

The annual increase of Northeastern regional timber stumpage prices: 1961 to 2002

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Abstract

Annual percentage rates of change for Northeastern regional sawtimber and pulpwood stumpage prices were estimated for the period 1961 to 2002. In addition, we examined if there have been any changes in the annual percentage rate of change during the same period. The results showed that the real (nominal) annual percentage rates of change for hardwood sawtimber and softwood pulpwood stumpage prices were 4.6 percent (8.5%) and 0.7 percent (4.6%), respectively. Annual real hardwood pulpwood stumpage prices increased at 0.6 percent while annual nominal hardwood pulpwood stumpage prices increased at a faster rate during 1961 to 1981 than during 1982 to 2002; namely, 7.3 vs. 1.6 percent, respectively. Annual nominal softwood sawtimber stumpage prices increased at 5.2 percent while annual real softwood sawtimber stumpage prices increased at a slower rate during 1961 to 1981 than during 1982 to 2002; namely, 0.6 vs. 2.2 percent, respectively. This research indicates that an average landowner holding an average mix of hardwood sawtimber could reasonably achieve a 4.6 percent annual increase in the revenue from a future sale of that sawtimber due to real price appreciation alone. The same landowner may achieve greater or lesser gains depending on species composition, structure, age, and density of the stand combined with prudent forest management choices. While the annual percentage rates of change described here may not reflect the stumpage markets of a specific sub-state region or individual property, they may provide a forestry consultant with additional information to help compare potential returns from forest management to other uses of a landowner's capital such as mutual funds, stocks, and bonds.

The demand for stumpage is derived from the demand for final products manufactured from wood. Stumpage price is often thought of as a residual; for example, the value left after all costs, including an allowance for profit, is deducted from the value of lumber at the mill, back to the stump. Stumpage price is important to the forestland owner because it is an important component in determining profit from growing timber. Likewise, it is important to the mill owner because stumpage price is a significant part of the cost of delivered logs and influences profit for the mill as the owner balances the demand for lumber against the cost of logs in a competitive market.

Much has been written concerning the impact of stumpage prices on forest management (e.g., Dennis 1989, Haight and Holmes 1991, Wagner et al. 1995, Lindahl and Plantinga 1997a, Plantinga 1998, Brazee et al. 1999, Linden and Uusivuori 2000, Prestemon and Holmes 2000). In addition, trends in stumpage prices have been analyzed to examine historical price movements and to help form expectations about future prices (e.g., Sendak and McEvoy 1989, Holmes

et al. 1990, Washburn and Binkley 1990, Howard and Chase 1995, Yin and Newman 1996, Lindahl and Plantinga 1997b, Kittredge and Haslam 2000, Irland et al. 2001, Linchan et al. 2003, Prestemon 2003). The value of and information contained in stumpage prices have been studied (e.g., Washburn and Binkley 1990, Yin and Newman 1996) and stumpage prices are required input into macroeconomic models of timber markets (Haynes and Skog 2002). Pub-

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lications by Timberland Investment Management Organizations, such as Timberland Report (James Sewall Co. various years), Hancock Timberland Investor (2002), and Wachovia (2002), indicate the importance these organizations place on stumpage prices in determining the returns of their timberland investments.¹ Finally, while stumpage price information is widely available, there is some evidence that nonindustrial private forestland (NIPF) owners do not use it in making decisions about forest management (Rosen and Kaiser 2003). Jones et al. (1995) estimate that less than 20 percent of NIPF timber harvests involve a forester. Describing the historical growth in stumpage prices provides the forester with another piece of information that illustrates potential financial benefits of forest management (e.g., Wagner et al. 2003).

Sendak (1994) provided estimates of the annual percentage rate of change for Northeastern regional timber stumpage prices for the period 1961 to 1991. The stumpage prices were delineated by hardwood vs. softwood and sawtimber vs. pulpwood. The purpose of this analysis is threefold. The first purpose is to update the 1961 to 1991 price series; an additional 11-year's worth of Northeastern regional timber stumpage price data have been collected. The data set now covers the period 1961 to 2002. The second purpose is to examine if there have been any changes in the annual percentage rate of change during the period 1961 to 2002. The final purpose is to provide foresters an additional piece of information when discussing forest management options with landowners, for land appraisals and valuation, and assessment of investment strategies.

Stumpage price data

Regional stumpage price data, for the period 1961 to 2002, were collected from nine Northeastern states: Connecticut, Maine, Massachusetts, New Hampshire, New York, Pennsylvania, Rhode Island, Vermont, and West Virginia (**Table 1**). Regional stumpage prices were estimated using the methods in Sendak (1994) and publicly reported stumpage prices as follows:

"The rule applied was to include the fewest number of species that accounted for at least 85 percent of the total cut as reported by the most recent forest inventory. If the 85-percent level was reached, additional species were included if they accounted for at least 5 percent of the total cut...Within a state and product group, such as hardwood sawtimber in New York, a volume-weighted average price for species in that group was calculated. These averages were then weighted by total timber volume cut for each product group to calculate region-wide averages...Through weighting, those species cut in the greatest quantities and those states that harvested the greatest quantities were assigned more importance in calculating average price."

There were several changes in state data reporting that should be noted when comparing **Table 1** to the regional stumpage prices for the period 1961 to 1991. Maine made major changes in data collection and reporting format in 1992. Southern New England expanded their reporting format in 1994 that required a change in the calculation of their aggregate prices. In the Summer of 1995 Stumpage Price Report, New York changed their reporting regions from 14 to 12 and renamed them based on location and log rule. All these changes affected the regional price estimates from 1992 through 1995.

In Maine, species cut weights and volumes cut were changed to reflect the latest forest survey (Griffith and Alerich 1996), pulpwood production (Widmann 1996), and the 1995 Wood Processor Report (Maine Forest Service 1997). In New Hampshire, stumpage price data were not reported in 1996. Stumpage prices for 1996 were estimated from 1995 and 1997 prices. The New Hampshire reporting format also changed; pulpwood being reported by weight instead of cords. In New York, the latest forest survey (Alerich and Drake 1995) and pulpwood production (Widmann 1996) were used to adjust species cut weights and volumes cut. In addition, the stumpage prices under Doyle and Scribner Rules were adjusted to International Rule basis by new factors reported in the Pennsylvania Stumpage Price Report. These new factors, based on a study of average size logs, were significantly different from the old factors (Finley and Rickenbach 1996) and were re-

flected in the prices for New York in 1996. In Pennsylvania, the new log rule factors were implemented in the fourth quarter of 1996 and were reflected in the prices reported from that quarter on. In Pennsylvania, the latest forest survey (Wharton and Bearer 1993) and pulpwood production (Widmann 1996) were used to adjust species cut weights and volumes cut. In West Virginia, the latest forest survey (Widmann and Murriner 1990) and pulpwood production (Widmann 1996) were used to adjust species cut weights and volumes cut. The new conversion factor from Doyle to International was applied (Finley and Rickenbach 1996). These changes affected the regional stumpage price estimates in 1996.

In 1999, small changes were noted in some state reports. For example, Pennsylvania reports pine and hemlock as two separate species now instead of a pine/hemlock group. The biggest change occurred in New Hampshire. The New Hampshire Extension Service changed their stumpage price reporting to once every 2 years. However, the New Hampshire Timberland Owners Association (NHTOA) reports prices quarterly. The NHTOA stumpage price information is now used here. The two price series showed remarkable agreement over the period that they overlapped, 1985 to 1997 (Sendak, unpublished report on file, Durham, NH). Species cut weights and volumes cut for pulpwood production were adjusted using Widmann and Griffith (1999).

Annual sawtimber-cut weighting factors were updated on the basis of state output reported on the Timber Product Output website maintained by the USDA Forest Service for the 1997 RPA Assessment. Species cut proportions and volumes were adjusted as new state Forest Inventory and Analysis data became available in print or on the web (e.g., pulpwood production for all states and sawtimber production for New York and West Virginia in 2002).

Table 1 shows the nominal and real stumpage prices of Northeastern hardwood and softwood sawtimber and pulpwood for the period 1961 to 2002. The nominal and real stumpage prices of hardwood and softwood sawtimber have generally increased over the period 1961 to 2002. During the period 2000 to 2001, the stumpage prices for hardwood and softwood sawtimber decreased;

¹ For example, Wachovia (2002) estimates that biological growth accounts for between 65 to 75 percent of timberland returns, timber price change accounts for between 25 to 30 percent, and land value change accounts for 2 to 5 percent.

Table 1. — Average nominal and real stumpage prices, by product group, in the Northeast: 1961 to 2002.

Year	Sawtimber price				Pulpwood price			
	Hardwood		Softwood		Hardwood		Softwood	
	Nominal	Real ^a	Nominal	Real ^a	Nominal	Real ^a	Nominal	Real ^a
	----- (\$/MBF) -----				----- (\$/cord) -----			
1961	13.64	43.17	13.86	43.87	1.31	4.15	1.97	6.24
1962	13.79	43.51	14.21	44.81	1.39	4.38	2.05	6.46
1963	14.34	45.36	14.90	47.15	1.46	4.62	2.15	6.80
1964	14.63	44.87	14.90	45.71	1.56	4.79	2.29	7.03
1965	14.64	45.32	15.47	47.91	1.48	4.57	2.53	7.82
1966	15.79	47.43	15.87	47.66	1.82	5.47	2.49	7.48
1967	14.91	44.64	16.30	48.81	2.07	6.20	2.63	7.88
1968	16.15	47.21	16.78	49.06	1.97	5.75	2.62	7.66
1969	17.92	50.33	18.19	51.10	2.09	5.87	2.58	7.26
1970	19.15	51.89	17.69	47.93	2.67	7.22	2.76	7.48
1971	18.93	49.68	18.66	48.98	2.12	5.56	2.76	7.25
1972	20.64	51.85	19.43	48.83	2.26	5.69	2.86	7.17
1973	21.02	46.71	20.90	46.43	2.48	5.51	3.33	7.39
1974	39.98	74.73	24.36	45.53	2.58	4.81	3.79	7.08
1975	38.65	66.18	28.52	48.84	3.10	5.31	3.79	6.48
1976	42.48	69.53	31.45	51.47	3.50	5.73	4.66	7.63
1977	48.09	74.09	33.14	51.06	3.77	5.81	4.45	6.85
1978	62.19	88.97	38.32	54.83	4.10	5.86	5.16	7.38
1979	81.69	103.79	46.93	59.64	4.69	5.95	5.62	7.14
1980	79.80	88.86	49.13	54.70	5.61	6.25	6.19	6.89
1981	81.25	82.91	48.99	49.99	5.38	5.49	6.42	6.55
1982	85.67	85.67	52.55	52.55	5.86	5.86	6.99	6.99
1983	104.87	103.52	51.19	50.53	6.03	5.95	6.62	6.53
1984	104.67	100.93	52.72	50.83	6.73	6.49	7.09	6.84
1985	104.85	101.60	53.63	51.97	6.48	6.28	6.99	6.77
1986	113.93	113.70	53.35	53.24	6.18	6.17	6.86	6.85
1987	132.65	129.03	58.47	56.88	6.46	6.29	6.90	6.71
1988	163.34	152.80	61.19	57.24	7.02	6.56	7.48	6.99
1989	142.78	127.25	65.50	58.38	6.80	6.06	8.08	7.20
1990	142.74	122.74	66.83	57.46	6.46	5.55	8.42	7.24
1991	139.73	119.94	65.14	55.92	6.45	5.53	8.95	7.68
1992	170.44	145.43	65.57	55.94	7.14	6.09	8.96	7.64
1993	225.87	189.97	71.47	60.11	6.11	5.14	9.06	7.62
1994	244.04	202.69	79.30	65.87	7.19	5.97	10.50	8.72
1995	231.61	185.74	86.39	69.28	7.23	5.80	11.72	9.40
1996	222.66	174.36	88.20	69.07	8.10	6.34	14.38	11.26
1997	257.33	201.67	96.83	75.89	8.20	6.42	14.60	11.44
1998	257.67	207.13	99.86	80.28	8.01	6.44	13.50	10.85
1999	259.90	207.09	107.37	85.55	8.00	6.38	11.98	9.55
2000	297.53	224.38	111.03	83.73	7.51	5.66	12.09	9.12
2001	267.69	199.47	104.60	77.94	7.77	5.79	11.78	8.78
2002	276.80	211.13	102.76	78.39	8.00	6.10	10.67	8.13

^a Adjusted for inflation by Producer Price Index, All-commodity (1982 = 100).

however, hardwood sawtimber stumpage prices turned upward in 2002 while softwood sawtimber stumpage prices did not. The nominal stumpage prices of hardwood pulpwood appear to have increased faster during the period 1961 to 1980 than during the period 1981 to

2002, while the real stumpage price of hardwood pulpwood showed a more moderate, but volatile, increase for the period 1961 to 2002. Hardwood pulpwood stumpage prices also declined during the period 1999 to 2000, but started to recover in 2001. Nominal and

real softwood pulpwood stumpage prices increased during the period 1961 to 1997, with dramatic increases between 1993 and 1997. From 1998 to 2002, nominal and real softwood pulpwood stumpage prices have declined rapidly.

Irland et al. (2001) discuss some of the limitations of publicly reported stumpage data given the manner in which it is collected, leading to potential sampling and non-sampling errors that may affect the accuracy of the reported data. This is a common problem with publicly reported stumpage price data. However, in the Northeast this is the most readily available and consistent source of time series stumpage data. Therefore, the results of the analysis that follows should be used with this caveat.

Methods

Equation [1] can be used to estimate the stumpage prices at any time t (P_t) if the continuous rate of change for stumpage price (r) is known:

$$P_t = P_0 e^{rt} \quad [1]$$

where P_0 denotes the stumpage price at time 0 and e denotes the exponential function. The continuous rate of change in stumpage prices can be estimated using linear regression by taking the natural log of equation [1]:

$$\ln(P_t) = \beta + r \times t + \varepsilon_t \quad [2]$$

where $\ln(P_t)$ denotes the natural log of P_t and ε_t denotes the regression error. Finally, the continuous rate of change (r) can be converted to an annual percentage rate of change (i) using equation [3] (Sendak 1991, 1994):

$$i = e^r - 1 \quad [3]$$

Equation [2] describes a time series analysis; as such, there are potential problems of autocorrelation. Determining the exact autoregressive process beyond a first-order autoregressive error term, AR(1), can be problematic (Judge et al. 1985, Greene 2000). We will use a stepwise autoregressive procedure to determine the order of the autoregressive error term. Because we are dealing with annual data, we will only test for first- and second-order autocorrelation. If either first- or second-order autocorrelation is present at the 5 percent level of significance, a maximum likelihood (ML) procedure will be used to correct for this problem (e.g., Pindyck and Rubinfeld 1981, Johnston 1984, Judge et al. 1985, Greene 2000, SAS 2002).

To determine if there was a change in the annual percentage rate of change during the period 1961 to 2002, the data had to be divided into at least two groups. Table 1 showed a potential change in the annual percentage rate of change of the

nominal and real sawtimber and pulpwood stumpage prices occurring at about 1981, this was especially evident in nominal hardwood pulpwood stumpage prices. Therefore, the data were divided into the following periods 1961 to 1981 and 1982 to 2002. The following regression analysis was used to test for a change in the annual percentage rate of change between 1961 to 1981 and 1982 to 2002:

$$\ln(P_t) = \beta_1 + \beta_2 \times d + r_1 \times t + r_2(d \times t) + \varepsilon_t \quad [4]$$

where d is a dummy variable:

$$d = \begin{cases} 0 & \text{if } t = 1961 \text{ to } 1981 \\ 1 & \text{if } t = 1982 \text{ to } 2002 \end{cases}$$

When $d = 0$, r_1 denotes the continuous rate of change for the period 1961 to 1981. When $d = 1$, $r_1 + r_2$ denotes the continuous rate of change for the period 1982 to 2002. Equation [3] was used to convert the continuous rate of change r_1 (for the period 1961 to 1981) and the continuous rate of change $r_1 + r_2$ (for the period 1982 to 2002) to annual percentage rates of change.

To determine if there is a significant difference between the annual percentage rate of change for the periods 1961 to 1981 and 1982 to 2002 requires testing for coincidence of the two straight lines given in equation [4]. Two lines are coincident if their intercepts are not significantly different and their slopes are not significantly different. This is a two-step process (Kleinbaum et al. 1998). First, a Chow F-test is used to test the null hypothesis that $\beta_2 = r_2 = 0$. If the null hypothesis is not rejected, then the lines are coincident. Thus, the annual percentage rate of change estimated for the period 1961 to 1981 is not significantly different than the annual percentage rate of change for the period 1982 to 2002. Second, if the null hypothesis that $\beta_2 = r_2 = 0$ is rejected, then the null hypothesis that $r_2 = 0$ is tested using a t-test. If the null hypothesis $r_2 = 0$ is rejected, then the two lines are not parallel and have different intercepts. Thus, the annual percentage rate of change estimated for the period 1961 to 1981 is significantly different than the annual percentage rate of change for the period 1982 to 2002. If the null hypothesis $r_2 = 0$ is not rejected, then the two lines are parallel but have different intercepts. Thus, the annual percentage rate of change estimated for the period 1961 to

1991 is not significantly different than that for the period 1961 to 2002. This regression analysis is also tested for first- and second-order autocorrelation and, if present, is corrected using the same process as just described.

The statistical analyses were done using SAS v. 9.0 (SAS 2002). The analysis done by Sendak (1994) was completed using a different statistical package. Therefore, we re-ran the statistical analysis on the 1961 to 1991 stumpage price data in SAS to make consistent comparisons to the 1961 to 2002 annual percentage rate change.

Results

The regression analysis results, from equation [2], of nominal and real Northeastern regional stumpage prices by species group (i.e., hardwood and softwood) and product (i.e., sawtimber and pulpwood) for the period 1961 to 2002 are given in Appendix A. The stepwise autoregressive procedure indicated there was positive first-order autocorrelation, but not second-order autocorrelation, in all cases. The ML procedure was used to estimate an AR(1) autoregressive term. The continuous rates of change were converted to annual percentage rates of change using Equation [3] and listed in Table 2. The annual percentage rates were significantly different from zero at greater than a 5 percent level of significance, except for the annual percentage rate of change for real softwood pulpwood.

The nominal and real annual percentage rates of change in Northeastern regional stumpage prices for the years 1961 to 1991 were re-estimated using SAS (2002). The stepwise autoregressive procedure indicated there was positive first-order autocorrelation, but not second-order autocorrelation, in all cases. The ML procedure was used to estimate an AR(1) autoregressive term. The continuous rates of change were converted to annual percentage rates of change using equation [3] and listed in Table 3. The annual percentage rates were significantly different from zero at greater than a 5 percent level of significance, except for the annual percentage rate of change for real softwood pulpwood.

Comparing the results presented in Tables 2 and 3 showed that the nominal annual percentage rate of change for hardwood and softwood sawtimber decreased; however, the real annual percentage rate of change for hardwood and

Table 2. — Nominal and real annual percentage rate of change in Northeastern regional stumpage prices by species and product group, 1961 to 2002.

Species and product group	Nominal	Real
	----- (%) -----	
Sawtimber		
Hardwood ^a	8.5	4.6
Softwood ^a	5.2	1.4
Pulpwood		
Hardwood	4.7 ^a	0.6 ^b
Softwood	4.6 ^a	0.7 ^c

^a Significantly different from zero ($p \leq 0.01$).

^b Significantly different from zero ($p \leq 0.05$).

^c Significantly different from zero ($p \leq 0.10$).

Table 3. — Re-estimation of the nominal and real annual percentage rate of change in Northeastern regional stumpage prices by species and product group, 1961 to 1991.

Species and product group	Nominal	Real
	----- (%) -----	
Sawtimber		
Hardwood ^a	9.2	4.3
Softwood ^a	5.6	0.8
Pulpwood		
Hardwood	6.1 ^a	0.9 ^b
Softwood	5.4 ^a	0.1 ^c

^a Significantly different from zero ($p \leq 0.01$).

^b Significantly different from zero ($p \leq 0.05$).

^c Not significantly different from zero.

Table 4. — Summary of the results for testing coincidence of stumpage prices between 1961 to 1981 and 1982 to 2002.

Stumpage price series	Coincidence test	Slope test
	$\beta_2 = r_2 = 0$	$r_2 = 0$
Sawtimber		
Hardwood (nominal) ^a	Fail to reject	N/A
Hardwood (real) ^a	Fail to reject	N/A
Softwood (nominal) ^a	Fail to reject	N/A
Softwood (real) ^b	Reject	Reject
Pulpwood		
Hardwood (nominal) ^c	Reject	Reject
Hardwood (real) ^a	Fail to reject	N/A
Softwood (nominal) ^a	Fail to reject	N/A
Softwood (real) ^a	Fail to reject	N/A

^aThe null hypothesis $\beta_2 = r_2 = 0$ failed to be rejected ($\alpha = 0.05$). This implied the two lines were coincident; there was no significant difference between the slopes and no significant difference between the intercepts.

^bThe null hypothesis $\beta_2 = r_2 = 0$ was rejected ($p = 0.052$). The null hypothesis $r_2 = 0$ was rejected ($p = 0.016$). This implied the two lines were not parallel and had different intercepts.

^cThe null hypotheses $\beta_2 = r_2 = 0$ and $r_2 = 0$ were rejected ($p \leq 0.01$). This implied the two lines were not parallel and had different intercepts.

softwood sawtimber increased. While there was a slight increase in the annual percentage rate of change for the real stumpage price of hardwood sawtimber, the increase in the annual percentage rate of change for the real stumpage price of softwood sawtimber was almost twice as large. The nominal annual percentage

rate of change for hardwood and softwood pulpwood decreased. The real annual percentage rate of change for hardwood pulpwood decreased while the real annual percentage rate of change for softwood pulpwood increased. However, the annual percentage rates of change and consequently the differences identified in Ta-

bles 2 and 3 do not describe statistical differences. Equation [4] was used to examine if the annual percentage rates of change were statistically different between 1961 to 1981 and 1982 to 2002.

The results of estimating Equation [4] are in Appendix B. The stepwise autoregressive procedure indicated there was positive first-order autocorrelation, but not second-order autocorrelation, in all cases. The ML procedure was used to estimate an AR(1) autoregressive term. The Chow F-test statistics tested for a significant difference between the slopes and intercepts of Equation [4] for the periods 1961 to 1981 and 1982 to 2002; i.e., $\beta_2 = r_2 = 0$. The Chow F-test statistics are given in Appendix B and the results of the coincidence and slope tests are summarized in Table 4. The null hypothesis that $\beta_2 = r_2 = 0$ failed to be rejected for nominal and real hardwood sawtimber, nominal softwood sawtimber, real hardwood pulpwood, and nominal and real softwood pulpwood. This implied there was no significant difference in the annual percentage rates of change between the periods 1961 to 1981 and 1982 to 2002 in these six cases. The results given in Table 2 describe the annual percentage rate of change in stumpage prices in these six cases for the period 1961 to 2002, *ceteris paribus*.

The null hypotheses that $\beta_2 = r_2 = 0$ and $r_2 = 0$ were rejected in the case of nominal hardwood pulpwood stumpage prices ($p \leq 0.01$). This implied there was a significant difference in the annual percentage rate of change between the periods 1961 to 1981 and 1982 to 2002. These results indicated that annual nominal hardwood pulpwood stumpage prices increased at a faster rate during 1961 to 1981 than during 1982 to 2002; namely, 7.3 vs. 1.6 percent, respectively (Table 5). For real softwood sawtimber stumpage prices, the null hypothesis that $\beta_2 = r_2 = 0$ was rejected ($p \leq 0.052$) and the null hypothesis that $r_2 = 0$ was rejected ($p \leq 0.016$). This implied there was a significant difference in the annual percentage rate of change between the periods 1961 to 1981 and 1982 to 2002. Annual real softwood stumpage prices increase at a slower rate during 1961 to 1981 than during 1982 to 2002; namely, 0.6 vs. 2.2 percent, respectively (Table 5).

Discussion and conclusions

Northeastern regional stumpage prices for the period 1961 to 2002 were

Table 5. — Nominal and real annual percentage rate of change in Northeastern regional stumpage prices by species and product group, 1961 to 2002.^a

Species and product group	Nominal	Real
	----- (%) -----	
Sawtimber		
Hardwood	8.5 ±1.5	4.6 ±0.5
Softwood	5.2 ±0.9	0.6 ±0.8 (1961 to 1981) 2.2 ±1.3 (1982 to 2002)
Pulpwood		
Hardwood	7.3 ±0.8 (1961 to 1981) 1.6 ±1.2 (1982 to 2002)	0.6 ±0.4
Softwood	4.6 ±1.0	0.7 ±0.7

^aUnless otherwise indicated, the annual percentage rates of change are for the period 1961 to 2002. Real prices were adjusted for inflation by Producer Price Index, All-commodity (1982 = 100).

^bThe annual percentage rates of change are given with their 95 percent confidence intervals (CI) with CI = SE * $t_{\alpha/2}$, where SE is the standard error of the coefficient and $t_{\alpha/2}$ is the t-value with $\alpha = 0.05$.

Table 6. — Nominal and real annual percentage rate of change in softwood stumpage prices from sawtimber sold from National Forests in the Pacific Northwest, 1961 to 2001.^a

Date	Nominal	Real
	----- (%) -----	
Sawtimber ^b		
1961 to 1981	16.4 ^c	9.8 ^c
1982 to 2001	2.6 ^c	0.6 ^d

^aSource: USDA Forest Service (Warren 1964 to 2001). Real prices were adjusted for inflation by Producer Price Index, All-commodity (1982 = 100).

^bThe null hypotheses $\beta_2 = r_2 = 0$ and $r_2 = 0$ were rejected ($p \leq 0.05$). This implied the two lines were not parallel and had different intercepts.

^cSignificantly different from zero ($p \leq 0.01$).

^dSignificantly different from zero ($p \leq 0.05$).

collected from nine Northeastern states – Connecticut, Maine, Massachusetts, New Hampshire, New York, Pennsylvania, Rhode Island, Vermont, and West Virginia – and weighted by species and timber cut within each state and the region (Table 1). These Northeastern regional stumpage prices have been increasing over the period 1961 to 2002 in both nominal and real terms (Table 2). In real terms, hardwood sawtimber and pulpwood stumpage prices increased at an average annual rate of 4.6 and 0.6 percent, respectively. The real stumpage price of softwood pulpwood increased at an average annual rate of 0.7 percent. In the case of real softwood sawtimber stumpage prices, the average annual rate for the period 1982 to 2002 was four times that esti-

mated for 1961 to 1981; namely, 2.2 vs. 0.6 percent, respectively.

The stumpage price series for the Northeast are doubly weighted by volume cut within states by species and within region by product and state. No statistical analyses were done on the individual state price trends but a comparison of the graphed data for hardwood sawtimber showed the same general trend as the regional price series. Pennsylvania, West Virginia, and New York accounted for 73 percent of the production in 2002 from the nine states included in the series. Species included in each varied by state, but northern red oak and white oak were important in all three states. Pennsylvania produced a large volume of black cherry, West Virginia produced a large volume of yellow-poplar, and New York produced a large volume of sugar maple. The individual state price trend for softwood sawtimber showed the same general trend as the regional price series. Maine alone accounted for 61 percent of the production in 2002 from the nine states and northern New England and New

York together accounted for 92 percent of production. Eastern white pine was a predominant species in all states but spruce-fir was the most important species group in Maine. Eastern hemlock and hard pines were also produced in some states in lesser quantities.

A comparison of the graphed data for hardwood pulpwood stumpage price for the individual states showed the same general trend as the regional price series. Maine alone accounted for 50 percent of the production from the nine states in 2002 and Maine, West Virginia, Pennsylvania, and New York accounted for 92 percent. As expected, the regional price series looked similar to Maine's. All states indicated a decline in price from 1998 to 2000 but in 2001 to 2002 some states recovered (Pennsylvania and New York), declined (West Virginia), or remained flat (Maine). The graphed data for softwood pulpwood stumpage price for the individual states showed the same general trend as the regional price series with a few notable differences more recently. Again, Maine alone accounted for a high percentage of production in 2002, 66 percent, while Maine, New York, Pennsylvania, and New Hampshire together accounted for 94 percent of production. Regionally, softwood stumpage price increased dramatically in 1993, peaked in 1997, and declined steadily through 2002. This was true for Maine and New Hampshire but prices in New York were more volatile over the same period of time with a dramatic decline in 2002. In Pennsylvania, prices for softwood pulpwood were generally flat but declined from 1996 to 1999 and increased from 2000 through 2002. Differences among states could be partially explained by species and market differences. In Maine and New Hampshire, spruce-fir and eastern white pine are the predominant species with some eastern hemlock. In New York, pine and hemlock account for almost all softwood pulpwood and in Pennsylvania individual species are not reported, but pine and hemlock are probably the predominant species.

As a point of comparison, real softwood sawtimber stumpage prices in the Pacific Northwest (PNW) increased at a slower rate for the period 1982 to 2001 than for the period 1961 to 1981; namely, 0.6 vs. 9.8 percent, respectively (Table 6).² However, real softwood sawtimber stumpage prices in the PNW were more volatile than in the Northeastern region. For example, in 1983 the average an-

² The same statistical procedures used to analyze the Northeastern region's stumpage prices were also used to examine PNW softwood sawtimber stumpage prices. The PNW softwood sawtimber stumpage prices used represent a volume-weighted average of all softwood sawtimber species sold in the PNW.

Table 7. — Nominal and real annual percentage rate of change in Louisiana stumpage prices by species and product group, 1961 to 2002.^a

Species and product group	Nominal	Real
	----- (%) -----	
Sawtimber		
Softwood	10.6 (1961 to 1981) ^b 5.5 (1982 to 2002) ^c	2.6 ^b
Pulpwood		
Hardwood	6.2 ^b	-0.8 (1961 to 1981) ^b 5.6 (1982 to 2002) ^b
Softwood	4.4 ^b	0.8 ^d

^a Source: Louisiana Department of Agriculture and Forestry (1961 to 2002). Real prices were adjusted for inflation by Producer Price Index, All-commodity (1982 = 100). Unless otherwise indicated, the annual percentage rates of change are for the period 1961 to 2002. If so indicated, the null hypotheses $\beta_2 = r_2 = 0$ and $r_2 = 0$ were rejected with ($p \leq 0.05$). This implied the two lines were not parallel and had different intercepts.

^b Significantly different from zero ($p \leq 0.01$).

^c Significantly different from zero ($p \leq 0.05$).

^d Not significantly different from zero.

nual real stumpage price for softwood sawtimber in the PNW was \$111.06/MBF, this price rose steadily to a peak of \$343.11/MBF in 1993 then dropped to \$86.67/MBF in 2001 (Warren 1964 to 2001). Real softwood sawtimber stumpage price in Louisiana rose steadily at an annual percentage rate of change of 2.6 percent for the period 1961 to 2002 (**Table 7**).³ This percentage rate of change is consistent with that of the Northeastern region's real softwood sawtimber price for the period 1982 to 2002 (**Table 5**).

In terms of pulpwood, the Northeastern region's real hardwood stumpage prices exhibited a "saw tooth" type rise during the period 1961 to 2002. While in Louisiana, real hardwood pulpwood stumpage prices decreased at an annual percentage rate of -0.8 percent during the period 1961 to 1981 then increased at an annual percentage rate of 5.6 percent during the period 1982 to 2002 (**Table 7**). Both the Northeastern region's and Louisiana's real hardwood stumpage prices showed a sharp decrease in the late 1990s with a recovery starting in 2001. The Northeastern region's and Louisiana's real softwood stumpage prices exhibited similar annual percentage rates of change; namely, 0.7 and 0.8 percent, respectively (**Tables 5 and 7**). However, there was greater variability associated with Louisiana's real soft-

wood pulpwood prices than with the Northeastern region's.

Consumption of solid wood products in the United States is expected to increase significantly over the next 50 years, driven mainly by housing; however, expansion of U.S. production and foreign imports is expected to dampen overall increases in product prices (Schuler et al. 2001, Adams 2002a, Schuler and Adair 2003). Regional differences are expected in growth in real stumpage prices. Increases in hardwood growing stock in the North and the high percentage of private ownership will see increasing harvests of both sawtimber and pulpwood and modestly rising stumpage prices, particularly in the Northeast (Adams 2002b). Dynamics between U.S. supply regions will lead to rising real softwood sawtimber stumpage prices in the North of about 0.9 percent annually and 0.4 percent for hardwood sawtimber (Adams 2002b). Some rise is also expected in real softwood pulpwood prices in the North but hardwood pulpwood price is expected to remain stable. Increased harvest and price changes in the North result from adjustments to timber inventories in the West and South (Adams 2002b, Luppold and Sendak 2004). Sendak et al. (2003) project a 1.1 percent annual rise in overall real stumpage price for northern New England and New York and a balance in growth to cut by 2050.

Lutz (2001,2002,2003b) showed that timberland returns were, to a degree, affected by changes in stumpage prices. He examined the National Council of Real Estate Investment Fiduciaries

(NCREIF) Timberland Index for the Northeast, the Southeast, and the West. In the Northeast, a drop in hardwood stumpage prices corresponded to a decline in the NCREIF Timberland Index in the first half of 2001. He found a similar relationship in the NCREIF Timberland Index for the Southeast with respect to a decline in stumpage prices. The NCREIF Timberland Index for the West showed little change given the declining stumpage prices in the latter half of the 1990s. However, as stumpage prices continued to decline into early 2002, the NCREIF Timberland Index for the West also declined. Using the NCREIF Timberland Index, Lutz (2003a) calculated the nominal annual returns to timberland for the period 1987 to 2002 in the Southeast as 11.1 percent, the Northeast as 11.9 percent, and the West as 20.4 percent.

The value of timberland can, in general, be described as the capitalized value of its periodic or annual net cash flow. The net cash flow depends on stumpage price, among other factors. For example, if hardwood trees did not grow, an average landowner holding an average mix of hardwood sawtimber could reasonably achieve an expected 4.6 percent annual increase in the revenue from a sale of that sawtimber due to real price appreciation alone. However, hardwood trees *do* grow and increase in volume and quality (i.e., log grade) as they get larger. Changes in volume depend on a number of factors such as the forest's species composition, structure, age class distribution, density, the planning horizon, and forest management choices. Furthermore, as hardwood logs change in log grade so do stumpage prices. Consequently, this average landowner could achieve greater than an expected 4.6 percent annual increase in the revenue from a future sale of that sawtimber. How this may change the value of the landowner's timberland depends on a number of additional factors including, but not limited to, the planning horizon for the timber sale, management costs, and the discount rate used by the landowner.

This financial analysis may not be trivial (Brazee and Mendelsohn 1988, Gomez et al. 1999, Wagner et al. 2003). Unfortunately, many nonindustrial forestland owners do not make use of published stumpage price information nor use a forester when making forest management decisions (Jones et al. 1995, Rosen and Kaiser 2003). In addition,

³ The same statistical procedures used to analyze the Northeastern region's stumpage prices were also used to examine Louisiana stumpage prices. Both softwood sawtimber and pulpwood were defined as southern yellow pine.

competing for a landowner's capital are returns on financial instruments such as mutual funds, stocks, and bonds. Information on these financial instruments is readily available to landowners through various media (newspapers, the web, nightly news, etc.). For example, the annual real returns on Treasury Bills, Russell 2000 Index, S & P 500 Index, Lehman Government/Credit Index, NCREIF Property Index, and Morgan Stanley Capital International Europe, Australasia, and Far East Index, ranged from 2.13 to 10.15 percent for the period 1987 to 2001 (Wachovia 2002).⁴

One must be *extremely* careful when using information from past stumpage prices to predict future stumpage prices (Haight and Holmes 1991, Yin and Newman 1996, Prestemon 2003). For example, the average annual percentage rates of change may not reflect the stumpage markets of a specific sub-state region or individual property. Nonetheless, it is the nature of forestry to predict revenues (and costs) from 1 to 100 plus years into the future. Given these caveats, the information in the preceding paragraphs, and the information in **Tables 6** and **7**, the real annual percentage rates of change for stumpage prices in the Northeastern region given in **Table 5** seem reasonable. The most suitable use of the estimates given in **Table 5** is for long-term analysis and, in this case, the real annual percentage rates of change should be used. As with any estimate of this type, it is best to bracket the annual percentage rate of change. **Table 5** provides the 95 percent confidence intervals of the estimates that can be used to determine a low and high value for the annual percentage rates of change. Furthermore, neither the forester nor the landowner should fall into the trap of the "job is done" syndrome; these financial analyses should be revisited frequently. Even so, these estimates give the forester and landowner additional information to help make informed decisions concerning forest management choices.

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⁴ Care should be taken when comparing returns from different investments due to differences in risk.

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Appendix A. Equation [2] results, 1961 to 2002

Nominal hardwood sawtimber.

Parameter	Estimate	t value
β	-156.9816	-10.76
r	0.0813	11.04
AR(1)	-0.8254	-8.74
Durbin-Watson = 1.92		
Regression R^2 = 0.77		

Real hardwood sawtimber.

Parameter	Estimate	t value
β	-83.8780	-18.51
r	0.0446	19.51
AR(1)	-0.4375	-3.01
Durbin-Watson = 1.80		
Regression R^2 = 0.91		

Nominal softwood sawtimber.

Parameter	Estimate	t value
β	-97.5858	-10.41
r	0.0511	10.8
AR(1)	-0.9119	-13.76
Durbin-Watson = 1.18		
Regression R^2 = 0.77		

Real softwood sawtimber.

Parameter	Estimate	t value
β	-23.2627	-4.49
r	0.0138	5.27
AR(1)	-0.8309	-9.53
Durbin-Watson = 1.60		
Regression R^2 = 0.42		

Nominal hardwood pulpwood.

Parameter	Estimate	t value
β	-88.8222	-5.89
r	-0.0455	5.98
AR(1)	-0.8917	-11.18
Durbin-Watson = 2.24		
Regression R^2 = 0.53		

Real hardwood pulpwood.

Parameter	Estimate	t value
β	-9.8566	-2.26
r	0.005851	2.66
AR(1)	-0.5509	-4.14
Durbin-Watson = 2.05		
Regression R^2 = 0.15		

Nominal softwood pulpwood

Parameter	Estimate	t value
β	-87.5502	-7.50
r	0.0450	7.63
AR(1)	-0.8701	-8.41
Durbin-Watson = 1.53		
Regression R^2 = 0.69		

Real softwood pulpwood

Parameter	Estimate	t value
β	-11.7272	-1.67
r	0.006935	1.96
AR(1)	-0.8194	-9.16
Durbin-Watson = 1.88		
Regression R^2 = 0.09		

Appendix B. Equation [4] results, 1961 to 1981 vs. 1982 to 2002

Nominal hardwood sawtimber.

Parameter	Estimate	t value
β_1	-190.3589	-7.50
β_2	65.4117	1.54
r_1	0.0983	7.63
r_2	-0.033	-1.54
AR(1)	-0.7466	-6.47
Chow F statistic = 1.26		
Durbin-Watson = 1.87		
Regression R^2 = 0.86		

Nominal hardwood pulpwood.

Parameter	Estimate	t value
β_1	-138.8192	-17.12
β_2	109.6482	9.15
r_1	0.0709	17.23
r_2	-0.0553	-9.14
AR(1)	-0.3645	-2.35
Chow F statistic = 43.48		
Durbin-Watson = 1.97		
Regression R^2 = 0.97		

Nominal softwood pulpwood.

Parameter	Estimate	t value
β_1	-114.9182	-6.88
β_2	57.1351	1.89
r_1	0.0589	6.95
r_2	-0.0288	-1.89
AR(1)	-0.8095	-7.08
Chow F statistic = 2.12		
Durbin-Watson = 1.56		
Regression R^2 = 0.81		

Real hardwood sawtimber.

Parameter	Estimate	t value
β_1	-76.8541	-6.45
β_2	-8.8233	-0.49
r_1	0.0411	6.79
r_2	0.004473	0.49
AR(1)	-0.4239	-2.80
Chow F statistic = 0.21		
Durbin-Watson = 1.81		
Regression R^2 = 0.91		

Real softwood sawtimber.

Parameter	Estimate	t value
β_1	-7.2963	-0.92
β_2	-32.3363	-2.53
r_1	0.005668	1.41
r_2	0.0163	2.53
AR(1)	-0.7004	-5.75
Chow F statistic = 3.21		
Durbin-Watson = 1.59		
Regression R^2 = 0.66		

Real softwood pulpwood.

Parameter	Estimate	t value
β_1	0.7428	0.05
β_2	-20.4494	-0.85
r_1	0.000602	0.08
r_2	0.0103	0.85
AR(1)	-0.7937	-7.45
Chow F statistic = 0.51		
Durbin-Watson = 1.80		
Regression R^2 = 0.13		

Nominal softwood sawtimber.

Parameter	Estimate	t value
β_1	-121.5956	-7.52
β_2	48.6898	1.73
r_1	0.0633	7.71
r_2	-0.0246	-1.73
AR(1)	-0.8819	-10.66
Chow F statistic = 1.70		
Durbin-Watson = 1.24		
Regression R^2 = 0.84		

Real hardwood pulpwood.

Parameter	Estimate	t value
β_1	-23.5294	-2.47
β_2	-28.5047	1.99
r_1	0.0128	0.32
r_2	-0.0144	-1.99
AR(1)	-0.4501	-2.99
Chow F statistic = 1.98		
Durbin-Watson = 2.02		
Regression R^2 = 0.27		