Tract Size

The bids model that considered only sales with less than 50 acres resulted in five significant variables at both the .10 and .05 levels (Table 6.1). Smaller tracts could not be considered separately, because the limited number of sales prevented using groups based on smaller sales. The positive coefficient for acres harvested shows that as the size of acres harvested rose between this grouping of sales, the number of bids reported rose. The coefficient on this variable is significant for smaller tracts, but is not significant for larger tracts (over 50 acres). Also, the elasticity of this variable in this model is 1.59 compared to .6089 in the base model. This indicates that the competitiveness of the sale increases as acreage size increases, at least up to the point at which smaller mills are unable to bid on larger tracts, as discussed earlier. The larger coefficient of the elasticity for this variable in the less than 50 acre model (1.59) compared to the elasticity of this variable in the base model (.6089) shows that acreage has a significant impact on

Table 6.1

Tract acreage and number of bids received

Dependent variable is the number of bids received
* indicates significance at the .10 level or less
(*L*) indicates that the variable is represented in the log form

Independent variable	Tract size less than 50 acres (n = 67)	Tract size greater than 50 acres (n = 26)
Estimated Acres Harvested, (acres) (*L*)	0.59677[22] (.00099)*[23] 1.59[24]	-0.13572 (.68353)
Estimated Hardwood (*L*) Sawtimber Removed, (tons)	9.70E-02 (.04065)* .081	-8.91E-03 (.93495)
Access 1 = Good or Excellent	-0.33125 (.59198)	1.9502 (.23471)
Road cost (*L*), (dollars)	4.14E-02 (.14980)	6.41E-03 (.81968)
BMP's Applied 1 = Yes	-0.54891 (.00073)*	0.36551 (.13641)
Landowner Determined Harvest, 1 = Yes	-3.47E-01 (.03020)*	5.50E-03 (.97790)
Distance to (*L*) Haul Road, (feet)	-9.60E-02 (.000253)* -.2733	1.03E-02 (.76620)
Year Round Logging 1 = 12 month harvest	0.17659 (.14298)	7.96E-02 (.63671)
Population Density (*L*) (Pop./ acreage of county)	0.01157 (.90846)	-4.05E-02 (.79959)

22 Regression coefficient
23 Significance probability
24 Elasticity = percent change in dependent variable for a 1% change in an independent variable

the number bids received once the tract size becomes smaller than 50 acres. However, once the tract is larger than 50 acres, the results suggest that acreage size is not longer important in predicting the competitiveness of the timber sale.

The volume of hardwood sawtimber removed is significant at the .05 level in the less than 50 acre grouping, while it is insignificant at the .10 level in both the base model and greater than 50 harvested acres model. The elasticity of this variable, .081, is not as high as the elasticity of the acres harvested variable (1.59) indicating that tract size has more influence than the volume of hardwood sawtimber, for the smaller tracts. As suggested by the sign of the harvest size variable, the volume of hardwood sawtimber in small tracts influences the number of bids received for a sale. However the smaller elasticity of this variable compared to the acres harvested variable in the same data grouping again shows that acreage is more important than the volume of hardwood sawtimber on the site in determining the number of bids received for a sale. Tracts with larger acreages often have more products on them, which attract more bidders. However, small sites that lack any hardwood sawtimber could receive fewer bids and a potentially lower price, as expected.

The negative coefficient and significance (.05 level) of distance haul road in the less than 50 acres group shows that distance to the haul road negatively effects the number of bids received for a sale. This variable is insignificant at the .10 level for the base model and the greater than 50 harvested acres group. The implication of this variable is that for smaller tracts that have long distances to haul roads such as tracts in more remote locations, fewer bids will be received for a sale. Longer haul distances might also be an indication of fragmented areas, which may offer fewer opportunities to gain access to a site.

The variable that identified if the landowner participated in determining the type of harvest was significant at the .05 level for the smaller tracts. The negative coefficient suggests the number of bids decreases when the landowner controls the method of harvest. Perhaps purchasers view landowner intervention as a constraint on the type of harvest, or an additional "cost" associated with the sale. The variable indicating whether BMPs needed to be applied to the site is significant at the .05 level for the less than 50 acres group. The negative coefficient suggests that the number of bids decreases when extensive BMPs are required for harvesting the site. Sales requiring BMPs are clearly an additional cost involved with harvesting, and perhaps only bid on by those who are facing mill constraints for procurement.

Volume Harvested

As seen in the price equation model, there may not be a linear relationship between the acreage harvested and the volume harvested from the tract. Models were estimated that examined how the number of bids submitted for a sale changes when the harvested volume is modified (Table 6.2). As performed in the price equation model, the models isolated sales that had harvested timber volumes less than or equal to 500 tons or greater than 500 tons.

In the regression using only tracts with less than 500 tons, the acres harvested variable was significant at the .05 level with a positive coefficient and an elasticity of 2.55 while this variable was insignificant in the greater than 500 tons regression. Thus the number of bids received for a sale actually increases on tracts with smaller volumes.

Although this model did not allow for the incorporation of the type of bidder (either agent of a sawmill or industrial firm), it does show that more bidders are attracted to tracts with smaller volumes, possibly due to the lower overall cost of the sale. Thus, smaller tracts that carry smaller harvested volumes could actually increase competition and result in a price premium for landowners.

The volume of hardwood sawtimber is not significant is the less than 500 tons grouping while it is significant at the .10 level in the greater than 500 tons grouping with a positive coefficient. This follows the same trend as in the acreage grouping models, where the greater than 50 acre regression showed that the volume of hardwood sawtimber increased the number of bids received for a sale. The .077 elasticity for the greater than 500 tons regression almost matches the .081 elasticity of the greater than 50 acres regression. Thus the volume of hardwood sawtimber in the larger tract size, larger volumes is not as important as the overall harvested acreage of the tract.

Two site characteristic variables were significant at either the .10 level (access to the site) or the .05 level (distance to haul road and year round logging) in the less than 500 tons grouping. These variables were not significant in the greater than 500 tons grouping. The distance to haul road variable had a negative coefficient implying that as distance to the haul road increased, the number of bids offered for the sale declined. Sites that supported year round logging increased the number of bids, as demonstrated by the positive coefficient of this variable. Tracts that have long haul distances make the tract

Table 6.2
Effect of total harvested volume on the number of bids received

Dependent variable is the number of bids received
* indicates significance at the .10 level or less
(*L*) indicates that the variable is represented in the log form

Independent variable	Tracts with less than 500 tons (n=13)	Tracts with greater than 500 tons (n=47)
Estimated Acres (*L*) Harvested, (acres)	0.951[25] (.00305)*[26] 2.55[27]	2.53E-02 (.80689)
Estimated Hardwood (*L*) Sawtimber Removed, (tons)	1.51E-01 (.16944)	9.56E-02 (.09922)* .077215
Access 1 = Good or Excellent	-1.6115 (.06994)*	1.1431 (.16969)
Road Cost (*L*), (dollars)	1.47E-02 (.58257)	-2.51E-02 (.31078)
BMP's Applied 1 = Yes	1.41E-01 (.55597)	8.74E-02 (.59967)
Landowner Determined Harvest 1 = Yes	1.49E-01 (.32875)	-4.59E-02 (.75188)
Distance to Haul Road (*L*), (feet)	-1.11E-01 (.04080)* -.378	-1.01E-01 (.66069)
Year Round Logging 1 = 12 month harvest	5.35E-01 (.04183)*	3.94E-02 (.81055)
Population Density (*L*) (Pop./ acreage of county)	-0.13033 (.42467)	2.18E-02 (.87289)

[25] Regression coefficient
[26] Significance probability
[27] Elasticity = percent change in dependent variable for a 1% change in an independent variable

less attractive to some purchasers by the increased costs associated with the longer distance. On the other hand, tracts that are capable of being harvested year round are attractive to more buyers due to the increased flexibility of being able to harvest the site year round. Thus the number of bidders increases.

Type of Harvest

If landowner preferences shift away from clearcutting to selection cutting, then the bidding behavior of forest industry could change. Thus, we grouped the data according to harvest type. In particular, the data was split according to whether the landowner indicated a preference for clearcutting versus various forms of selection harvesting (Table 6.3). In the group involving clearcutting only, none of the variables were significant at the .10 level, while in the selection cutting group, only two variables, acres harvested and volume of hardwood sawtimber, were significant at the .10 level or below in the select cut model.

The acres harvested variable was significant at the .05 level in the select cut group; recall that this variable is significant at the same level in the base model with both having a positive coefficient. Clearly, the number of bids received in a timber sale is affected by the size of the harvested area for select cut sales only. The larger the harvested area of the select cut harvest sale, the higher the number of bids received. Smaller, select cut harvests, receive less bids and a potentially lower price for their timber due to the lack of competitiveness. On the other hand, size of the harvested tract has no impact on the number of bids received when the type of harvest is a clear cut.

Table 6.3
Type of harvest and the number of bids received

Dependent variable is the number of bids received
* indicates significance at the .10 level or less
(*L*) indicates that the variable is represented in the log form

Independent variable	Clearcut only (n=30)	Select cut only (n=100)
Estimated Acres Harvested (*L*), (acres)	8.52E-02[28] (.59739)[29]	0.47991 (.00045)* 1.36[30]
Estimated Hardwood (*L*) Sawtimber Removed, (tons)	4.62E-02 (.50864)	0.24137 (.09421)* .214
Access 1 = Good or Excellent	0.3454 (.73553)	-0.1718 (.84759)
Road Cost (*L*), (dollars)	-3.70E-02 (.12946)	3.97E-02 (.31621)
BMP's Applied 1 = Yes	1.35E-01 (.49971)	-0.35502 (.15416)
Landowner Determined Harvest, 1 = Yes	-3.36E-01 (.37895)	-8.61E-02 (.64498)
Distance to Haul Road (*L*), (feet)	-2.61E-04 (.99304)	-3.88E-02 (.36399)
Year Round Logging 1 = 12 month harvest	0.30763 (.16971)	-7.13E-02 (.73272)
Population Density (L) (Pop./ acreage of county)	0.11693 (.42972)	-6.23E-02 (.68471)

[28] Coefficient
[29] Significance probability
[30] Elasticity = percent change in dependent variable for a 1% change in an independent variable

The elasticity of the acres harvested variable is .6089 in the base model and 1.36 in the select cut regression group. The larger elasticity of the select cut regression suggests that the number of bids received in a select cut harvest is very sensitive to size of the harvested area. However, for clearcutting, where the logger can harvest increased volume, size of harvested area was less important, especially after the 50 acre threshold size was reached, as our earlier results demonstrated.

The other significant variable in the select cuts regression is the volume of hardwood sawtimber to be harvested, but it is only significant at the .10 level. The positive coefficient of this variable implies that for tracts being harvested with select cuts, the more the volume of hardwood sawtimber harvested results in an increased number of bids received for the sale. Again, this variable was insignificant at the .10 level for the clear cut regression, indicating that the volume of hardwood sawtimber does not have as large an influence in bidding when the harvest method is a clear cut.

Chapter 7.
Summary and Conclusions

The previous analysis allows for a summarization of which site and landowner characteristics influence both the selling price of timber and the overall competitiveness of timber sales when contrasted with the impacts of forest fragmentation.

From the variables included in our study, access is the most important predictor of price offers for timber sales. Our results establish that access to harvestable timber is the most important predictor of both the rents a firm will capture from a sale and the likelihood they will bid on the sale. Sites that are amenable to allowing a harvesting crew access the site increase the price paid by the purchaser. This suggests that to fully characterize the impacts of fragmentation on forest supply availability, future work should attempt to identify both how access to harvestable timber changes as a result of parcelization of timber and land, and to what extent access impacts the costs of harvesting.

Acreage size is less important in determining bid prices for timber once the total volume harvested reaches a level of 500 tons, or when there is mature hardwood on the site and the acreage is greater than 50 acres. This result is dependent on having a large proportion of bidders in an area consist of smaller capacity sawmills, which would be the case in fragmented areas where rents to timber processors may be lower due to the increased competition. The results demonstrate the willingness of the sawmill firms to bid on tracts with smaller volumes. This is consistent with the smaller mill capacity and less available capital possessed by these firms relative to the larger paper mills

Competition for tracts may cause unexpected effects of tract size on bid prices for timber sales. Our finding concerning sawmill-based bidding for smaller tracts has important consequences for the pattern of competition in the forest sector. Surprisingly most of the competition for timber sales on smaller tracts or those in fragmented areas are primarily due to smaller sawmill operators. The implication for this concern is the definition of areas identified as the "economic margin" for timber sale activity. With increased fragmentation, there could be a development of two margins where competition is most intense. Previously, the margin has been identified as procurement areas furthest from the population centers, since profits in these areas are low and favor those firms with smaller cost and capital commitments.

There is supporting evidence concerning the numbers of bids received in sealed bids sales for small tracts nearest to population centers. A proportionally higher number of small sawmill agents bid for timber closer to population centers. Perhaps the larger procurement operators (i.e. industrial firms) forego the smaller close-in tracts for the lower harvesting costs afforded from larger tracts away from population centers. The rents may be higher for these tracts if access is difficult and the larger procurement operations may have more resources with which to search for more accessible larger tracts that may be further away.

A trend identified by Conway (1998) showed that as absentee ownership increases, the likelihood that landowners prefer a selection type of harvest instead of clearcutting increases. Selection cutting increases logging costs and results in bid prices per ton of timber harvested that are decreasing functions of tract size. This effect concerning tract size occurs only for those sales where the landowners specify that clearcutting cannot be conducted. Thus, as absentee ownership increases in fragmented areas, it is not certain that bid prices for timber sales will increase. They will increase only if the effect of harvesting type is dominated by the increased competition among sawmills in those areas to supply wood to their mills. The ultimate effect of harvesting preference and tract size depends on the trends in competition for timber sales. Moreover, the impacts of fragmentation on the timber markets are uncertain, despite that forest industry might experience decreased profits.

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Appendix

Limdep Estimation Results for Table 3.1

º LIMDEP Estimation Results Run log line 52 Page 1 º
º Sample was reset: REJECT RPOPD=1$ º
º Sample was reset: REJECT PT=-999$ º
º Current sample contains 129 observations. º
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º Ordinary least squares regression Weighting variable = ONE º
º Dependent variable is LPT Mean = 3.95751, S.D. = 1.3795 º
º Model size: Observations = 48, Parameters = 12, Deg.Fr. = 36 º
º Residuals: Sum of squares= 26.0598 Std.Dev. = 0.85081 º
º Fit: R-squared = 0.70865, Adjusted R-squared = 0.61962 º
º Model test: F[11, 36] = 7.96, Prob value = 0.00000 º
º Diagnostic: Log-L = -53.4497, Restricted(á=0) Log-L = -83.0469 º
º Amemiya Pr. Crt.= 0.905, Akaike Info. Crt.= 2.727 º
º Autocorrel: Durbin-Watson Statistic = 1.24083, Rho = 0.37959 º
º Results Corrected for heteroskedasticity º
º Breusch - Pagan chi-squared = 22.8984, with 11 degrees of freedom º
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Variable	Coefficient	Standard Error	t-ratio	P[³T³òt]	Mean of X
LHACRES	-0.19618	0.16962	-1.212	0.03921	3.758
PPURCH	2.1347	0.28443	5.682	0.00000	0.6042
LHSA	0.50760	0.12772	0.985	0.33122	0.8675
NACC1	4.0336	1.0154	1.702	0.00000	1.000
LROADC	-0.936E-02	0.34403E-01	-1.302	0.71574	3.174
BMP	.31732	0.27593	-0.067	0.04335	0.7500
LHARV	0.424E-1	0.26336	-1.988	0.74792	0.7292
LDIST	-1.70E-2	0.37499E-01	-2.319	0.93194	3.426

WETD	0.15288	0.20289	0.121	0.32316	0.7500
LPDIST	-.17012	0.93912E-01	0.058	0.05994	3.871
LPPROD	1.0659	0.22303	2.782	0.0000	-0.4705
LPOPD	2.48E-02	0.26645	3.580	0.76464	3.150

LIMDEP Estimation Results for Table 4.1

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º  LIMDEP Estimation Results                    Run log line   52  Page   1 º
º  Sample was reset:  REJECT   PT=-999$                                º
º  Sample was reset:  REJECT   DHACRES=0$                                º
º  Current sample contains     26 observations.                        º
ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼
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º Ordinary    least squares regression    Weighting variable = ONE      º
º Dependent variable is LPT       Mean =    3.60989, S.D. =      1.2989 º
º Model size: Observations =     101, Parameters =  12, Deg.Fr. =    89 º
º Residuals:  Sum of squares=    47.5615     Std.Dev. =         0.73103 º
º Fit:        R-squared = 0.71810, Adjusted R-squared =         0.68326 º
º Model test: F[ 11,     89] =   20.61,    Prob value =         0.00000 º
º Diagnostic: Log-L =   -105.2814, Restricted(á=0) Log-L =    -169.2243 º
º             Amemiya Pr. Crt.=    0.598, Akaike Info. Crt.=      2.322 º
º Autocorrel: Durbin-Watson Statistic =   1.26078,   Rho =      0.36961 º
º Results Corrected for heteroskedasticity                              º
º Breusch - Pagan chi-squared =    39.4387, with  11 degrees of freedom º
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Variable	Coefficient	Standard Error	t-ratio	P[³T³òt]	Mean of X
LHACRES	-.30954	0.15636	0.538	0.38098	4.193
PPURCH	1.6732	0.22079	10.463	0.01113	0.6238
LHSA	4.49E-01	0.76506E-01	-0.009	0.03806	0.8259
NACC1	3.4993	0.65920	3.866	0.1094	1.000
LROADC	.423E-02	0.27034E-01	-0.262	0.95323	3.635
BMP	0.64502	0.14021	1.392	0.06396	0.7723
LHARV	0.34305	0.14490	0.277	0.34976	0.6139
LDIST	-0.625E-01	0.22047E-01	-0.480	0.44619	3.556

WETD	1.7642	0.12966	-0.136	0.01175	0.7723
LPDIST	-0.50909	0.66646E-01	-1.496	0.20452	4.059
LPPROD	.90625	0.11364	9.978	0.00097	-0.6448
LPOPD	0.2.18E-01	0.91196E-01	0.868	0.58733	3.867

LIMDEP Estimation Results for Table 4.1

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º  LIMDEP Estimation Results                    Run log line   52  Page   1 º
º  Sample was reset:  REJECT   PT=-999$                              º
º  Sample was reset:  REJECT   DHACRES=0$                                º
º  Current sample contains      67 observations.                     º
Èííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííí¼
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º Ordinary    least squares regression    Weighting variable = ONE      º
º Dependent variable is LPT       Mean =    4.14861, S.D. =      1.4556 º
º Model size: Observations =      67, Parameters =  12, Deg.Fr. =    55 º
º Residuals:  Sum of squares=    39.0248     Std.Dev. =        0.84234 º
º Fit:        R-squared = 0.72092, Adjusted R-squared =        0.66510 º
º Model test: F[ 11,     55] =   12.92,    Prob value =        0.00000 º
º Diagnostic: Log-L =    -76.9623, Restricted(á=0) Log-L =    -119.7165 º
º             Amemiya Pr. Crt.=    0.837, Akaike Info. Crt.=      2.656 º
º Autocorrel: Durbin-Watson Statistic =   1.84681,   Rho =      0.07659 º
º Results Corrected for heteroskedasticity                         º
º Breusch - Pagan chi-squared =    10.8544, with  11 degrees of freedom º
Èííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííí¼
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Variable	Coefficient	Standard Error	t-ratio	P[³T³òt]	Mean of X
LHACRES	-0.51971	0.19242	-2.701	0.00917	3.197
PPURCH	1.6216	0.35740	4.537	0.00003	0.7015
LHSA	0.91590E-02	0.87487E-01	0.105	0.91700	0.8404
NACC1	5.9409	1.2792	4.644	0.00002	1.000
LROADC	-0.49543E-01	0.35652E-01	-1.390	0.17024	2.180
BMP	0.34225	0.22269	1.537	0.13006	0.6716
LHARV	-0.21038	0.21921	-0.960	0.34140	0.5672
LDIST	0.23118E-02	0.27501E-01	0.084	0.93331	3.844

WETD	0.22680	0.23320	0.973	0.33503	0.8060
LPDIST	-0.24879	0.16068	-1.548	0.12728	4.066
LPPROD	0.98767	0.15215	6.491	0.00000	-0.4809
LPOPD	0.43110E-02	0.14751	0.029	0.97679	3.763

LIMDEP Estimation Results for Table 4.1

º LIMDEP Estimation Results Run log line 52 Page 1 º
º Sample was reset: REJECT PT=-999$ º
º Sample was reset: REJECT DHACRES=0$ º
º Current sample contains 61 observations. º
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site characteristics

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º Ordinary least squares regression Weighting variable = ONE º
º Dependent variable is LPT Mean = 3.58528, S.D. = 1.2744 º
º Model size: Observations = 62, Parameters = 12, Deg.Fr. = 50 º
º Residuals: Sum of squares= 23.7940 Std.Dev. = 0.68984 º
º Fit: R-squared = 0.75984, Adjusted R-squared = 0.70700 º
º Model test: F[11, 50] = 14.38, Prob value = 0.00000 º
º Diagnostic: Log-L = -58.2855, Restricted(á=0) Log-L = -102.5050 º
º Amemiya Pr. Crt.= 0.568, Akaike Info. Crt.= 2.267 º
º Autocorrel: Durbin-Watson Statistic = 1.67986, Rho = 0.16007 º
º Results Corrected for heteroskedasticity º
º Breusch - Pagan chi-squared = 26.2736, with 11 degrees of freedom º
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Variable	Coefficient	Standard Error	t-ratio	P[³T³òt]	Mean of X
LHACRES	.27409	0.27637	0.992	0.32610	4.559
PPURCH	2.4603	0.24071	10.221	0.00000	0.6290
LHSA	2.79E-1	0.14726	1.900	0.06321	0.8817
NACC1	1.2578	1.3879	0.906	0.36914	1.000
LROADC	0.74688E-01	0.36148E-01	2.066	0.04401	3.903
BMP	0.11546	0.16103	1.107	0.47377	0.7742
LHARV	0.17824	0.17031	1.398	0.27366	0.6613
LDIST	-0.23854E-01	0.27739E-01	-0.878	0.16827	3.404
WETD	0.18725	0.16943	1.105	0.03655	

0.7903

LPDIST	.93731	0.89306E-01	-2.148	0.000000	4.086
LPOPD	0.15562E-01	0.91383E-01	0.170	0.86547	3.905

LIMDEP Estimation Results for Table 4.2

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º LIMDEP Estimation Results Run log line 54 Page 1 º
º Sample was reset: REJECT PT=-999$ º
º Sample was reset: REJECT NTOTALT=0$ º
º Current sample contains 32 observations. º
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site characteristics

ÉÍÍÍ»
º Ordinary least squares regression Weighting variable = ONE º
º Dependent variable is LPT Mean = 5.44062, S.D. = 0.9105 º
º Model size: Observations = 32, Parameters = 11, Deg.Fr. = 21 º
º Residuals: Sum of squares= 9.49704 Std.Dev. = 0.67249 º
º Fit: R-squared = 0.63048, Adjusted R-squared = 0.45451 º
º Model test: F[10, 21] = 3.58, Prob value = 0.00660 º
º Diagnostic: Log-L = -25.9699, Restricted(á=0) Log-L = -41.8985 º
º Amemiya Pr. Crt.= 0.608, Akaike Info. Crt.= 2.311 º
º Autocorrel: Durbin-Watson Statistic = 2.15952, Rho = -0.07976 º
º Results Corrected for heteroskedasticity º
º Breusch - Pagan chi-squared = 13.2113, with 10 degrees of freedom º
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Variable	Coefficient	Standard Error	t-ratio	P[³T³òt]	Mean of X
LHACRES	-0.10943	0.16707	-0.655	0.51956	2.890
PPURCH	3.6405	0.44634	8.156	0.00000	0.9688
NACC1	0.97826	1.2167	0.804	0.43039	1.000
LROADC	0.10098E-01	0.29686E-01	0.340	0.73711	0.8761
BMP	0.54443	0.29093	1.871	0.07530	0.5313
LHARV	0.19821	0.21820	0.908	0.37398	0.4688
LDIST	0.67436E-01	0.55570E-01	1.214	0.23840	4.778
WETD	0.66802	0.31464	2.123		

0.04580 0.8125
LPDIST 0.31312E-01 0.22452 0.139
0.89042 3.973
LPPROD 0.52682 0.36446 1.445
0.16309 -0.1720
LPOPD -0.99801E-02 0.19044 -0.052
0.95870 3.797

LIMDEP Estimation Results for Table 4.2

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º  LIMDEP Estimation Results                    Run log line   54  Page   1 º
º  Sample was reset:  REJECT   PT=-999$                          º
º  Sample was reset:  REJECT   NTOTALT=0$                              º
º  Current sample contains      96 observations.                       º
ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼
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site characteristics

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º Ordinary    least squares regression    Weighting variable = ONE      º
º Dependent variable is LPT       Mean =    3.37279, S.D. =      1.1167 º
º Model size: Observations =      96, Parameters =  11, Deg.Fr. =    85 º
º Residuals:  Sum of squares=    48.1504     Std.Dev. =        0.75265 º
º Fit:        R-squared = 0.59356, Adjusted R-squared =        0.54574 º
º Model test: F[ 10,     85] =   12.41,    Prob value =        0.00000 º
º Diagnostic: Log-L =   -103.0972, Restricted(á=0) Log-L =    -146.3126 º
º             Amemiya Pr. Crt.=    0.631, Akaike Info. Crt.=      2.377 º
º Autocorrel: Durbin-Watson Statistic =   1.38145,   Rho =      0.30927 º
º Results Corrected for heteroskedasticity                          º
º Breusch - Pagan chi-squared =    19.3483, with  10 degrees of freedom º
ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼
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Variable	Coefficient	Standard Error	t-ratio	P[³T³òt]	Mean of X
LHACRES	0.11608	0.15854	0.732	0.46605	4.168
PPURCH	1.8726	0.24616	7.607	0.00000	0.5729
NACC1	3.2035	0.71524	4.479	0.00002	1.000
LROADC	-0.23689E-02	0.27054E-01	-0.088	0.93043	3.676
BMP	0.27084	0.15805	1.714	0.09023	0.7813
LHARV	-0.57883E-02	0.14510	-0.040	0.96827	0.6563
LDIST	-0.40580E-01	0.22160E-01	-1.831	0.07057	3.233
WETD	-0.24218E-01	0.15591	-0.155		

0.87693 0.7917
LPDIST -0.15403 0.73871E-01 -2.085
0.04006 4.117
LPPROD 0.82125 0.13784 5.958
0.00000 -0.7084
LPOPD -0.57658E-01 0.10049 -0.574
0.56764 3.818

LIMDEP Estimation Results for Table 4.3
º LIMDEP Estimation Results   Run log line   55 Page   1 º
º Sample was reset: REJECT   HTYPE=1$ º
º Sample was reset: REJECT   HTYPE=3$ º
º Current sample contains   60 observations.   º
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site characteristics

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º Ordinary   least squares regression   Weighting variable = ONE   º
º Dependent variable is LPT   Mean =   4.69947, S.D. =   1.2434 º
º Model size: Observations =   48, Parameters = 11, Deg.Fr. =   37 º
º Residuals: Sum of squares=   13.5712   Std.Dev. =   0.60563 º
º Fit: R-squared = 0.81324, Adjusted R-squared =   0.76276 º
º Model test: F[10,   37] =   16.11,   Prob value =   0.00000 º
º Diagnostic: Log-L =   -37.7910, Restricted(á=0) Log-L =   -78.0613 º
º   Amemiya Pr. Crt.=   0.451, Akaike Info. Crt.=   2.033 º
º Autocorrel: Durbin-Watson Statistic =   2.34517,   Rho =   -0.17259 º
º Results Corrected for heteroskedasticity   º
º Breusch - Pagan chi-squared =   18.6123, with 10 degrees of freedom º
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Variable   Coefficient   Standard Error   t-ratio   P[³T³òt]
Mean of X

LHACRES   -3.77E-2   0.99974E-01   -2.544   0.77388
3.714
PPURCH   2.1626   0.20136   6.897
0.00000   0.9583
BMP   0.15269   0.15805   1.714
0.34999   0.7813
LHSA   -1.83E-01   0.12617   0.482
0.09741   1.260
NACC1   3.1653   0.76297   5.629
0.00403   1.000
LROADC   -8.39E-02   0.39102E-01   -0.137
0.01020   1.536
LHARV   0.21713   0.20405   0.037
0.22082   0.6875
LDIST   6.84E-2   0.34497E-01   0.922

0.00535	4.237		
WETD	0.1421	0.16961	0.161
0.37803	0.7917		
LPDIST	-.978E-2	0.12186	0.430
0.59249	4.012		
LPPROD	1.2592	0.11134	10.512
0.00000	-0.6872		
LPOPD	8.59E-02	0.11196	0.878
0.39646	3.886		

LIMDEP Estimation Results for Table 4.3

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º  LIMDEP Estimation Results                    Run log line   53  Page   1 º
º  Sample was reset:  REJECT   PT=-999$                          º
º  Sample was reset:  REJECT   ABSET=0$                            º
º  Current sample contains     103 observations.                 º
Èíííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííí¼
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site characteristics

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º Ordinary    least squares regression    Weighting variable = ONE      º
º Dependent variable is LPT       Mean =    3.95314, S.D. =      1.3658 º
º Model size: Observations =     103, Parameters =  15, Deg.Fr. =    88 º
º Residuals:  Sum of squares=    45.5296     Std.Dev. =        0.71929 º
º Fit:        R-squared = 0.76070, Adjusted R-squared =        0.72263 º
º Model test: F[ 14,     88] =   19.98,    Prob value =        0.00000 º
º Diagnostic: Log-L =   -104.1078, Restricted(á=0) Log-L =    -177.7556 º
º             Amemiya Pr. Crt.=    0.593, Akaike Info. Crt.=      2.313 º
º Autocorrel: Durbin-Watson Statistic =   1.64756,   Rho =      0.17622 º
º Results Corrected for heteroskedasticity                          º
º Breusch - Pagan chi-squared =    25.8006, with  14 degrees of freedom º
Èííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííííí¼
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Variable	Coefficient	Standard Error	t-ratio	P[³T³òt]	Mean of X
LHACRES	-0.1702	0.10245	-1.129	0.10781	3.857
LTHS	0.0191	0.37080E-01	-0.201	0.81357	3.172
PPURCH	2.0441	0.30110	5.674	0.00000	0.6796
LPOPD	8.59E-2	0.25441E-01	2.416	0.33566	3.962
NACC1	3.7150	0.49087	8.670	0.00000	1.000
LROADC	-0.0349	0.22837E-01	-1.202	0.17530	3.043
BMP	0.1709	0.15640	0.541	0.24720	0.7282
LHARV	-0.0462	0.14647	-0.493		

0.73575 0.6214
LDIST -0.0139 0.20430E-01 -0.333
0.51594 3.584
WETD 0.1265 0.15165 0.785
0.25685 0.7864
LPDIST -0.0426 0.68285E-01 -0.040
0.48360 4.010
LPPROD 1.2072 0.10694 10.780
0.00000 -0.5731

LIMDEP Estimation Results for Table 4.3

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º  LIMDEP Estimation Results                    Run log line   54  Page
1 º
º  Sample was reset:  REJECT   PT=-999$                              º
º  Sample was reset:  REJECT   DHACRES=0$
º
º  Current sample contains      25 observations.                   º
ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼


 site characteristics

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»
º Ordinary    least squares regression    Weighting variable = ONE
º
º Dependent variable is LPT       Mean =    3.50635, S.D. =      1.3148
º
º Model size: Observations =      91, Parameters =  17, Deg.Fr. =    74
º
º Residuals:  Sum of squares=    44.2111     Std.Dev. =        0.77295
º
º Fit:        R-squared = 0.71585, Adjusted R-squared =        0.65441 º
º Model test: F[ 16,     74] =   11.65,    Prob value =        0.00000 º
º Diagnostic: Log-L =    -96.2777, Restricted(á=0) Log-L =    -
153.5281 º
º           Amemiya Pr. Crt.=    0.709, Akaike Info. Crt.=      2.490 º
º Autocorrel: Durbin-Watson Statistic =   1.81278,   Rho =      0.09361
º
º Results Corrected for heteroskedasticity                       º
º Breusch - Pagan chi-squared =    71.1450, with  16 degrees of
freedom º
ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
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  Variable       Coefficient      Standard Error              t-ratio
P[³T³òt]        Mean of X

  LHACRES      -.34461          0.18463                    1.179
0.08578         4.289
  LTHS           .40696          0.41509E-01                0.388
0.00759         2.834
```

PPURCH	2.95	0.34790	4.724	0.00001	0.6044
NACC1	3.892	0.83226	3.548	0.02078	1.000
LROADC	.16472	0.28004E-01	-0.467	0.00636	3.668
BMP	0.47426	0.16976	0.372	0.12707	0.7802
LHARV	0.26135	0.15650	-0.255	0.50134	0.6593
LDIST	.0279	0.22545E-01	-0.310	0.64212	3.362
WETD	0.86137	0.18661	0.311	0.06050	0.8022
LPDIST	-.72378	0.90570E-01	-0.644	0.00216	4.123
LPPROD	.90769	0.11594	8.457	0.00001	-0.6533
POPD	.16754	0.32134	0.348	0.29422	0.8242

LIMDEP Estimation Results for Table 4.4

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º LIMDEP Estimation Results   Run log line   53 Page   1 º
º Sample was reset: REJECT   PT=-999$ º
º Sample was reset: REJECT   HSA=-999$ º
º Current sample contains   68 observations.   º
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site characteristics

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º Ordinary   least squares regression   Weighting variable = ONE   º
º Dependent variable is LPT   Mean =   3.87786, S.D. =   1.3951 º
º Model size: Observations =   129, Parameters = 13, Deg.Fr. =   116 º
º Residuals: Sum of squares=   73.5645   Std.Dev. =   0.79635 º
º Fit: R-squared = 0.70471, Adjusted R-squared =   0.67416 º
º Model test: F[12,   116] =   23.07,   Prob value =   0.00000 º
º Diagnostic: Log-L =   -146.8166, Restricted(á=0) Log-L =   -225.4933 º
º   Amemiya Pr. Crt.=   0.698, Akaike Info. Crt.=   2.478 º
º Autocorrel: Durbin-Watson Statistic =   1.67067,   Rho =   0.16466 º
º Results Corrected for heteroskedasticity   º
º Breusch - Pagan chi-squared =   23.7532, with 12 degrees of freedom º
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Variable	Coefficient	Standard Error	t-ratio	P[³T³òt]	Mean of X
LHACRES	-6.65E-2	0.95157E-01	-2.073	0.69534	3.852
PPURCH	1.2784	0.23584	8.964	0.00009	0.6667
LHSA	1.01E-01	0.87908E-01	0.654	0.28411	0.8602
NACC1	4.5819	0.68352	6.020	0.00000	1.000
LROADC	-1.43E-02	0.26559E-01	-0.323	0.60879	3.008
LHARV	-4.65E-01	0.16620	0.151	0.04676	0.6124
LDIST	-1.96E-02	0.20027E-01	-0.115	0.40496	3.632
WETD	3.87E-2	0.15462	1.031		

0.81638 0.7984
LPDIST -0.17272 .88987E-01 -1.941
0.05469 4.076
LPPROD .89549 0.11415 9.302
0.00000 -0.5806
LPOPD -9.08E-02 0.84552E-01 0.245
0.34848 3.831

LIMDEP Estimation Results for Table 4.4

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ÉÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
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º  LIMDEP Estimation Results                    Run log line   52  Page   1 º
º  Sample was reset:  REJECT   PT=-999$                           º
º  Sample was reset:  REJECT   DHACRES=0$                              º
º  Current sample contains      48 observations.                   º
ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼
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site characteristics

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º Ordinary    least squares regression    Weighting variable = ONE     º
º Dependent variable is LPT       Mean =    4.90978, S.D. =      1.2895 º
º Model size: Observations =      26, Parameters =  12, Deg.Fr. =    14 º
º Residuals:  Sum of squares=    13.2394     Std.Dev. =        0.97246 º
º Fit:        R-squared = 0.68151, Adjusted R-squared =        0.43127 º
º Model test: F[ 11,     14] =    2.72,    Prob value =        0.04043 º
º Diagnostic: Log-L =    -28.1187, Restricted(á=0) Log-L =     -42.9929 º
º            Amemiya Pr. Crt.=    1.382, Akaike Info. Crt.=     3.086 º
º Autocorrel: Durbin-Watson Statistic =   1.90834,   Rho =     0.04583 º
º Results Corrected for heteroskedasticity                        º
º Breusch - Pagan chi-squared =    15.5977, with  11 degrees of freedom º
ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼
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  Variable       Coefficient         Standard Error       t-ratio
P[³T³òt]          Mean of X

  LHACRES      -0.25431              0.34218              -0.905
0.01529          2.573
  PPURCH        1.3889               0.57246               2.923
0.00000          0.8462
  LHSA          6.08E-2              0.19594               2.290
0.63242          1.030
  NACC1         4.2951               2.0473                1.709
0.00000          1.000
  LROADC       -5.35E-03             0.70847E-01           0.060
0.89184          0.8049
  BMP           0.64502              0.32071               2.011
0.06396          0.5385
  LHARV         7.58E-3              0.35462               0.967
0.97054          0.5769
  LDIST         3.17E-02             0.79753E-01          -0.784
```

0.36268	3.904		
WETD	2.73E-2	0.60937	2.895
0.87262	0.9231		
LPDIST	5.23E-2	0.38254	-1.331
0.66979	4.151		
LPPROD	1.1704	0.21808	4.156
0.00000	-0.3368		
LPOPD	9.83E-2	0.39164	0.555
0.38557	3.743		

LIMDEP Estimation Results for Table 5.1

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ÉÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
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º  LIMDEP Estimation Results                    Run log line   51  Page   1 º
º  Sample was reset:  REJECT   ABSET=-999$                                  º
º  Sample was reset:  REJECT   PT=-999$                                 º
º  Current sample contains     60 observations.                      º
ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼
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site characteristics

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ÉÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ»
º Ordinary    least squares regression    Weighting variable = ONE      º
º Dependent variable is LPT       Mean =    3.88975, S.D. =      1.3940 º
º Model size: Observations =     128, Parameters =  13, Deg.Fr. =   115 º
º Residuals:  Sum of squares=    73.0860     Std.Dev. =        0.79720 º
º Fit:        R-squared = 0.70385, Adjusted R-squared =        0.67295 º
º Model test: F[ 12,    115] =   22.78,    Prob value =        0.00000 º
º Diagnostic: Log-L =   -145.7590, Restricted(á=0) Log-L =    -223.6410 º
º             Amemiya Pr. Crt.=    0.700, Akaike Info. Crt.=      2.481 º
º Autocorrel: Durbin-Watson Statistic =   1.66286,   Rho =      0.16857 º
º Results Corrected for heteroskedasticity                        º
º Breusch - Pagan chi-squared =    25.0986, with  12 degrees of freedom º
ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼
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Variable	Coefficient	Standard Error	t-ratio	P[³T³òt]	Mean of X
LHACRES	.21029	0.93182E-01	-2.024	0.02798	3.848
LHSA	8.46E-2	0.90272E-01	0.612	0.11513	0.8669
NACC1	.1329	0.55491	7.306	0.82890	1.000
LROADC	-4.96E-3	0.27253E-01	-0.306	0.84078	2.976
BMP	02.67E-2	0.15674	1.979	0.85618	0.7188
LHARV	-4.83E-02	0.14805	0.124	0.70673	0.6094
LDIST	-1.7721E-1	0.19931E-01	-0.105	0.44688	3.619
WETD	1.1425E-1	0.15686	0.998		

0.37931	0.7969		
LPDIST	-0.15629	0.93044E-01	-1.680
0.09572	4.081		
LPOPD	-.08455	0.83793E-01	-0.072
0.49775	3.813		

LIMDEP Estimation Results for Table 6.1

º LIMDEP Estimation Results Run log line 55 Page 1 º
º Sample was reset: REJECT HTYPE=2$ º
º Sample was reset: REJECT HTYPE=3$ º
º Current sample contains 67 observations. º
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site characteristics

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º Ordinary least squares regression Weighting variable = ONE º
º Dependent variable is LPT Mean = 3.61643, S.D. = 1.2201 º
º Model size: Observations = 68, Parameters = 11, Deg.Fr. = 57 º
º Residuals: Sum of squares= 35.4022 Std.Dev. = 0.78809 º
º Fit: R-squared = 0.64504, Adjusted R-squared = 0.58276 º
º Model test: F[10, 57] = 10.36, Prob value = 0.00000 º
º Diagnostic: Log-L = -74.2949, Restricted(á=0) Log-L = -109.5100 º
º Amemiya Pr. Crt.= 0.722, Akaike Info. Crt.= 2.509 º
º Autocorrel: Durbin-Watson Statistic = 1.39931, Rho = 0.30034 º
º Results Corrected for heteroskedasticity º
º Breusch - Pagan chi-squared = 28.2560, with 10 degrees of freedom º
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Variable	Coefficient	Standard Error	t-ratio	P[³T³òt]	Mean of X
LHACRES	.59677	0.16912	-0.394	0.00099	3.862
BMP	-0.54981	0.30329	4.215	0.00073	0.5588
LHSA	9.70E-2	0.93664E-01	1.081	0.04065	0.6167
LROADC	4.14E-2	0.27892E-01	-0.515	0.14980	3.583
NACC1	-.33125	0.79035	5.797	0.59198	1.000
LHARV	-3.47E-1	0.22861	-2.033	0.03020	0.5441
LDIST	-9.690E-02	0.23468E-01	-0.839	0.000253	3.154
WETD	0.17659	0.16630	0.233	0.14298	0.8382
LPOPD	.01157	0.96094E-01	-0.945		

0.90846	3.769

LIMDEP Estimation Results for Table 6.1

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º LIMDEP Estimation Results Run log line 55 Page 1 º
º Sample was reset: REJECT HTYPE=1$ º
º Sample was reset: REJECT HTYPE=3$ º
º Current sample contains 26 observations. º
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site characteristics

ÉÍÍÍ»
º Ordinary least squares regression Weighting variable = ONE º
º Dependent variable is LPT Mean = 4.69947, S.D. = 1.2434 º
º Model size: Observations = 48, Parameters = 11, Deg.Fr. = 37 º
º Residuals: Sum of squares= 13.5712 Std.Dev. = 0.60563 º
º Fit: R-squared = 0.81324, Adjusted R-squared = 0.76276 º
º Model test: F[10, 37] = 16.11, Prob value = 0.00000 º
º Diagnostic: Log-L = -37.7910, Restricted(á=0) Log-L = -78.0613 º
º Amemiya Pr. Crt.= 0.451, Akaike Info. Crt.= 2.033 º
º Autocorrel: Durbin-Watson Statistic = 2.34517, Rho = -0.17259 º
º Results Corrected for heteroskedasticity º
º Breusch - Pagan chi-squared = 18.6123, with 10 degrees of freedom º
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Variable	Coefficient	Standard Error	t-ratio	P[³T³òt]	Mean of X
LHACRES	-0.13572	0.99974E-01	-2.544	0.68353	3.714
BMP	.36551	0.20136	6.897	0.13641	0.9583
LHSA	-8.91E-03	0.12617	0.482	0.93495	1.260
NACC1	1.9502	0.76297	5.629	0.23471	1.000
LROADC	6.41E-03	0.39102E-01	-0.137	0.81968	1.536
LHARV	5.50E-03	0.20405	0.037	0.97790	0.6875
LDIST	1.03E-02	0.34497E-01	0.922	0.76620	4.237
WETD	7.96E-02	0.16961	0.161		

0.63671 0.7917
LPOPD -4.05E-2 0.11196 0.878
0.79959 3.886

LIMDEP Estimation Results for Table 6.2
º LIMDEP Estimation Results   Run log line   60 Page
1 º
º Sample was reset: REJECT   TOTALT=-999$
º
º Sample was reset: REJECT   NTOTALT=0$
º
º Current sample contains   13 observations.   º
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site characteristics

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º Ordinary   least squares regression   Weighting variable = ONE
º
º Dependent variable is LRANGE   Mean =   8.82087, S.D. =
3.4252 º
º Model size: Observations =   13, Parameters = 10, Deg.Fr. =   10
º
º Residuals: Sum of squares=   109.857   Std.Dev. =   1.63690
º
º Fit: R-squared = 0.81273, Adjusted R-squared =   0.77162 º
º Model test: F[9,   41] =   19.77,   Prob value =   0.00000 º
º Diagnostic: Log-L =   -91.9334, Restricted(á=0) Log-L =   -
134.6505 º
º   Amemiya Pr. Crt.=   3.205, Akaike Info. Crt.=   3.997 º
º Autocorrel: Durbin-Watson Statistic =   1.71301,   Rho =   0.14349
º
º Results Corrected for heteroskedasticity   º
º Breusch - Pagan chi-squared =   9.1454, with   9 degrees of
freedom º
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Variable   Coefficient   Standard Error   t-ratio
P[³T³òt]   Mean of X

LHACRES   0.951   0.38011
1.896   0.00305   4.146
LBIDS   4.5132   0.46533
9.699   0.00000   1.319
LHSA   1.51E-1   0.22846   -

1.414 0.16944 1.139
NACC1 -1.6115 2.4740
1.153 0.06994 1.000
LROADC 1.47E-02 0.92250E-01 -
0.117 0.58257 1.724
BMP 1.41E-1 0.42219
-0.726 0.55597 0.6078
LHARV 1.49E-1 0.43068
-1.963 0.32875 0.5098
LDIST -1.11E-01 0.61870E-01
-0.762 0.04080 3.208
WETD 5.35E-1 0.43316
-1.533 0.04183 0.7843
LPOPD -0.13033 0.33398
-1.007 0.42467 3.851

LIMDEP Estimation Results for Table 6.2
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º LIMDEP Estimation Results Run log line 53 Page 1 º
º Sample was reset: REJECT DIST=-999$ º
º Sample was reset: REJECT ABSET=-999$ º
º Current sample contains 47 observations. º
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site characteristics

ÉÍÍÍ»
º Ordinary least squares regression Weighting variable = ONE º
º Dependent variable is LRANGE Mean = 8.32991, S.D. = 3.6869 º
º Model size: Observations = 47, Parameters = 11, Deg.Fr. = 36 º
º Residuals: Sum of squares= 152.898 Std.Dev. = 1.65237 º
º Fit: R-squared = 0.82958, Adjusted R-squared = 0.79915 º
º Model test: F[10, 56] = 27.26, Prob value = 0.00000 º
º Diagnostic: Log-L = -122.7091, Restricted(á=0) Log-L = -181.9866 º
º Amemiya Pr. Crt.= 3.179, Akaike Info. Crt.= 3.991 º
º Autocorrel: Durbin-Watson Statistic = 2.13962, Rho = -0.06981 º
º Results Corrected for heteroskedasticity º
º Breusch - Pagan chi-squared = 7.5875, with 10 degrees of freedom º
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Variable Coefficient Standard Error t-ratio
P[³T³òt] Mean of X

LHACRES 2.53E-2 0.31479
1.717 0.80689 3.864
LHSA 9.56E-2 0.19430 -
1.793 0.09922 1.182
NACC1 1.1431 1.5878
1.216 0.16969 1.000
LROADC -2.51E-02 0.74967E-01 0.071
0.31078 1.730
BMP 8.74E-2 0.42955 -
0.417 0.59967 0.5373
LHARV -4.59E-2 0.39361 -
2.118 0.75188 0.5373
LDIST -1.01E-01 0.58471E-01 -
0.566 0.66069 3.228
WETD 3.94E-2 0.45711 -

1.752 0.81055 0.7612
LPOPD 2.18E-2 0.29808 -
0.798 0.87289 3.798

LIMDEP Estimation Results for Table 6.3

º LIMDEP Estimation Results Run log line 54 Page 1 º
º Sample was reset: REJECT HTYPE=2$ º
º Sample was reset: REJECT HTYPE=3$ º
º Current sample contains 30 observations. º
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site characteristics

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º Ordinary least squares regression Weighting variable = ONE º
º Dependent variable is LPT Mean = 3.72219, S.D. = 1.3282 º
º Model size: Observations = 26, Parameters = 12, Deg.Fr. = 14 º
º Residuals: Sum of squares= 14.4255 Std.Dev. = 1.01508 º
º Fit: R-squared = 0.67290, Adjusted R-squared = 0.41589 º
º Model test: F[11, 14] = 2.62, Prob value = 0.04655 º
º Diagnostic: Log-L = -29.2341, Restricted(á=0) Log-L = -43.7615 º
º Amemiya Pr. Crt.= 1.506, Akaike Info. Crt.= 3.172 º
º Autocorrel: Durbin-Watson Statistic = 1.25152, Rho = 0.37424 º
º Results Corrected for heteroskedasticity º
º Breusch - Pagan chi-squared = 19.2527, with 11 degrees of freedom º
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Variable	Coefficient	Standard Error	t-ratio	P[³T³òt]	Mean of X
LHACRES	8.52E-2	0.25786	0.390	0.59739	3.844
PPURCH	0.60213	0.55377	1.087	0.29526	0.4615
LHSA	4.62E-02	0.12144	0.657	0.50864	0.5464
NACC1	.3454	1.4653	1.505	0.73553	1.000
LROADC	-3.70E-02	0.33901E-01	-0.986	0.12946	3.808
BMP	1.35E-1	0.48899	-1.925	0.49971	0.7308
LHARV	-3.36E-1	0.56643	-2.267	0.37895	0.6154
LDIST	-2.61E-4	0.57602E-01	-1.950		

0.99304 3.096
WETD .30763 0.33720 -2.301
0.16971 0.8077
LPDIST 0.21288 0.13673 1.557
0.14180 3.737
LPPROD 0.43284 0.30912 1.400
0.18321 -0.4064
LPOPD 0.11693 0.31533
2.825 0.42972 3.109

Vita

Upon leaving Virginia Tech, Curt Hensyl is employed with International Paper. Initially, he was a procurement forester in southeastern North Carolina. He is currently working in Savannah, Georgia as International Paper's Geospatial Technology Manager.