# An Examination of the Relationship between the Conservation Reserve Program and Stumpage Prices in the South


By

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**Executive Summary:**

A Wall Street Journal article published in 2018 entitled "Thousands of Southerners Planted Trees for Retirement. It Didn't Work.[1]" suggests that the USDA Conservation Reserve Program (CRP) is one of the main reasons for a current hypothetical oversupply of timber in the South. The article further asserts that a decline in stumpage[2] prices throughout the South is attributable to (1) industry consolidation and a resulting lack of competition among mills and (2) the previously mentioned oversupply of timber. Additional Wall Street Journal articles including "Man who Steered Timber Subsidy Program Calls it His Biggest Regret[3]" and "Lumber Prices are Soaring. Why Are Tree Growers Miserable?[4]" further support the notion. The claim that an oversupply of timber as well as demand shocks, most notably the housing crisis of 2008, have contributed to a decline of stumpage prices is familiar to many timberland managers in the South. The notion has also gained a foothold outside of the context of the popular financial press and media commentary: an article published by the Alabama A&M and Auburn University Extension Service entitled "Why Stumpage Prices Are Low Despite Historic High Lumber Prices[5]" directly links the decline of stumpage prices, the oversupply of timber, and the CRP and explicitly suggests a relationship between the CRP and lack of growth in stumpage prices. While the contentious issue has inspired debate

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[1] Dezember, Ryan. "Thousands of Southerners Planted Trees for Retirement. It Didn't Work." *The Wall Street Journal*, Dow Jones & Company, 9 Oct. 2018, https://www.wsj.com/articles/thousands-of-southerners-planted-trees-for-retirement-it-didnt-work-1539095250.

[2] Stumpage is the dollar amount a landowner is paid "on the stump" for their timber harvest. It varies by class.

[3] Dezember, Ryan. "Man Who Steered Timber Subsidy Program Calls It His Biggest Regret." *The Wall Street Journal*, Dow Jones & Company, 19 Oct. 2018, https://www.wsj.com/articles/man-who-steered-timber-subsidy-program-calls-it-his-biggest-regret-1539946801?mod=article_inline.

[4] Dezember, Ryan, and Vipal Monga. "Lumber Prices Are Soaring. Why Are Tree Growers Miserable?" *The Wall Street Journal*, 24 Feb. 2021, https://www.wsj.com/articles/lumber-prices-are-soaring-tree-growers-miserable-11614177282.

[5] Maggard, Adam, and Daowei Zhang. "Why Stumpage Prices Are Low despite Historic High Lumber Prices." *Alabama Cooperative Extension System*, 18 Mar. 2021, https://www.aces.edu/blog/topics/forestry/why-stumpage-prices-are-low-despite-historic-high-lumber-prices/.

in both academic and southern forest landowner communities, the implication that the CRP contributed significantly to the oversupply of timber in the South may not be supported by historical evidence.

Because the issue is explicitly related to the impact of federal and state subsidies, it addresses an economic inefficiency, and thus offers an opportunity to explore the impact of government orientation toward forest landowner assistance programs as well as the long-term consequences of policy decisions stemming from that orientation. Further, because planting decisions involve considering the financial costs of planting as well as the expected return for growing timber to maturity, growth and decline in private landowner planting due to incentives provided by the CRP beginning in 1986 provides a useful study that may inform optimal policy decisions in the future by illuminating landowner decision making sensitivity relative to subsidies.

My research asks the following questions:

1. Over the long-term (the period for which stumpage data is available, 1935 - 1995), is there a relationship between stumpage prices and the supply of timber in the South?
2. Over the long-term (the period for which construction activity data is available, 1964 – 2020), is there a relationship between stumpage prices in the South and construction activity in the United States?
3. Are differences in impact between shifts in demand and shifts in supply on stumpage prices by timber product class observable in the South?
4. What do the results of questions (1), (2), and (3) indicate about the extent to which the Conservation Reserve Program may be said to influenced stumpage prices in the Southeast?

I will begin with an introduction that contextualizes my work by providing an overview of tree planting in the South. Here, I will include commentary and figures that situate the CRP within the broader tree planting effort in the South as well as demonstrate how tree planting in key segments – federal, private, industrial, and state – evolved over the course of 1925 – 1999. While planting volume data exists for years after 1999, that data is collected through surveying nurseries and is contingent upon interpolating that data through tree per acre assumptions. This method contrasts data from 1925 – 1999, for which there is federal oversight and no interpolation involved. I will also expand on a key premise of this analysis, which is that landowners consider financial returns when evaluating land management decisions such as whether or not to plant or harvest timber. I will follow that overview with commentary and figures demonstrating how stumpage prices change over time as well as key findings on the central drivers of that volatility. The introduction will be followed by a description of my method. Here, I will describe key assumptions in my analysis as well as present an overview of the quantitative analysis process that I used. A discussion of the results obtained through those methods will follow. This report will close with a discussion of the results and a summary of key conclusions.

## Introduction

Major events in the history of tree planting in the South include The New Deal (when "Tree planting in the South began in earnest[6]"), a post WWII boom, and a steady increase in annual planting volume from 1966-1978 as cost-share programs, strong markets, and landowner assistance programs accelerated tree plantings. During the New Deal (1935-1942), >1 million acres were planted by CCC volunteers[7]. Conservation programs in the Farm Bill have roots in the New Deal and began with legislation passed by congress in the 1930s to alleviate soil erosion. Early iterations of the New Deal were "largely subordinate to price support goals" but "used to pay farmers to temporarily hold land out of production in hopes of controlling supplies, increasing prices and conserving soil resources."[8] Conservation agendas became more prominent in the mid-1980s, specifically because of the conservation policies in the Food Security Act of 1985. The 1985 Farm Bill is the beginning of modern conservation policy which is specifically and predominantly oriented toward addressing conservation challenges[9]. The overarching conservation agenda in this bill focused on removing "highly erodible land and wetlands from crop production" through conservation compliance[10].

[6] Hernandez, George A., and Richard A. Harper. "Tree Planting in the South, 1025 - 2012." *Tree Planters' Notes*, vol. 59, no. 2, 2016.

[7] Williston, H.L. 1986. A statistical history of tree planting in the South 1925–1985. Misc. Rep. SA-MR 8, September 1986. Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southern Region, State and Private Forestry. 23 p. http://www.rngr.net/publications/statistical-history.

[8] "Historic Background on the Conservation Reserve Program." Farmdoc Daily (7):82. Department of Agriculture and Consumer Economics, University of Illinois at Urbana-Champaign, May 4, 2017.

[9] *Ibid.*

[10] Economic Research Center. (n.d.). *United States Food Security Act - Ers.usda.gov*. United States Department of Agriculture. Retrieved October 15, 2021, from https://www.ers.usda.gov/webdocs/publications/41995/15133_aib498_1_.pdf?v=3716.6

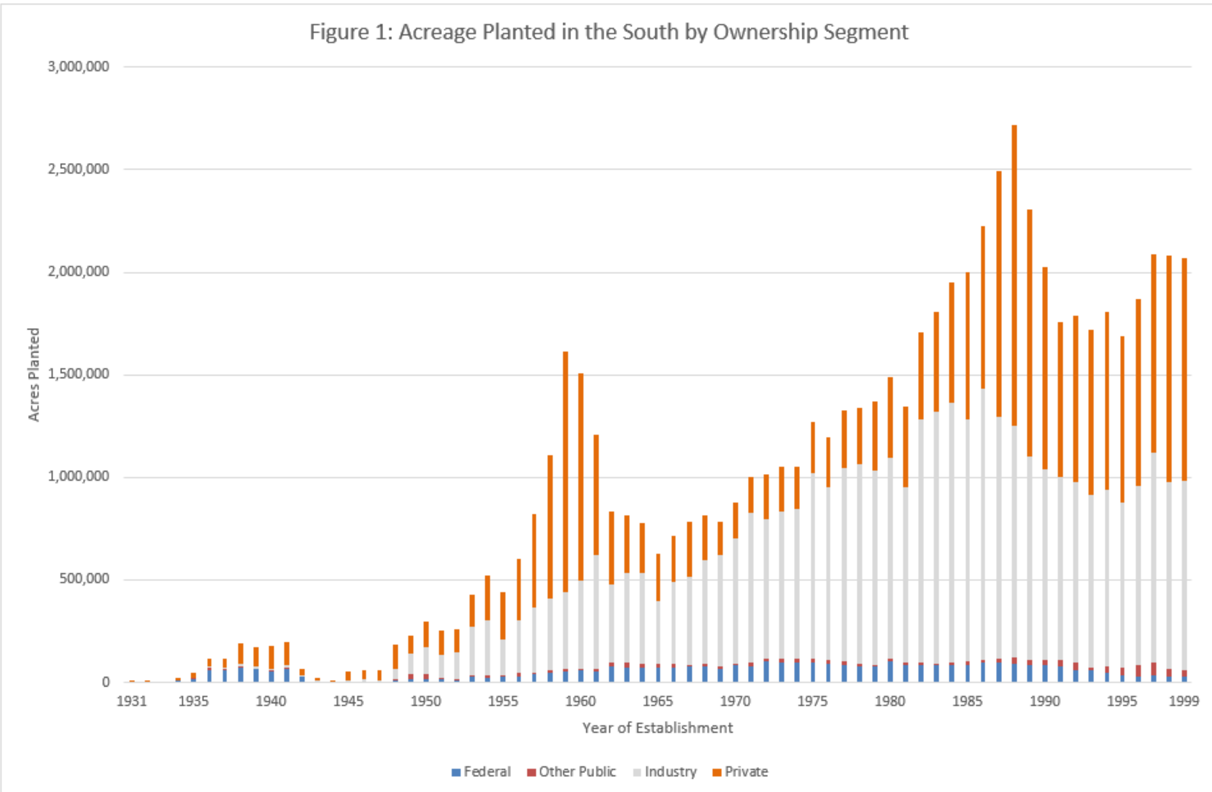
**Federal Tree Planting Initiatives**

Major conservation initiatives in the 21st century in the United States include the Soil Bank Program and the Conservation Reserve Program. Both programs are federal programs administered by the USDA. The Soil Bank program was designed to facilitate a decline in agricultural commodity surpluses by encouraging farmers to voluntarily retire agricultural land. Between 1956 – 1965, 1.9 million acres of timber was planted because of the program. The Conservation Reserve Program began in 1986 and I estimate that it contributed an average of ~300,000 acres per year between 1986 and 1999 for a total of ~4.1 million acres over that 13-year period. Based on this estimate, the CRP accounted for ~14% of all tree planting in the South from 1986 – 1999. This estimate is based on total pine planting acreage reported in the South multiplied by the percentage of overall planting that occurred in the South during a given year. While this approach could bias overall CRP acreage in the South downward, it is consistent with academic estimates[11] that report a total of “nearly” 6 million acres between 1986 and 2008.

[11] Hernandez, George A., and Richard A. Harper. “Tree Planting in the South, 1025 - 2012.” *Tree Planters' Notes*, vol. 59, no. 2, 2016

**Planting by Land Ownership Category**

The federal government funded a record keeping effort for tree planting nationwide between 1926 and 1999, at which time funding was eliminated. The data tracks planting volume by state and ownership segments, which include Federal, Other Public, Industry, and Private. Figure 1 provides a summary of historic data.




The mix of planting on federal, other public, industry, and private lands evolved significantly over the 73 years in which records were kept by the federal government. The majority of planting that occurs (>85%), on average and over the long-term (1930 - 1999), is comprised of private and industry segment activity. On average, the private segment accounts for 43% of planted acres and Industry accounts for 44% of planted acres between 1930 and 1999. From 1986 (the beginning of the CRP) to 1999, private planting without CRP subsidies decreased from all-time average of 39% of all plantings to 33% of total planted acres (Table 1).

**Table 1: Private Ownership Acreage with and without CRP Assistance**

| % of total acreage | |
|---|---|
| 1986 - 1999 | (CRP) |
| Total Private | 48% |
| Non-CRP Private | 33% |
| CRP | 14% |

During the CRP period, total private land plantings increased to 48% (average ~14% of private planting was with CRP assistance). As demonstrated in tables 2 and 3, industry planting decreased relative to its average from 1950 – 1999 during the years of the CRP (average 54% from 1950 – 1999, 48% from 1986 – 1999). These averages vary over decade and reflect broad, gradual changes in industry and private landowner orientations toward planting. Most notably, industry planting increased as a percentage of overall planting in the latter half of the twentieth century, specifically 1950 - 1980. This is because industry sought a secure supply for ongoing production and purchased and managed timberland to achieve that goal. Private planting decreased during this period but then increased in the 1980s and 1990s.

**Table 2: Percentage of Overall Acreage Planted by Decade and Ownership Segment**

| | 1930- 1999 | 1930 - 1940 | 1940 - 1950 | 1950 - 1960 | 1960 - 1970 | 1970 - 1980 | 1980 - 1990 | 1990 - 1999 | 1950 - 1999 | CRP 1986 - 1999 |
|---|---|---|---|---|---|---|---|---|---|---|
| Federal | 10% | 28% | 14% | 5% | 9% | 8% | 5% | 3% | 6% | 3% |
| Other Public | 3% | 7% | 3% | 2% | 2% | 1% | 1% | 2% | 2% | 2% |
| Industry | 44% | 16% | 21% | 41% | 53% | 70% | 57% | 47% | 54% | 48% |
| Private | 43% | 50% | 61% | 52% | 36% | 21% | 37% | 48% | 39% | 48% |

**Table 3: Acres Planted (000s) by Ownership Category (Federal, Other Public, Industry, Unassisted Private, CRP)**

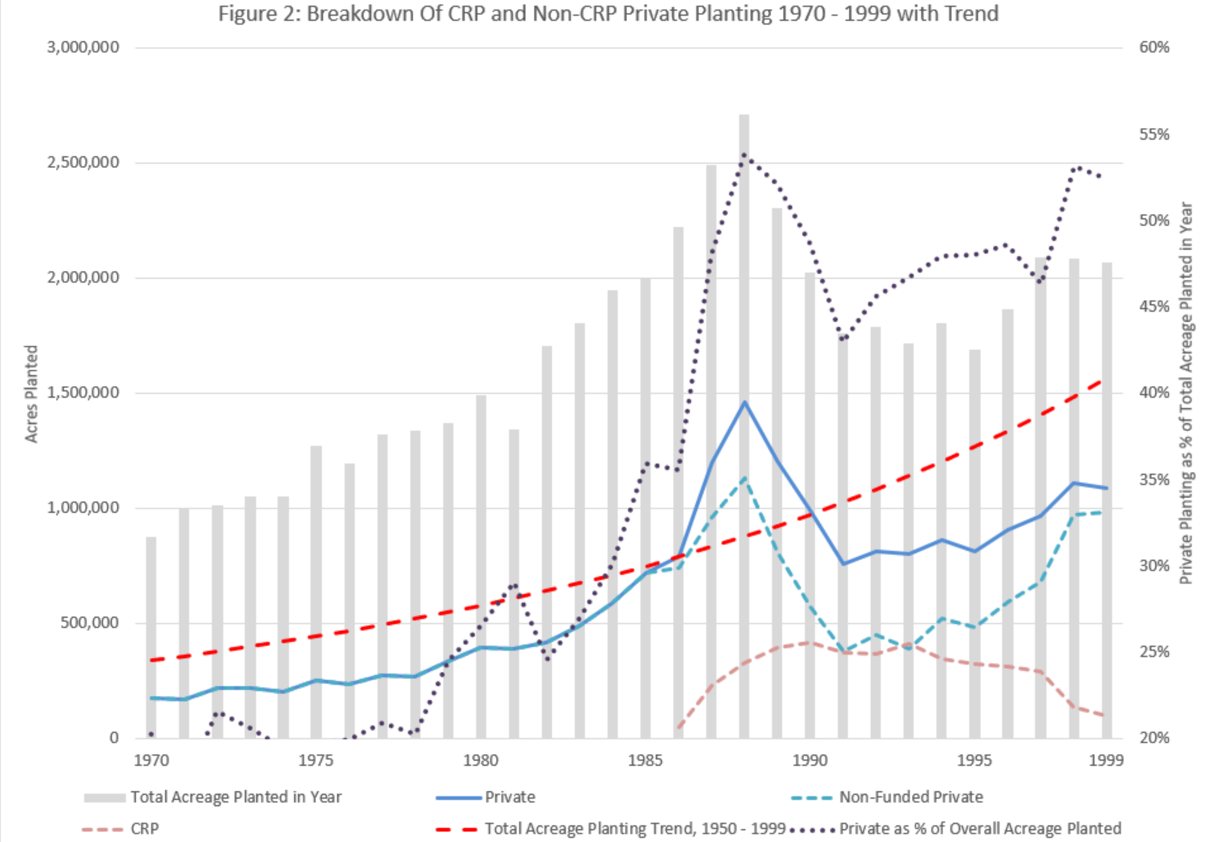
| | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Federal | 94.4 | 100.4 | 91.2 | 85.6 | 86.9 | 79.9 | 62.1 | 57.2 | 49.0 | 35.7 | 29.4 | 34.3 | 31.2 | 29.0 |
| Other Public | 14.5 | 17.4 | 28.4 | 23.8 | 24.5 | 28.6 | 32.4 | 17.1 | 26.7 | 38.1 | 58.2 | 64.7 | 37.5 | 28.1 |
| Industry | 1,323.6 | 1,177.4 | 1,133.6 | 994.2 | 929.3 | 894.7 | 879.9 | 842.2 | 863.4 | 803.9 | 872.8 | 1,022.0 | 906.7 | 929.1 |
| Private | 790.7 | 1,196.1 | 1,462.1 | 1,202.4 | 987.0 | 756.3 | 816.1 | 802.3 | 865.0 | 811.9 | 907.7 | 969.6 | 1,108.6 | 1,086.1 |
| Non Assisted Private | 741.3 | 962.5 | 1,130.4 | 806.4 | 570.6 | 381.2 | 448.8 | 388.7 | 520.8 | 486.5 | 593.4 | 680.3 | 971.5 | 985.5 |
| Total Acreage | 2,223.1 | 2,491.3 | 2,715.2 | 2,306.0 | 2,027.8 | 1,759.5 | 1,790.5 | 1,718.9 | 1,804.0 | 1,689.5 | 1,868.0 | 2,090.6 | 2,083.9 | 2,072.2 |
| CRP | 49.3 | 233.6 | 331.7 | 396.1 | 416.4 | 375.1 | 367.3 | 413.6 | 344.2 | 325.4 | 314.3 | 289.3 | 137.1 | 100.6 |

| Table 4: Average Acres Planted by Ownership Category ( Federal, Other Public, Industry, Private, Non-Subsidized Private) and Decade, 1930 - 1999 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1930 - 1939 | 1940 - 1949 | 1959 - 1959 | 1960 - 1969 | 1970 - 1979 | 1980 - 1989 | 1990 - 1999 | 1930 - 1999 |
| Federal | 28,342 | 19,211 | 29,061 | 70,791 | 88,993 | 90,403 | 49,470 | **53,753** |
| Other Public | 4,047 | 4,140 | 11,160 | 15,382 | 15,146 | 14,921 | 35,593 | **14,341** |
| Industry | 5,038 | 21,192 | 235,101 | 440,972 | 809,136 | 1,132,826 | 894,378 | **505,520** |
| Private | 32,427 | 60,971 | 358,706 | 360,213 | 236,387 | 765,219 | 911,062 | **389,284** |
| Non-CRP Private | | | | | | 664,146 | 602,726 | **321,749** |
| Total Acreage | 69,853 | 105,514 | 634,028 | 887,359 | 1,149,662 | 2,003,369 | 1,890,503 | **962,898** |

**CRP acreage from 1980 - 1989 includes only 1986 - 1989*

I estimate that the Conservation Reserve Program contributed ~2/3 of overall planting in the private segment in the South from 1986 - 1999. During this period, non-subsidized private planting decreased as subsidized private planting increased.  This decrease in non-subsidized planting is important because it illuminates how landowner planting decisions vary when a subsidy is introduced (Figure 2). In this case, private planting volumes overall decreased as subsidized planting comprised 2/3 of planting in the category. Notably, private planting during this time grew at a rate lower than the 1950 – 1999 trend of 5% for total acreage planted.

Figure 2: Breakdown Of CRP and Non-CRP Private Planting 1970 - 1999 with Trend



## Stumpage Prices

Stumpage is the residual dollar amount received by a landowner after the costs of cutting, hauling, and delivering are incurred and is net any additional fixed (FC) or variable costs (VC) (table 5).

Conceptually,

Stumpage[12]=“mill delivered price” -cutting - skidding - loading - hauling - other FC – VC

**Table 5: Stumpage Defined**

| |
|---|
| **"Mill Delivered Price"** |
| - Cost of Cutting |
| - Cost of Skidding |
| - Cost of Loading |
| - Cost of Hauling |
| - Other FC |
| - Other VC |
| **Stumpage** |

Stumpage prices are specific to timber product classes including pine sawtimber (PST), pine chip and saw (CNS), and pine pulpwood (PPW). Pine sawtimber is the largest class and when representing an averaged sized whole tree on the stump, the tree has a lower diameter at breast height (DBH)[13] threshold of 12 inches. CNS and PPW whole tree DBH ranges span from 8 – 11 inches and 5 – 7 inches, respectively. PST, CNS, and PPW become merchantable at 12, 17, and 25 years of age. Table 6 provides a summary of these attributes.

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[12] Spong, Ben. “What is Stumpage?” West Virginia University Extension Service. May 18, 2018. https://extension.wvu.edu/wayne/ag-natural-resources/news/2018/05/18/what-is-stumpage

[13] 56 inches

| Table 6: Timber Product Class and Corresponding DBH, Merchantability Thresholds | | | | |
|---|---|---|---|---|
| Timber Class | Code | DBH (inches) | | Assumed Harvest Age |
| | | Lower Merchantability Limit | Upper Merchantability Limit | |
| Pine Sawtimber | PST | 12 | - | 25 |
| Pine Chip-and-Saw | CNS | 8 | 11 | 17 |
| Pine Pulpwood | PPW | 5 | 7 | 12 |

In nominal[14] terms, stumpage prices increased at a CAGR[15] of 8% between 1935 and 1999. A CAGR, or Compound Annual Growth Rate, reflects a mean annual growth rate over a certain period and is used in this instance as an approximation of long-term annual growth rate for stumpage prices. It is the measure chosen because it captures the overall trend reflected in the fragmented, 5-year frequency data available for 1935 – 1975.

Significant (+10% year over year) periods of growth in stumpage prices include the years immediately after WWII, the 1970s, and the early 1990s. Stumpage prices have declined steadily since the financial crisis of 2008. Including all available data (1935-2021), stumpage prices increased by 5.7% per year on average between 1935 and 2021 in nominal terms. During the same period, the average annual increase in the Consumer Price Index (CPI), the dominant measure for inflation, was 3.6%. Figure 3a illustrates long-term stumpage prices along with cumulative inflation measured by the CPI over the same period. Figure 3b illustrates annual growth in PST stumpage and the CPI.

[14] Not adjusted in any way for inflation
[15] Compound Annual Growth Rate, calculated as (end value / beginning value) ^ ( 1 / t) - 1

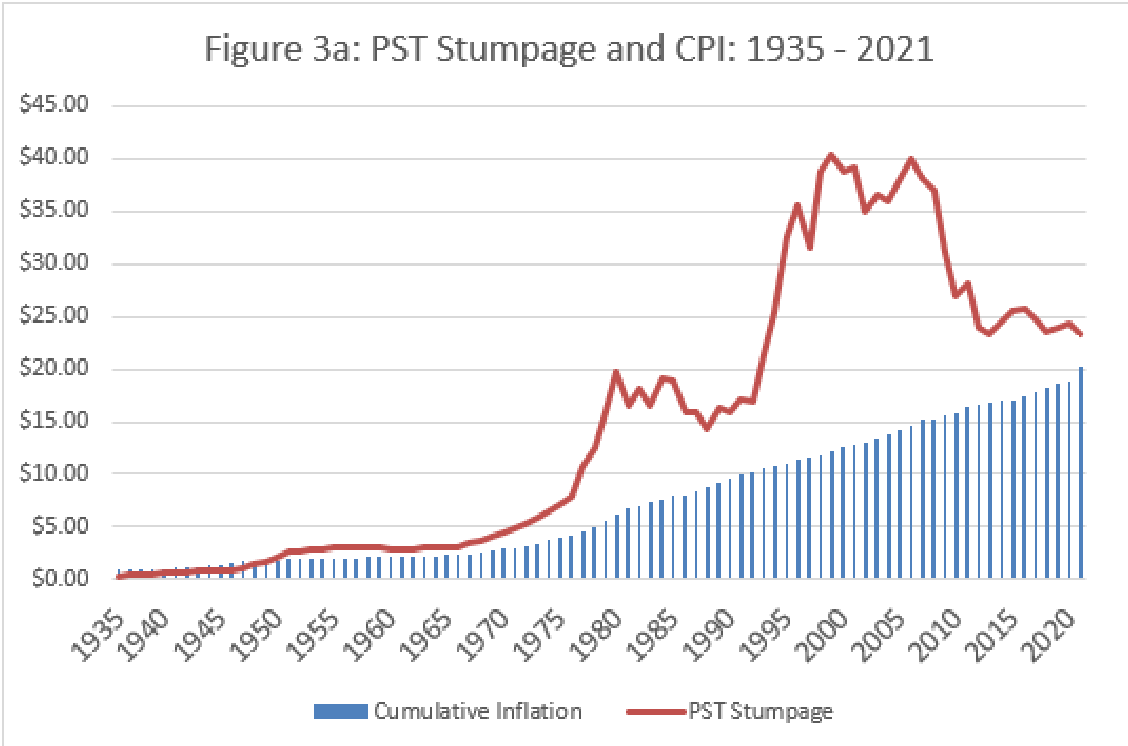


Figure 3a: PST Stumpage and CPI: 1935 - 2021
$45.00
$40.00
$35.00
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$0.00
1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
Cumulative Inflation
PST Stumpage

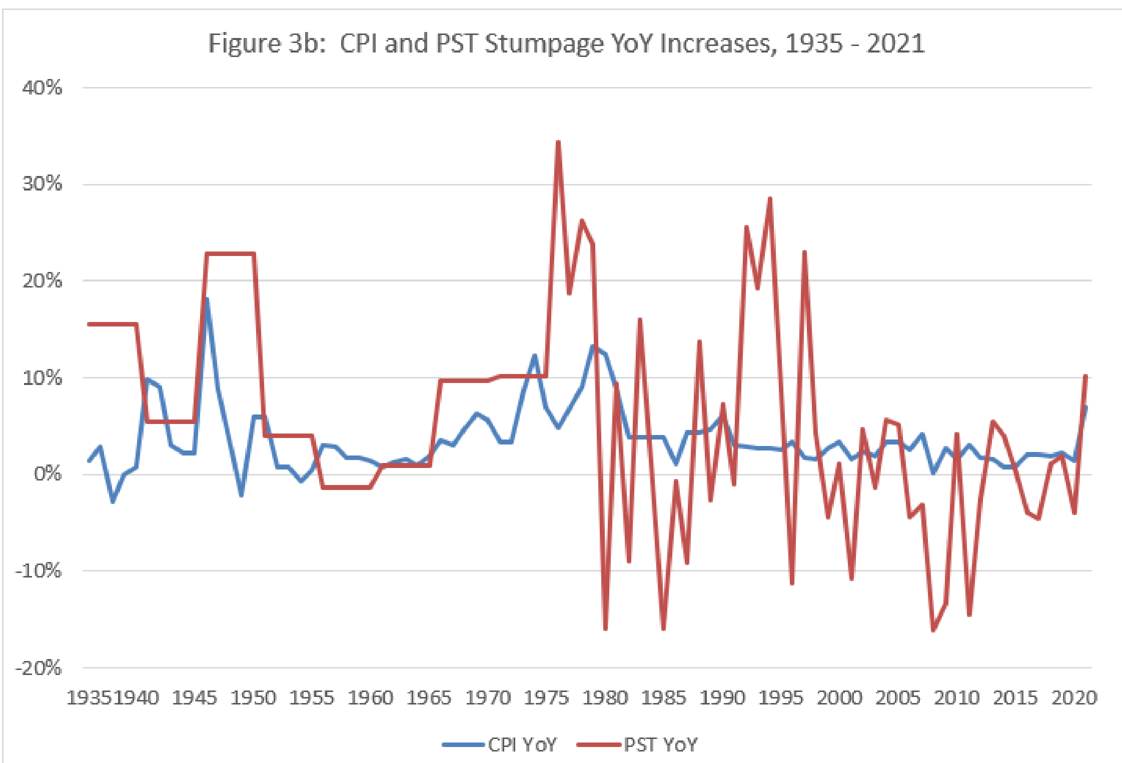
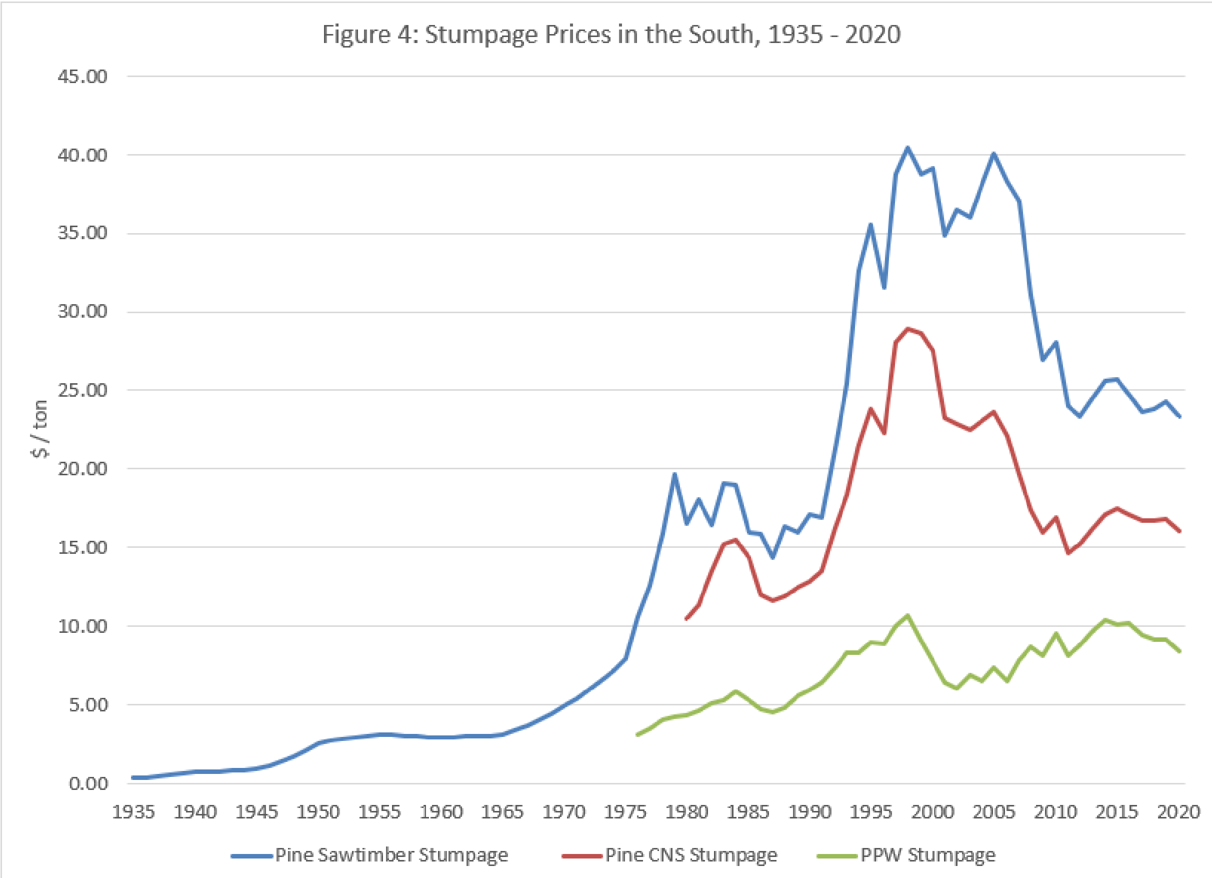


Figure 3b: CPI and PST Stumpage YoY Increases, 1935 - 2021
40%
30%
20%
10%
0%
-10%
-20%
1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
CPI YoY
PST YoY

hac

Average stumpage prices peaked in the late 1990s and early 2000s, with an all-time high of $40.46 per ton for Pine Sawtimber in 1998. Stumpage has been volatile over time (Figure 4) and is primarily driven by cyclicality in demand within key end use markets as well as shifts in timber supply.




Examples of cyclicity in key end use markets include the economic recovery of the late 1970s. An example of shifts in timber supply is the late 80s and early 90s, a period of both economic recovery and shifting supply as much of the harvest in the west was relocated to the South as a result of concerns related to the Endangered Species Act driven by the spotted owl controversy.[16] Other demand drivers during this time include tariff avoidance and tree mortality from southern pine beetle epidemics. The

[16] Adams, Darius M. "Harvest, Inventory, and Stumpage Prices: Consumption Outpaces Harvest, Prices Rise Slowly." Journal of Forestry. March 2002.

supply shock of El Niño (a seasonal, temporal driver that exacerbated the spotted owl driven supply shock) also occurred at this time[17]. Tables 7, 8, and 9 show developments in stumpage prices.

**Table 7: Stumpage Prices and Growth 1976* - 1999, Quarterly**

| | Mean | Median | Min | Max | % periods increase | % periods decrease | SD | Var |
|---|---|---|---|---|---|---|---|---|
| Pine Sawtimber (PST) Stumpage ($/ton) | $22.23 | $18.16 | $10.59 | $45.86 | 63% | 37% | 8.99 | 80.75 |
| Pine Sawtimber (PST) Stumpage YoY Growth | 7% | 6% | -23% | 40% | | | 0.17 | 0.03 |
| Pine Chip and Saw (CNS) Stumpage ($/ton) | $17.13 | $14.95 | $9.91 | $31.64 | 68% | 32% | 6.11 | 37.39 |
| Pine Chip and Saw (CNS) Stumpage YoY Growth | 6% | 7% | -22% | 32% | | | 0.13 | 0.02 |
| Pine Pulpwood (PPW) Stumpage ($/ton) | $6.30 | $5.71 | $3.12 | $12.29 | 79% | 21% | 8.99 | 80.75 |
| Pine Pulpwood (PPW) Stumpage YoY Growth | 7% | 6% | -23% | 40% | | | 0.17 | 0.03 |

** Chip and Saw Data begins 1Q 1980*

**Table 8: Stumpage Prices and Growth 1976* - 2021, Quarterly**

| | Mean | Median | Min | Max | % periods increase | % periods decrease | SD | Var |
|---|---|---|---|---|---|---|---|---|
| Pine Sawtimber (PST) Stumpage ($/ton) | $25.89 | $24.56 | $10.59 | $45.86 | 55% | 45% | 8.60 | 74.00 |
| Pine Sawtimber (PST) Stumpage YoY Growth | 3% | 1% | -23% | 40% | | | 0.14 | 0.02 |
| Pine Chip and Saw (CNS) Stumpage ($/ton) | $18.10 | $16.85 | $9.91 | $31.64 | 56% | 44% | 4.98 | 24.77 |
| Pine Chip and Saw (CNS) Stumpage YoY Growth | 2% | 1% | -22% | 32% | | | 0.11 | 0.01 |
| Pine Pulpwood (PPW) Stumpage ($/ton) | $7.33 | $7.50 | $3.12 | $12.29 | 63% | 37% | 2.08 | 4.35 |
| Pine Pulpwood (PPW) Stumpage YoY Growth | 3% | 4% | -26% | 37% | | | 0.11 | 0.01 |

** Chip and Saw Data begins 1Q 1980*

**Table 9: Stumpage Prices and Growth 2009 - 2021, Quarterly**

| | Mean | Median | Min | Max | % periods increase | % periods decrease | SD | Var |
|---|---|---|---|---|---|---|---|---|
| Pine Sawtimber (PST) Stumpage ($/ton) | $24.90 | $24.60 | $22.50 | $29.41 | 50% | 50% | 1.55 | 2.44 |
| Pine Sawtimber (PST) Stumpage YoY Growth | -1% | 0% | -20% | 17% | | | 0.08 | 0.01 |
| Pine Chip and Saw (CNS) Stumpage ($/ton) | $18.10 | $16.85 | $9.91 | $31.64 | 51% | 49% | 4.98 | 24.91 |
| Pine Chip and Saw (CNS) Stumpage YoY Growth | 2% | 1% | -22% | 32% | | | 0.11 | 0.01 |
| Pine Pulpwood (PPW) Stumpage ($/ton) | $9.29 | $9.28 | $7.50 | $11.28 | 48% | 52% | 0.86 | 0.76 |
| Pine Pulpwood (PPW) Stumpage YoY Growth | 1% | 0% | -23% | 37% | | | 0.11 | 0.01 |

[17] Joseph Bachman, Executive in Residence in Natural Resources Finance, Nicholas School of the Environment at Duke University. Personal Communication, February 28, 2022.

## Financial Considerations of a Timberland Investment

A key premise in this analysis is that landowner decisions relative to planting timber are influenced by anticipated financial returns for doing so. When a government subsidy supports a decrease in the cost basis for an investment in forest land, the financial return on that investment increases. Assuming one planting timber as an investment chooses to manage a stand planted with government assistance as commercial timber and grows the stand into maturity, that landowner's overall financial return is higher relative to the financial return that would have been realized without a reduction in cost basis for the investment. The magnitude of the additional pro forma return is presented in Table 10.

**Table 10: Pro Forma Financial Returns of Timberland Investments with and without CRP Assistance**

| **Year of Establishment** | **1965** | **1970** | **1975** | **1980** | **1986*** | **1990** | **1995** |
|---|---|---|---|---|---|---|---|
| | | | | | **No CRP Assistance** | | |
| Thinning Income $_{t+15}$ | $126 | $156 | $171 | $264 | $198 | $221 | $269 |
| Final Harvest Income $_{t+25}$ | $1,225 | $2,137 | $2,269 | $2,028 | $1,521 | $1,825 | $1,713 |
| IRR | 5.8% | 8.1% | 8.4% | 8.4% | 7.03% | 7.81% | 7.79% |
| NPV | $69 | $339 | $383 | $358 | $185 | $281 | $271 |
| | | | | | ***CRP Cost Assistance*** | | |
| Thinning Income $_{t+15}$ | $126 | $156 | $171 | $264 | ***$198*** | ***$221*** | ***$269*** |
| Final Harvest Income $_{t+25}$ | $1,225 | $2,137 | $2,269 | $2,028 | ***$1,521*** | ***$1,825*** | ***$1,713*** |
| IRR | 5.8% | 8.1% | 8.4% | 8.4% | ***10.3%*** | ***11.15%*** | ***11.21%*** |
| NPV | $69 | $339 | $383 | $358 | ***$352*** | ***$448*** | ***$438*** |
| | | | | | ***CRP Cost Assistance + Rental Payment ($40 per annum for 10 years)*** | | |
| Thinning Income $_{t+15}$ | $126 | $156 | $171 | $264 | ***$198*** | ***$221*** | ***$269*** |
| Final Harvest Income $_{t+25}$ | $1,225 | $2,137 | $2,269 | $2,028 | ***$1,521*** | ***$1,825*** | ***$1,713*** |
| IRR | 6% | 8% | 8% | 8% | ***61.74%*** | ***58.22%*** | ***58.20%*** |
| NPV | $69 | $339 | $383 | $358 | ***$1,144*** | ***$1,208*** | ***$1,181*** |

## Methods:

To answer questions 1-4 above, I obtained tree planting records dating back to 1926, stumpage prices dating back to 1935, detailed records for CRP planting by state, and incorporated census bureau statistics on construction activity as a proxy for lumber demand. Historic planting data dating back to 1926 and detailed records of CRP activity were given to me by Richard A. Harper[18]. Data on construction activity in the United States is available through the US Census Bureau. I used the reported annual numbers for construction put in place in current dollars (nominal, not adjusted for inflation), which reports annual, seasonally adjusted numbers beginning in 1964 as a proxy for lumber demand.

I isolated the relationship between pine sawtimber (PST) stumpage and supply by assuming a 25-year lag between year of planting and harvest to capture the 25-year period required for a pine tree in the Southern US to become merchantable at the higher diameter product class. For years in which there is sufficient data, (1976-1999), I assumed a 17-year lag for Pine Chip-and-Saw (CNS) and a 12-year lag for Pine Pulpwood (PPW) to allow for the planted trees to grow to sufficient diameter to reach those product classes, respectively. As in the case for Sawtimber, these lags represent the amount of time it takes for a tree to reach the lower diameter threshold for PPW and CNS classes. I assumed standard qualifications for each timber class, primarily a diameter at breast height of 5-7", 8-11", and >12" inches for PPW, CNS, and PST, respectively. These assumptions are summarized in table 6.

**Table 6: Timber Product Class and Corresponding DBH, Merchantability Thresholds**

| Timber Class | Code | DBH (inches) Low | DBH (inches) High | Assumed Harvest Age |
|---|---|---|---|---|
| Pine Sawtimber | PST | 12 | - | 25 |
| Pine Chip-and-Saw | CNS | 8 | 11 | 17 |
| Pine Pulpwood | PPW | 5 | 7 | 12 |

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[18] Richard A. Harper, Retired: USDA Forest Service, Forest Inventory and Analysis, Analyst, and Professional Consultant

PST, CNS, and PPW stumpage prices for the years 1976-2021, 1980-2021, and 1976-2021, respectively, were obtained through Timbermart South. Timbermart South data is specific to the Southeast. For years prior to 1976, I relied on data from "The South's Fourth Forest: Alternatives for the Future."[19] As data from this source reports data in 5-year increments, I used a CAGR to convert quarterly data into an annual growth rate for the reported years and used this annual growth rate to approximate years in which data was not reported. This results in a smooth growth pattern between the five-year increments. While an imperfect approximation, it captures the directional trend in planting volumes for those years and overall growth rate in aggregate over the period analyzed. Data from this source is also specific to timber harvested from public land. While this contrasts to Timbermart South, it is sufficient as measure that captures overall stumpage price growth and directional trend at the regional scale.

To address question 1,

*Over the long-term (1925 – 1999), is there a relationship between stumpage prices and the supply of timber in the South?*

I used all available years of data and performed a regression analysis with acreage planted as the independent variable and PST stumpage at t + 25 as the dependent variable. As CNS and PPW stumpage prices are not available until 1976 and 1980, respectively, I used only those years for those timber classes. The hypotheses of my regression were:

$H_o$: There is not a relationship between stumpage prices and supply of timber in the South

$H_{a:}$ There is a relationship between stumpage prices and supply of timber in the South

To address question 2,

[19] U.S. Dept. of Agriculture, Forest Service. (1988). *The South's Fourth Forest: Alternatives for the Future*.

*Over the long-term (1964 - 2020), is there a relationship between stumpage prices in the South and construction activity in the United States?*

I conducted a regression analysis with the following hypotheses:

> $H_o$: There is not a relationship between stumpage prices in the South and construction activity in the United States
>
> $H_{a:}$ There is not a relationship between stumpage prices in the South and construction activity in the United States

I used data from all years in which construction activity data is available (1964 –2020) and test for all years in which construction data overlaps with stumpage data: 1964 – 2020 for PST, 1980 – 2020 for CNS, and 1976 – 2020 for PPW. Construction activity is the independent variable and PST, CNS, and PPW stumpage prices are the dependent variables. Here, construction activity is the assumed proxy for lumber demand. Because harvest rates are a function of demand for wood in construction, I believe using historic data from this key end market serves as a sufficient proxy for demand[20]. I did not lag any variables in this portion of the analysis because (1) landowners typically receive payment at time of harvest and (2) timber is typically processed into lumber within a short window after harvest. While acknowledging that there may be additional inventory stocks in the value chain, demand for lumber is fundamentally linked to its use in key end markets and volume of supply is fundamentally linked to volume harvested. In the affirmative case, I report on differences in correlation and statistical significance across PST, CNS, and PPW classes.

To address question 3,

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[20]"Future forest conditions in the U.S. depend in part on timber harvest rates, which are a function of overall demand for wood in construction." https://www.fs.fed.us/research/highlights/highlights_display.php?in_high_id=1466

*Are differences in the relationship between shifts in demand and shifts in supply on stumpage prices by timber class observable in the South?*

I performed a regression using only years in which I had overlapping data for timber classes and construction activity. These years include 1964 – 1999 for PST, 1980 – 1999 for CNS, and 1976 – 1999 for PPW. I contrasted correlation and statistical significance for each. The independent variables are acreage planted and construction activity; the dependent variable is stumpage price by class.

To address question 4,

*What do the results of questions (1), (2), and (3) indicate about the extent to which the Conservation Reserve Program may be said to influence stumpage prices in the Southeast?*

I integrated conclusions from (1), (2), and (3) and incorporated insights from industry professionals.

## Results

*Over the long-term (1925 – 1999), is there a relationship between stumpage prices and the supply of timber in the South?*

$H_o$: There is not a relationship between stumpage prices and supply of timber in the South

$H_{a:}$ There is a relationship between stumpage prices and supply of timber in the South

**Table 11: Stumpage ~ Acreage Planted**

| Timber Product Class | Statistical Test | Time Range | $R^2$ | P-Value | Coefficient |
|---|---|---|---|---|---|
| $PST_{t+25}$ | PST Stumpage t + 25 ~ Acres Planted | 1935 - 1995 | 0.46 | < .001 *** | 1.1E-05 |
| $CNS_{t+17}$ | CNS Stumpage t + 17 ~ Acres Planted | 1964 - 1999 | 0.31 | < .001 *** | 5.3E-06 |
| $PPW_{t+12}$ | PPW Stumpage t + 12 ~ Acres Planted | 1963 - 1999 | 0.67 | < .001 *** | 2.9E-06 |

When assessed for all years in which data is available, results indicate a statistically significant relationship between stumpage prices for PST, CNS, and PPW timber product classes. $R^2$ values of 0.46, 0.31, and 0.67 were for $PST_{t+25,}$ $CNS_{t+17,}$ and $PPW_{t+12,}$ respectively (table 10). These results support the alternative hypothesis for PST and PPW timber product classes. Tables 14, 15 and 16 (appendix) show full regression results.

*Over the long-term (1964 – 2020), is there a relationship between stumpage prices in the South and construction activity in the United States?*

$H_o$: There is not a relationship between stumpage prices in the South and construction activity in the United States

$H_{a:}$ There is not a relationship between stumpage prices in the South and construction activity in the United States

**Table 12: Stumpage ~ Construction Activity**

| Timber Product Class | Statistical Test | Time Range | $R^2$ | 0 | Coefficient |
|---|---|---|---|---|---|
| PST | PST Stumpage ~ Construction Activity | 1964 - 2020 | 0.54 | < .001 *** | 2.1E-05 |
| CNS | CNS Stumpage ~ Construction Activity | 1980 - 2020 | 0.09 | 0.051 | 4.4E-06 |
| PPW | PPW Stumpage ~ Construction Activity | 1976 - 2020 | 0.50 | < .001 *** | 4.0E-06 |

When assessed for all years in which data for construction activity in the US is available, results indicated a statistically significant relationship between PST and PPW product classes and construction activity. While results for CNS are statistically insignificant, a $R^2$ values of 0.54 and 0.50 were obtained for PST and PPW, respectively. These results support the alternative hypothesis for PST and PPW timber product classes. Tables 17, 18, and 19 (appendix) illustrate full regression results.

*Are differences in impact between shifts in demand and shifts in supply on stumpage prices by timber class observable in the South?*

**Table 13: Stumpage ~ Acreage Planted, Construction Activity**

| Timber Product Class | Statistical Test | Time Range | X = Acreage Planted | | | X = Construction Activity | | |
|---|---|---|---|---|---|---|---|---|
| | | | $R^2$ | P-Value | Coefficient | $R^2$ | P-Value | Coefficient |
| PST | Stumpage ~ X | 1964 - 1999 | 0.50 | < .001 *** | 1.77E-05 | 0.87 | < .001 *** | 5.12E-05 |
| CNS | Stumpage ~ X | 1980 - 1999 | 0.01 | 0.657 | -1.5E-06 | 0.75 | < .001 *** | 3.87E-05 |
| PPW | Stumpage ~ X | 1976 - 1999 | 0.85 | < .001 *** | 4.0E-06 | 0.81 | < .001 *** | 1.24E-05 |

Using overlapping years of stumpage data and construction activity (1964 – 1999, 1980 – 1999, and 1976 – 1999 for PST, CNS, and PPW, respectively), statistically significant results were obtained for PST and PPW (table 12). Results for CNS are statistically insignificant. Differences in correlation between demand and supply exist and vary by classes for which statistically significant results were obtained. An $R^2$ value of 0.87 indicates a strong correlation between PST and construction activity. This contrasts to a comparatively moderate explanatory power of $R^2 = 0.50$ for $PST_{t+25}$ ~ Acres Planted. Variability is PPW stumpage correlates more to planting volume ($R^2 = 0.85$) relative to construction activity in the US ($R^2 = 0.81$). These results demonstrate a difference between the impact of supply shifts and the impact of supply shifts on stumpage prices. Tables 20 – 25 (appendix) provide full regression results.

*What do the results of questions (1), (2), and (3) indicate about the extent to which the Conservation Reserve Program may be said to influenced stumpage prices in the Southeast?*

Results indicate statistically a significant relationship between PST and PPW timber product classes with both acreage planted and construction activity. Results for both timber classes and independent variables exhibit moderate explanatory power.

**Table 14: Summary of Results**

| Timber Product Class | Statistical Test | Time Range | $R^2$ | P-Value | Coefficient |
|---|---|---|---|---|---|
| $PST_{t+25}$ | PST Stumpage t + 25 ~ Acres Planted | 1935 - 1995 | 0.46 | < .001 *** | 1.1E-05 |
| $CNS_{t+17}$ | CNS Stumpage t + 17 ~ Acres Planted | 1964 - 1999 | 0.31 | < .001 *** | 5.3E-06 |
| $PPW_{t+12}$ | PPW Stumpage t + 12 ~ Acres Planted | 1963 - 1999 | 0.67 | < .001 *** | 2.9E-06 |

| Timber Product Class | Statistical Test | Time Range | $R^2$ | 0 | Coefficient |
|---|---|---|---|---|---|
| PST | PST Stumpage ~ Construction Activity | 1964 - 2020 | 0.54 | < .001 *** | 2.1E-05 |
| CNS | CNS Stumpage ~ Construction Activity | 1980 - 2020 | 0.09 | 0.051 | 4.4E-06 |
| PPW | PPW Stumpage ~ Construction Activity | 1976 - 2020 | 0.50 | < .001 *** | 4.0E-06 |

| Timber Product Class | Statistical Test | Time Range | X = Acreage Planted | | | X = Construction Activity | | |
|---|---|---|---|---|---|---|---|---|
| | | | $R^2$ | P-Value | Coefficient | $R^2$ | P-Value | Coefficient |
| PST | Stumpage ~ X | 1964 - 1999 | 0.50 | < .001 *** | 1.77E-05 | 0.87 | < .001 *** | 5.12E-05 |
| CNS | Stumpage ~ X | 1980 - 1999 | 0.01 | 0.657 | -1.5E-06 | 0.75 | < .001 *** | 3.87E-05 |
| PPW | Stumpage ~ X | 1976 - 1999 | 0.85 | < .001 *** | 4.0E-06 | 0.81 | < .001 *** | 1.24E-05 |

**Discussion:**

Results vary across timber product class and selection of years tested (table 13). Over the period for which data is available, PST stumpage exhibits a stronger correlation toward construction activity, a demand-driven variable, than toward acreage planted, a supply variable. PPW exhibits strong correlation to both acreage planted and construction activity, with the former slightly stronger than the latter. Because recent speculation about the CRP's impact on stumpage prices is predicated upon the existence of a strong relationship between acreage planted and stumpage prices, these findings call into question a key premise of that argument.

*Over the long-term (1925 – 1999), is there a relationship between stumpage prices and the supply of timber in the South?*

According to the results of the analysis, there is a relationship between PST stumpage prices and acreage planted. A moderate correlation of $R^2 = 0.46$ suggests that roughly half of the variability in stumpage prices reported from 1964 – 2020 can be explained by planting volume. While availability of stumpage prices allows for a larger sample size, PPW exhibits an even stronger result, with roughly 2/3 of variability in PPW stumpage explained by shifts in planting volume. These findings illustrate a fundamental relationship between stumpage prices and planting volumes.

Results demonstrating a higher correlation between demand and PST relative to acres planted and PST could reflect a higher willingness to harvest when landowners perceive high returns for executing a timber harvest. Unlike PST, explanatory power between PPW stumpage and both demand and supply is consistently strong. On the demand side, the incongruous result could reflect the tendency of overall consumer expenditure to track with construction activity expenditure.

*Over the long-term (1964 - 2020), is there a relationship between stumpage prices in the South and construction activity in the United States?*

The relationship between stumpage prices across PST and PPW timber product classes and construction activity in the United States is statistically significant over the entire period which data is available (1964 – 2020 for PST, 1976 – 2020 for PPW). During these periods, roughly half of the variability in stumpage prices is explained by variation in construction activity. These findings demonstrate the existence of a relationship between stumpage prices in the South and construction activity.

*Are differences in impact between shifts in demand and shifts in supply on stumpage prices by timber class observable in the South?*

Results demonstrate a difference in the impact of planting volumes and construction activity on stumpage prices. Specifically, when assessing exclusively on years which overlapping data is available, construction activity has a meaningfully higher (0.87 vs. 0.50) explanatory power for PST. Divergent results were obtained for PPW, with $R^2 = 0.84$ for planting volumes marginally higher than $R^2 = .81$ for construction activity in the United States. Notably, construction activity in the United States explains more stumpage price variation during the window tested (1965 – 1995) relative to acreage planted than over the long-term (1964 – 2020). This is likely due, at least in part, to the demand shock precipitated by the Global Financial Crisis of 2008.

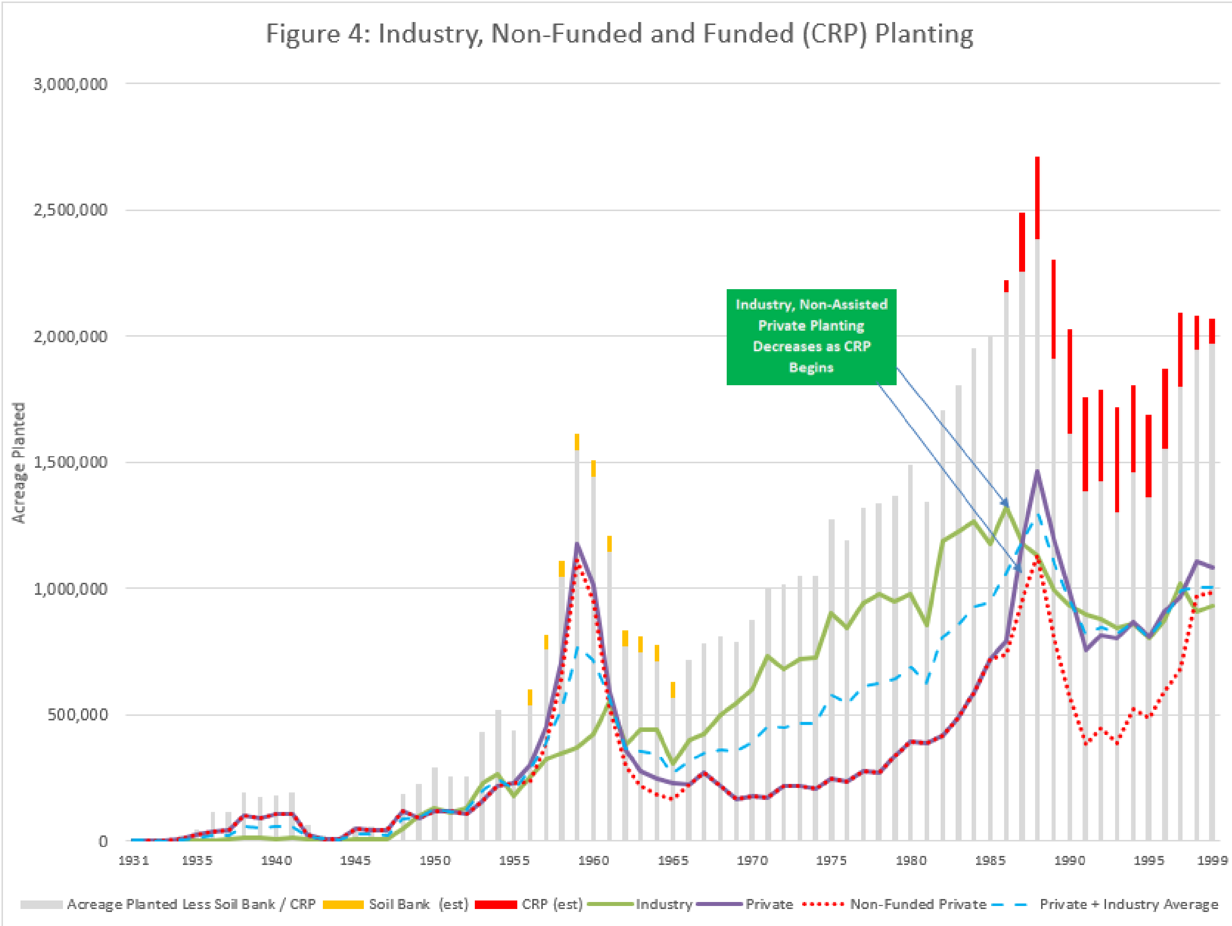
## The Big Picture

The above statistical analysis demonstrates long-term, statistically significant relationships between both acreage planted in the South and construction activity in the United States on stumpage prices in the South. The assessment further supports the view that that demand shifts, i.e. construction activity in the US, are more impactful on PST stumpage than supply drivers, i.e. planting volume in the South. In addition to these considerations regarding statistical analysis, insights from conversations with professionals in the forestry industry strengthen the conclusion that the CRP did not meaningfully influence an oversupply that resulted in declining stumpage prices.

Data points from David N. Wear[21], non-resident senior fellow at Resources for the Future in Durham, North Carolina, support his skepticism about a direct relationship between the CRP and declines in stumpage. Specific considerations include:

1. **Substitution Effects:** Landowners who chose to utilize funding provided through the CRP may have chosen to proceed with planting without CRP assistance if said funding was unavailable. Substitution effects may have a meaningful impact in determining the extent to which the CRP may be said to have impacted overall planting. Because this effect is impossible to measure precisely, it is a dynamic which could merit future research. A visualization below incorporates estimates for CRP acreage and illustrates the relative shifts in industry and overall private planting. This idea is supported by a visualization demonstrating a marked decrease in private planting without CRP assistance as the CRP began in 1986 (Figure 4).

[21] David N. Wear, Non-Resident Senior Fellow, Resources for the Future. Personal Communication, January 17, 2022.




2. **Definition of Oversupply:** It is not necessarily true that the current timber inventory in the South is an oversupply. Lower than expected returns could be a reflex of continued adjustment in the sector.

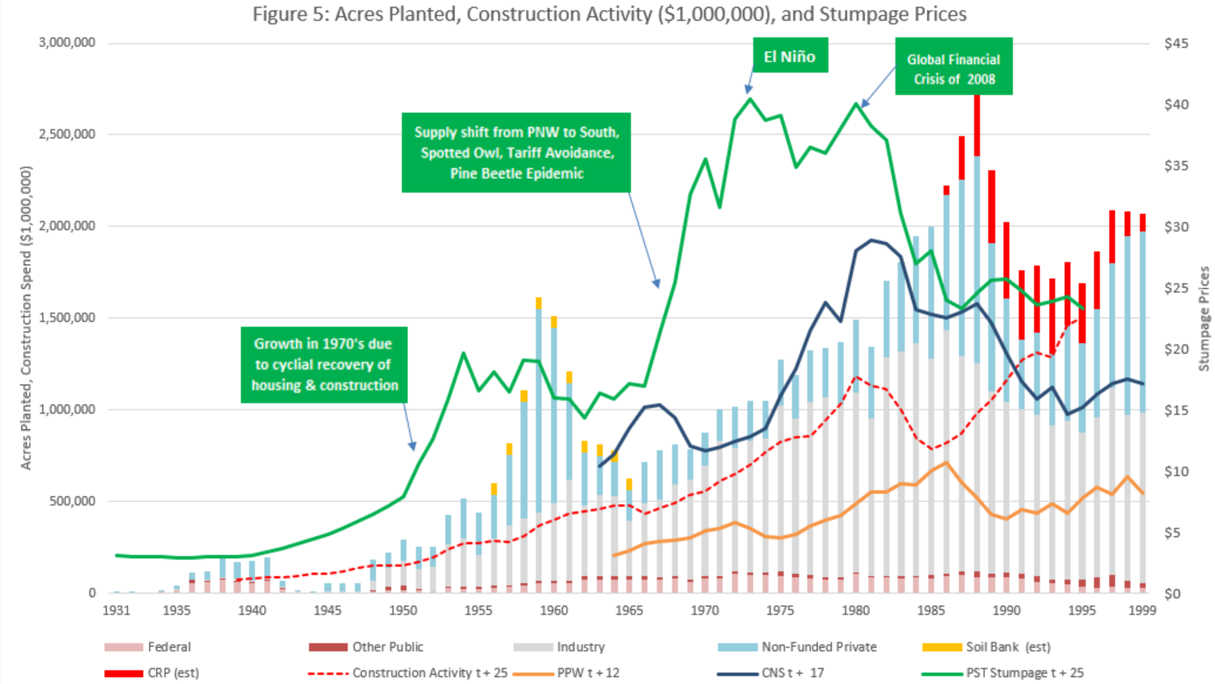
3. **Variable Management Intensity:** As farmers opting to plant with assistance of the CRP may not have the same managerial goals as commercial timber operations, operational inventory may not have changed to the same extent that overall timber acreage was changed as a result of the CRP. This insight is supported by survey results indicating that only 4% of CRP participants intended to leave planted acreage in tree cover for commercial timber production[22].

[22] Dangerfield, C. W., Newman, D. H., & Moorhead, D. J. (n.d.). *Land When CRP Payments End: What History Tells Us In Georgia*. Retrieved January 1, 2022, from https://bugwoodcloud.org/resource/files/14830.pdf

4. **Transition from "Mining Old Growth" to Modern Period of Harvesting Secondary Growth:** Prices increased throughout the 1990's as the transition from mining old growth timber in the United States became more oriented toward harvesting second-growth timber. As the transition has now occurred, prices could be reverting toward a mean.

Bridging these considerations with the data analysis component associated with questions (1), (2), and (3), it is clear that the relationship between acreage planted, the expansion or contraction of overall timber area that resulted from the CRP, and the influence of those factors on stumpage prices is nuanced and imprecise. However, certain events from 1970 – 2008 are useful in connecting developments in the economy to volatility in stumpage prices in the South. Specifically, cyclical recovery in housing and construction in the 1970s overlaps with stumpage price increases in the 1970s. Similarly, increases in stumpage prices in the 1990s can be attributable to supply shifts from the Pacific Northwest to the South, the growing presence of Canadian industry in the South due to tariff avoidance, and the mountain pine beetle epidemic. Finally, the housing crisis of 2008 is a significant inflection point that precipitated a dramatic decline in demand for forest products.

Figure 5: Acres Planted, Construction Activity ($1,000,000), and Stumpage Prices



## Limitations

While the quantitative and qualitative insights above illuminate nuances and trends in the relationship between planting volumes, stumpage prices, and the CRP, there are limits to their applicability. Specifically,

1. Assumptions made may have had a significant impact on overall results.

CRP acreage in the South could be higher than estimated. Data on CRP acreage planted at the state level is imprecise. While fully acknowledging this limitation, the results of my assessment are consistent with academic estimates. Additionally, stumpage data for years prior to 1976 relies on historical data from public lands in the South, which may not precisely align with data including private land. Finally, stumpage prices reflect local market conditions. An examination of trends at the regional scale will not apply to every individual market within the region.

2. Results are heavily influenced by the period that is analyzed.

The scope of this analysis is limited by availability of planting, stumpage, and construction activity data. Results may vary depending on the period assessed.

3. Insignificant results for CNS

This could be due to a smaller sample size, a relatively low volume of timber assuming harvest at $t = 17$, or, as discussed above, exogenous factors.

4. Lag Assumptions:

   Assumed harvest ages may not fully capture the relationship between timber product classes and corresponding stumpage prices. Timber remains merchantable beyond the lower merchantability thresholds used as assumptions in this analysis.

## Recommendations for future research on this topic

1. Use the results above as a baseline and focus on specific markets in the South. Contrasting local conditions with the overall regional trends can lead to unique local market insights.
2. Access and apply import and export data to introduce more demand variables and assess for differences in the relationship between those variables and construction activity in the US
3. Investigate the relationship between total forested area rather than acres planted. While acreage planted can be a reasonable proxy for overall timber supply, it excludes operational inventory generated naturally and thus does not fully capture supply.

**Acknowledgement**

Thank you to Dr. Nicolette Cagle and Joe Bachman both of Duke University for extraordinary mentorship and support throughout this project. I am also extremely grateful to Richard A. Harper (Retired: USDA Forest Service, Forest Inventory and Analysis, Analyst, and Professional Consultant), whose data enabled this analysis. I am equally grateful to Andy Malmquist (Retired Biometrician: Timberland Investment Analytics) and David N. Wear (Non-Resident Senior Fellow: Resources for the Future) for their perspective and wisdom about the subject.

# Appendix

**Table 14**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.68 |
| R Square | 0.46 |
| Adjusted R Square | 0.45 |
| Standard Error | 541273 |
| Observations | 61 |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 153706 | 135252 | 1.14 | 0.26 | -116933.11 | 424344.15 | -116933.11 | 424344.15 |
| Acreage Planted | 1.12178E-05 | 5781 | 7.04 | 0.00 | 29112.69 | 52246.56 | 29112.69 | 52246.56 |

**Table 15**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.56 |
| R Square | 0.31 |
| Adjusted R Square | 0.29 |
| Standard Error | 4.45 |
| Observations | 37.00 |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 10.33 | 2.12 | 4.88 | 0.00 | 6.03 | 14.63 | 6.03 | 14.63 |
| Acreage Planted | 0.00 | 0.00 | 3.98 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 16**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.82 |
| R Square | 0.67 |
| Adjusted R Square | 0.66 |
| Standard Error | 1.15 |
| Observations | 36.00 |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 2.24 | 0.57 | 3.97 | 0.00 | 1.09 | 3.39 | 1.09 | 3.39 |
| Acreage Planted | 0.00 | 0.00 | 8.26 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 17**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.74 |
| R Square | 0.54 |
| Adjusted R Square | 0.53 |
| Standard Error | 7.92 |
| Observations | 57.00 |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 8.97 | 1.86 | 4.84 | 0.00 | 5.25 | 12.69 | 5.25 | 12.69 |
| Construction Activity | 0.00 | 0.00 | 8.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 18**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.31 |
| R Square | 0.09 |
| Adjusted R Square | 0.07 |
| Standard Error | 4.86 |
| Observations | 41.00 |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 14.65 | 1.87 | 7.84 | 0.00 | 10.87 | 18.43 | 10.87 | 18.43 |
| Construction Activity | 0.00 | 0.00 | 2.01 | 0.051 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 19**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.71 |
| R Square | 0.50 |
| Adjusted R Square | [illegible] |
| Standard Error | 1.52 |
| Observations | 45.00 |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 4.27 | 0.50 | 8.48 | 0.00 | 3.25 | 5.28 | 3.25 | 5.28 |
| Construction Activity | 0.00 | 0.00 | 6.52 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 20**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.71 |
| R Square | 0.50 |
| Adjusted R Square | 0.49 |
| Standard Error | 7.87 |
| Observations | 36.00 |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 5.67 | 2.24 | 2.54 | 0.02 | 1.13 | 10.22 | 1.13 | 10.22 |
| Acreage Planted | 0.00 | 0.00 | 5.84 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 21**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.11 |
| R Square | 0.01 |
| Adjusted R Square | -0.04 |
| Standard Error | 4.87 |
| Observations | 20.00 |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 23.93 | 6.77 | 3.53 | 0.00 | 9.70 | 38.16 | 9.70 | 38.16 |
| Acreage Planted | 0.00 | 0.00 | -0.45 | 0.657 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 22**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.92 |
| R Square | 0.85 |
| Adjusted R Square | 0.84 |
| Standard Error | 0.86 |
| Observations | 24.00 |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 1.10 | 0.49 | 2.24 | 0.04 | 0.08 | 2.11 | 0.08 | 2.11 |
| Acreage Planted | 0.00 | 0.00 | 11.18 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 23**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.93 |
| R Square | 0.87 |
| Adjusted R Square | 0.86 |
| Standard Error | 4.04 |
| Observations | 36.00 |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | -0.40 | 1.30 | -0.31 | 0.76 | -3.05 | 2.24 | -3.05 | 2.24 |
| Construction Activity | 0.00 | 0.00 | 14.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 24**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.86 |
| R Square | 0.75 |
| Adjusted R Square | 0.73 |
| Standard Error | 3.20 |
| Observations | 20.00 |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | -1.14 | 2.61 | -0.44 | 0.67 | -6.63 | 4.35 | -6.63 | 4.35 |
| Construction Activity | 0.00 | 0.00 | 7.27 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 25**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.90 |
| R Square | 0.81 |
| Adjusted R Square | 0.80 |
| Standard Error | 0.98 |
| Observations | 24.00 |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0.88 | 0.59 | 1.48 | 0.15 | -0.35 | 2.10 | -0.35 | 2.10 |
| Construction Activity | 0.00 | 0.00 | 9.59 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |