ESTIMATING TIMBER SUPPLY FROM PRIVATE FORESTS

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Abstract: Nonindustrial private landowners, who hold a majority of the Nation's commercial forests, own land primarily for reasons other than timber production. The multiple objective and dynamic nature of private ownership make planning and estimation of timber availability from this sector extremely difficult.

Insight into the determinants of timber supply from private forests is provided through development of both theoretical and empirical models of harvest behavior. Tobit and probit models were used to analyze cross-sectional, and pooled time-series and cross-sectional data, respectively. The results highlight the influence of forest characteristics and landowner affluence on the harvest decision. Decomposition of the Tobit coefficients indicates that changes in timber supply are expected to result primarily from changes in the number of acres from which timber is offered for sale and to a much lesser extent from changes in per-acre harvesting intensity.

INTRODUCTION

Almost half of the Nation's hardwoods, approximately 140 million cubic feet of growing stock and 334 million board feet of sawtimber, are contained in the Northeast and North Central regions (USDA Forest Service 1988). For several decades growth has outpaced removals, leading to a doubling of sawtimber volumes since 1952. Increased use of this vast resource could stimulate the regional economy, improve our trade balance, and breathe economic life into rural communities.

An immense population, with a growing appetite for wood products, lives within, or in close proximity to, the region. Demand projections indicate substantial increases in roundwood consumption, well into the future (USDA Forest Service 1982).

There is great potential for increased utilization of the region's hardwoods. Concerns over tropical deforestation and a more competitive dollar may focus attention on eastern hardwoods as a strategic resource in supplying world markets. New and existing technologies for producing composite products from low-quality hardwoods offer numerous opportunities. The political viability of additional nuclear reactors and environmental concerns over increased coal use make wood an attractive alternate energy resource. This is particularly true in the

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energy-dependent Northeast. Traditional sawmilling and manufacturing of specialty products will remain important and are particularly attractive to localities seeking to enhance their economic fortunes.

There is a seemingly abundant resource, sufficient final demand, and some arguably good reasons to use this resource. However, there is apprehension over availability. Seventy percent of the region's hardwood resource occurs on nonindustrial private forests (USDA Forest Service 1988). An additional 21 percent occurs on public lands, where intense recreation pressures often limit timber harvesting. Since forest industry holds only 9 percent of the hardwood growing stock, the key to increased utilization rests with the nonindustrial private landowner.

Surveys reveal that most nonindustrial owners hold land primarily for reasons other than timber production (Widmann and Birch 1988, Birch and Dennis 1980). The multiple objective and dynamic nature of private ownership leads to complex and difficult-to-predict supply responses.

Planning and policy development are further hampered by a lack of knowledge of how trends in demographic patterns of landownership and forest characteristics will affect harvest behavior. There are fears that timber availability will be further limited by increased fragmentation of the forest and by an increasingly affluent landowning population, who may be more interested in the nontimber aspects of forest ownership. In addition to the large increases in timber volume, changes in species composition will influence future harvesting. Red maple has increased dramatically across the region and is now the second most abundant species in New Hampshire, the state from which the empirical portion of this study is drawn.

This study provides insight into the determinants of timber supply from private forests through development of both theoretical and empirical models of harvest behavior. Forest, owner, and economic variables are fully integrated into the analyses.

A MICROECONOMIC MODEL OF HARVEST BEHAVIOR

This model was adapted from an approach originally developed by Becker (1965) to analyze an individual's choice in allocating time between work and leisure. Each landowner seeks to maximize utility (satisfaction) from nontimber or forest-related amenities and from the generalized purchasing power of income, subject to two constraints:

$$\max\ U(A,I) \tag{1}$$

subject to

$$I = PH + E \ \textit{and}\ A = V - H \tag{2}$$

where

$U(A,I)$ = utility defined over A and I,
A = quantity of timber reserved for amenities,
I = total income,
P = stumpage price,
H = quantity of timber harvested,
E = exogenous income,
and
V = initial timber inventory.

The first constraint defines total income as the sum of income from the sale of timber and all income from other sources, and the second defines the amount of timber retained for amenities as the initial timber inventory less the amount harvested.

The first-order conditions of the Lagrangian solution for utility maximization indicate that the landowner will maximize total satisfaction when the following condition is met:

$$P\frac{\partial U}{\partial I} = -\frac{\partial U}{\partial A}\frac{\partial A}{\partial H} \qquad (3)$$

At the optimal mix of amenities and income, the satisfaction gained from increased timber income just equals the satisfaction foregone from amenities to obtain that income.

Further analysis of the first-order condition, called comparative statics, indicates how changes in different variables are expected to influence timber supply. Comparative statics analyses are performed by differentiating equation 2 with respect to the variable of interest. Binkley (1981) and Dennis (1989) provide more detailed discussions of the comparative statics results regarding timber supply.

In this simple model, changes in most of the variables have the expected effect. An increase in the initial timber inventory (V) has a positive effect on harvesting. More timber is available for both amenities and harvest. Increased exogenous income (I) has a negative effect on harvesting. Greater wealth reduces the relative value of additional income and makes harvesting less desirable.

Comparative statics results are not always so obvious. Differentiating with respect to stumpage price (P) yields an ambiguous result. This ambiguity arises from the interaction of two opposing effects. As prices rise we expect landowners to harvest more timber because the relative price of timber is higher. This is called the substitution effect; timber income is substituted for amenities. However, there is an opposing income effect. Swedish economists have called it the Volvo effect (Johansson and Lofgren 1985). Landowners harvest enough timber to buy a new Volvo and then stop; so, increasing the price of timber could actually reduce the harvest.

Normally we expect the substitution effect to dominate and the supply curve to be upward sloping (Figure 1a). However, if the income effect is dominant, the supply curve could be backward bending as shown in Figure 1b. Which effect dominates is an important empirical

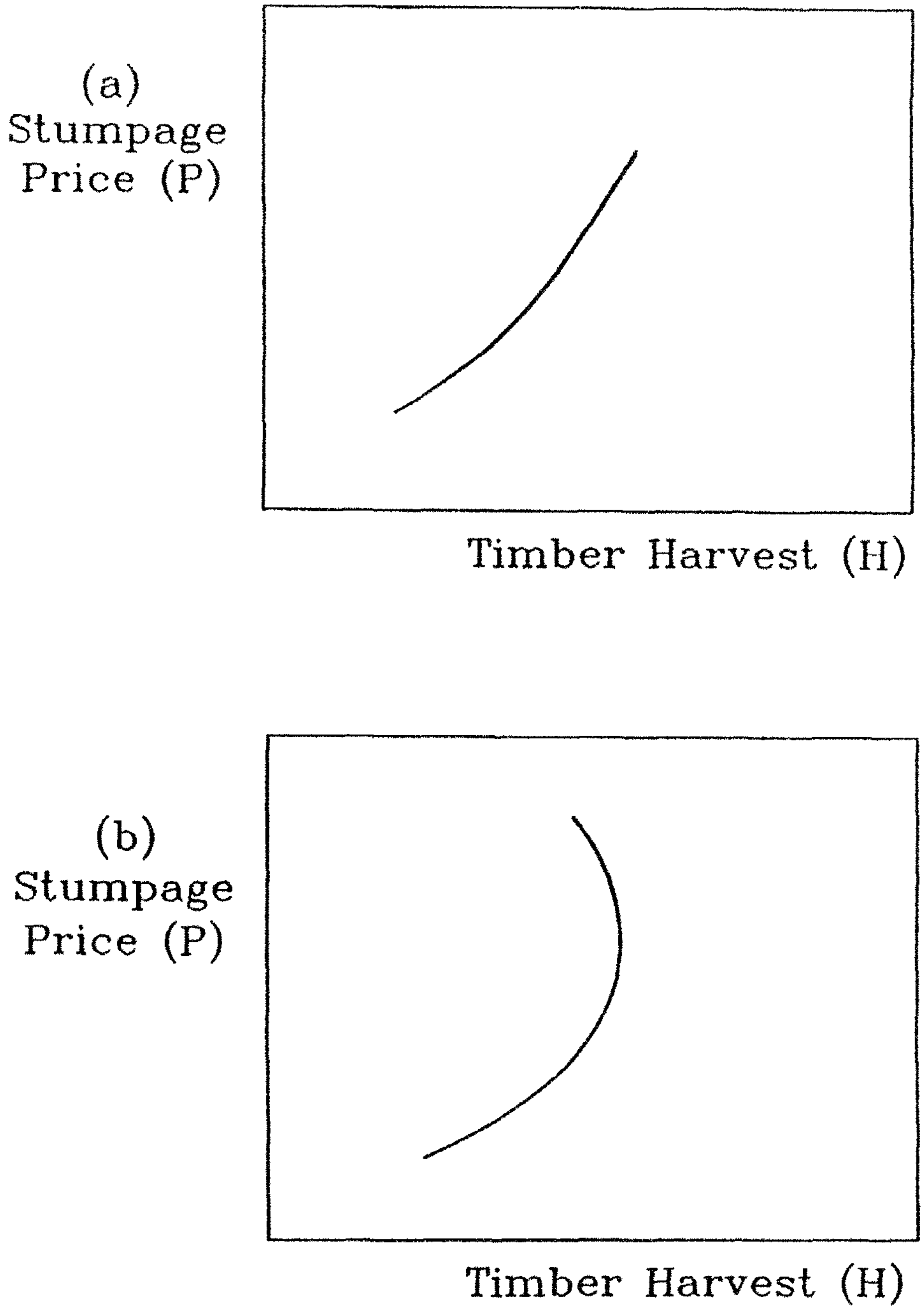

Figure 1. Two possible shapes for an individual landowner's supply curve for timber.

question.

Although theoretical models provide insight into harvest behavior, usefulness is limited by the simplifying assumptions required to make the model tractable. Additional insight can be provided empirically.

DATA SOURCES AND CHARACTERISTICS

Forest data were obtained from 68 fixed-radius (1/5 acre) sample plots measured by the USDA Forest Service, during its periodic statewide survey of New Hampshire. Frieswyk and Malley (1985) provide a thorough discussion of survey procedures. Each sample plot was measured in 1973 and again in 1983, with all trees either measured or accounted for (e.g. harvest or mortality). Species composition and a variety of other forest characteristics were recorded.

A questionnaire, sent to each landowner in conjunction with the forest survey, provided data on ownership (Birch 1988). This included information on size of holding, tenure of ownership, education, age, occupation, whether the owner was raised in an urban or rural environment, and several other owner characteristics. Descriptive statistics for selected forest and owner variables are provided in Table 1.

The exact offer price that each landowner faced was unknown, so price indices, representing sawlogs, pulpwood, and fuelwood, were constructed to proxy for offer prices. The prices were taken from the New Hampshire Forest Market Reports, published annually by the New Hampshire Cooperative Extension Service. Sawtimber prices were available by county and species, pulpwood prices were reported by region (north and south), and statewide prices were reported for fuelwood. The indices were weighted by the relative proportion of removals for each product during 1983, as reported by Frieswyk and Malley (1985) and Nevel, Engalichev, and Gove (1986).

METHODS

The data available for estimating harvest behavior may be examined in several ways. Two dependent variables were considered: (1) a dichotomous variable indicating whether timber was harvested, and (2) the quantity of timber harvested. In addition, an estimation strategy may be employed that accounts for only cross-sectional effects or a combination of cross-sectional and time-series effects.

A binary choice (probit) model was used to analyze the landowner's decision of whether to harvest timber from a particular parcel. Detailed general discussions of probit analysis may be found in most textbooks on econometrics (e.g. Judge et al. 1982). Dennis (1990) provides a thorough discussion of the application of probit analysis to timber harvesting data, which is outlined below.

Probit analysis was used to estimate the relationship between a dichotomous dependent variable (Y_i), coded 1 if timber was harvested from the sample plot, and 0 if no harvesting occurred, and selected explanatory variables (X_i). It is assumed that a landowner's propensity to harvest timber from a particular parcel is represented by an unobservable random index (Y_i^*), which is defined as a function of observable characteristics (X_i'B) and a random

Table 1.--Descriptive Statistics[a]

Variable[b]	Units	Mean	Std. dev.	Harvested mean	Non harvested mean
Timber harvest	bd ft/ac	111	332	628	0
Timber volume	bd ft/ac	961	949	1,597	824
Volume (white pine)	bd ft/ac	477	934	1,275	306
Ratio (white pine)	proportion	0.41	0.42	0.73	0.34
Volume (red oak)	bd ft/ac	79	197	136	67
Ratio (red oak)	proportion	0.10	0.24	0.15	0.08
Ownership size	acres	425	1434	917	320
Education	years	15.9	3.8	13.7	16.4
Landowner age	years	59	12	60	58
Tenure	years	23	13	23	23
Coded variables:					
Professional	proportion	0.44	0.50	0.33	0.46
New Hampshire resident	proportion	0.72	0.45	0.75	0.71

[a]N = 68.
[b]See Table 2 for definitions.

disturbance (e_i). If the observed choice (Y_i) equals one when $Y_i^* > 0$ and zero when $Y_i^* < 0$, then :

$$P(Y_i=1)=P(Y_i^*>0)=P(e_i<X_i'B)=F(X_i'B)=\int_{-\infty}^{XB} f(e)de \tag{4}$$

where F( ) is the cumulative distribution function and f( ) is the probability density function of e_i. Normal specifications are assumed for these functions in the probit model.

Since the model is nonlinear, the estimated coefficients do not represent the change in the probability of timber harvest (P_i) resulting from a unit change in an explanatory variable. Since:

$$P_i=F(X_i'B) \text{ and } X_i'B=F^{-1}(P_i), \tag{5}$$

the coefficients estimate the effect of a change in an explanatory variable on $F^{-1}(P_i)$. The magnitude of the change in harvest probability depends on the original probability as determined by the initial values of all the variables and coefficients:

$$\frac{\partial P_i}{\partial X_{ik}} = f(X_i'B)B_k \tag{6}$$

where k indexes the explanatory variables. The estimated sign shows the direction of change, but the magnitude is influenced by the steepness of the cumulative distribution function at X_i'B.

Additional insight into harvesting behavior may be obtained through analysis of a model that includes the quantity of timber harvested. We assume that landowner's harvest timber when their desire to do so reaches a certain level and the observed harvest provides a measure of that desire. However, because no measure of the relative desire is obtained when there is no harvest the sample is said to be censored at zero. Judge et al. (1985) defines a censored sample as one in which some observations on the dependent variable, corresponding to known sets of independent variables, are not observable. Least-squares estimation procedures produce biased and inconsistent estimates for censored samples because the conditional expectation of the error term is not zero.

Tobin's (1958) pioneering analyses of censored samples, with respect to consumer durables, has led to these models being termed "Tobit models". Amemiya (1984) provides a thorough survey of censored regression models.

As with the probit model, coefficients obtained from Tobit analysis must be interpreted with care. McDonald and Moffitt (1980) offer an innovative procedure for interpreting these coefficients. They show how Tobit analysis can be used to determine both changes in the probability of being above the limit, zero in the case at hand, and changes in the dependent variable if it is already above the limit. Thus, estimated timber supply responses resulting from marginal changes in an explanatory variable may be decomposed into changes in harvesting intensity on lands already being harvested and changes in the number of acres harvested. A more detailed discussion of analytical procedures for analyzing censored samples, with specific reference to timber harvesting, is provided by Dennis (1989).

Both probit and Tobit models may be estimated from cross-sectional or pooled time-series and cross-sectional data. The cross-sectional approach has the advantage of yielding unbiased estimates with minimum variance. Its main disadvantage is that it ignores information on variation over time. A pooled time-series and cross-sectional approach may be used to examine the influence of both annual and cross-sectional variation in the explanatory variables on the harvest decision. This procedure permits the introduction of variables, such as interest rates, that only vary over time, and also allows for annual, as well as cross-sectional, variation in stumpage prices. Although the presence of autocorrelation will cause the variance to be larger than if the same number of independent observations were used, this approach has the advantage of using more information to yield unbiased estimates.

RESULTS AND DISCUSSION

Two models were used to analyze harvesting behavior. Tobit analysis was performed on cross-sectional data, where the dependent variable measured the quantity of timber harvested during the period between surveys (1973 to 1983). A probit model was used to analyze pooled cross-section and time-series data. In this situation the dependent variable was dichotomous, indicating whether timber was harvested from a sample plot during a particular year.

For the pooled sample, the exact year of harvest was obtained from a questionnaire sent to each landowner or by personal contact if there was any ambiguity. Linear interpolation was used to calculate timber volumes for the years between surveys. Harvested trees were removed from plot totals and species composition was adjusted accordingly for years subsequent to harvest.

Table 2 provides a list of acronyms and a brief description for the explanatory variables, and Table 3 shows the regression results. The results are discussed first with respect to the estimated signs and statistical significance of the selected explanatory variables and then with respect to overall inferences concerning timber supply.

Signs and Significance of the Coefficients

Economies of scale in timber harvesting and the assumption of decreasing marginal utility of timber reserved for amenities led us to anticipate a positive relationship between harvesting and both size of forest ownership and timber inventory. The estimated coefficients (probit model) for the natural logarithm of ownership size and for per-acre timber volume were positive, but not statistically significant at the 10-percent level. Tobit analysis yielded a positive correlation between harvesting and timber inventory that was significant at the 5-percent level. Mean per-acre timber volumes were 1.6 mbf for plots that were subsequently harvested, compared to 0.9 mbf for plots that were not harvested.

The presence of commercially valuable species, such as white pine and red oak, were expected to enhance the probability of harvest. The empirical results support this hypothesis. Statistically significant coefficients were obtained for variables measuring the proportion of total timber volumes represented by these species, for both the probit and Tobit models. On average, stands that were subsequently harvested contained about double the percentage of white pine and red oak than those that were not harvested.

Positive coefficients were obtained for the price variables but neither were significant at the 10-percent level. The income and substitution effects, discussed earlier, effectively may be canceling one another. However, before accepting this conclusion there are several other possible reasons for the apparent lack of price responsiveness to consider.

Table 2.--Variable Summary

Variable	Definition (unit)
ACRES	Total woodland acres owned.
MBF	Timber volume (Mbf/acre).
PINE	Proportion of white pine; ratio = [volume of white pine (Mbf/acre)/MBF].
OAK	Proportion of oak[a]; ratio = [volume of oak (Mbf/acre)/MBF].
PI	Composite price index [real (1983) dollars, weighted by state level production]; includes stumpage prices for sawlogs, pulpwood and fuelwood.
SPI	Sawlog price index; sawlog portion of PI.
PICHG	Change in PI between current and previous year.
R	Yields for 3-year Treasury bills (percent).
ED	Years of formal education.
PRO	Coded variable equal, to 1 if owner was employed in a white collar occupation, and 0 otherwise.

[a]Includes red, white, and black oaks.

Since price indices do not generally measure the exact price that a landowner was offered, an "error in variables" problem is suspected. If the price index measures the true offer price with a random error, then the statistical significance of the price coefficient will be biased toward zero. Therefore, the probability of incorrectly rejecting the hypothesis that the coefficient is not zero is greater than the indicated level of significance. This potential problem is particularly troublesome when analyzing the cross-sectional sample, because the price variable is an average of annual prices for the period between surveys. Although pooling the time-series and cross-sectional data provides an improvement by including annual as well as cross-sectional price variation, the results were still not significant.

Multicollinearity is also of concern when analyzing the pooled sample. Correlations are expected between stumpage prices and variables, such as interest rates, that measure or are correlated with timber demand (see below). A potential consequence is that the precision of estimation is reduced, but more importantly, it becomes difficult to disentangle the relative influences of the correlated explanatory variables.

Table 3.--Results

Explanatory variables	Tobit[a] coefficient	Std. error	Probit[b] coefficient	Std. error
Constant	-2.765	2.319	-1.804	1.305
Log_e (ACRES)			0.127	0.101
MBF	0.320**	0.119	0.167	0.131
PINE	1.810**	0.693	1.057**	0.431
OAK	1.432*	0.764		
PI			0.043	0.036
SPI	0.040	0.036		
PICHG			-0.016	0.011
R			-0.126*	0.074
ED	-0.127**	0.053	-0.145**	0.054
PRO	0.585	0.381	0.638*	0.372

**Significant at 5% level.
*Significant at 10% level.
[a]Cross-sectional sample (N = 68); dependent variable equals quantity of timber harvested between surveys (1973-1983).
[b]Pooled cross-sectional and time-series sample (N = 706); dependent variable coded 1 if harvest occurred in a particular year and 0 otherwise.

Price responsiveness may be further obscured by the possibility that landowners are not responding to current price increases because they anticipate higher prices in the future. The most recent price change was used as an indication of price expectation in the pooled sample. Although not significant at the 10-percent level, the estimated coefficient had the anticipated negative sign, providing weak evidence that expectations of future prices affect current decisions.

The expected influence of interest rates on timber harvesting is ambiguous. Higher interest rates effectively increase the opportunity cost of growing timber, making current harvesting more desirable. However, changes in interest rates affect exogenous income, which influences harvest behavior. Interest rates are also correlated with the demand for timber. Housing starts and the demand for consumer goods, such as furniture, are sensitive to mortgage rates and rates charged on consumer credit. Changes in timber demand influence harvest decisions by affecting stumpage prices and by causing timber buyers to adjust their efforts at securing stumpage. Examples of buyer effort that are expected to influence harvesting decisions are advertising and number of landowner contacts.

To examine the influence of interest rates on harvesting decisions, the yield on 3-year Treasury bills, a readily available form of alternate investment and general indicator of interest rates across the economy, was introduced as an explanatory variable in the probit analysis of the pooled sample. A negative relationship was estimated between interest rates and timber harvesting, which suggests that the positive influence expected from an increase in the opportunity cost of growing timber was outweighed by other factors. Since no direct measure of buyer effort was available, the number of housing starts and an index of lumber and wood products manufacturing were used as proxies in an effort to disentangle these effects. The coefficients for these variables, whether introduced singly or in combination, were not significantly different from zero at even the 20-percent level, and the interest rate coefficient remained negative. The problem of multicollinearity may be obscuring the relative influences of the correlated variables, namely stumpage price, interest rate, and buyer effort.

Our theoretical model indicated that the harvest decision is influenced by exogenous income and by the relative value landowners place on amenities and consumption. Concerns have arisen that demographic changes in landownership, particularly with respect to increasing affluence, may adversely affect timber supply. Several explanatory variables that measure a landowner's education, age, occupation, early life environment, and state residency were examined to provide insight into the merit of these concerns.

Education and income levels were used to examine the affect of affluence on timber harvesting. Coefficients were negative, but not significant at the 5-percent level, when both variables were included in the model. The low significance levels probably were due to the high collinearity between the two variables. The significance level for each variable improved beyond the 5-percent level when the other was removed from the model. I chose to retain education in the model because 15-percent of the landowners did not respond to the income question. Deletion of this many observations weakened the overall model.

Both analyses yielded a strong negative correlation between education and timber harvesting. There are several plausible explanations for this correlation. Education may directly influence the way landowners value amenities and income or it may proxy for social background or other factors that influence attitudes toward timber harvesting. Also, more highly educated individuals generally have larger incomes, which our theoretical analyses suggest reduce the marginal utility of timber income. It appears that affluence, whether measured by income or education, has a negative effect on timber harvesting.

The influence of occupation on the propensity to harvest timber was examined using two coded variables that indicated whether the owner was a professional or was retired. Probit analysis yielded a positive coefficient for the variable indicating professional status. There is no clear intuitive interpretation for this result. Perhaps professionals have a greater tendency to view their woodlands as an income-producing asset or are more aware of market opportunities than others. No relationship was established between retirement status and timber harvesting.

Several other ownership variables were examined but no significant correlations were found. These included the landowner's age, whether he or she was raised in a rural or urban environment, in-state residency, tenure of ownership, and whether the owner was involved in the purchase or sale of forest land within the previous 10 years.

Inferences About Timber Supply

Further analysis of the Tobit model, using the procedures of McDonald and Moffitt (1980), provides insight into timber supply from private forests. The signs of the coefficients indicate the direction of change but the magnitude of the marginal responses is determined by the values for all the independent variables and coefficients. Figure 2 shows the X_iB distribution. The results were interpreted at three values for the explanatory variables (X_iB): (1) -1.75, arbitrarily chosen to represent the lower portion of the distribution; (2) -1.098, computed using the mean values for the explanatory variables for the entire sample; and (3) 0.038, computed using the mean values for the harvested plots (see Table 4). Because the dependent variable measured harvest activity over the period 1973 to 1983, the estimates are per-acre values for an 11-year interval.

The first row of Table 4 gives the expected harvest, which may be obtained by multiplying the probability of harvest by the conditional harvest, shown in the second and third rows, respectively. The expected per-acre harvest varied considerably depending on the values of explanatory variables. The probability of harvest was miniscule when computed for the lower third of the distribution and this led to a very small expected harvest. Furthermore, estimated marginal responses were very small for these observations. Directing efforts to increase timber supply at more responsive portions of the population appears more fruitful.

The expected harvest was approximately 18 times larger when computed at values equivalent to the mean values of the plots that were subsequently harvested than for the sample mean. The estimated marginal responses were also considerably higher for these observations. Decomposition of the results indicates that the marginal responses are expected to occur primarily from changes in per-acre harvesting intensity and, to a lesser extent, from changes in the number of acres harvested.

Elasticities measure the estimated response resulting from a 1 percent increase in an explanatory variable. A supply elasticity of 1.06 was estimated for the inventory variable (MBF), which corroborates the inventory elasticity assumed in several aggregate supply models (e.g. Adams and Haynes 1980, Cardellichio and Veltkamp 1981, and Binkley and Cardellichio 1986).

An estimated supply elasticity of approximately -7.0 for the education variable provides credence to concerns that increased affluence may adversely affect timber availability. A 1 year increase in education level reduced the expected harvest by 36 percent when evaluated at the sample mean.

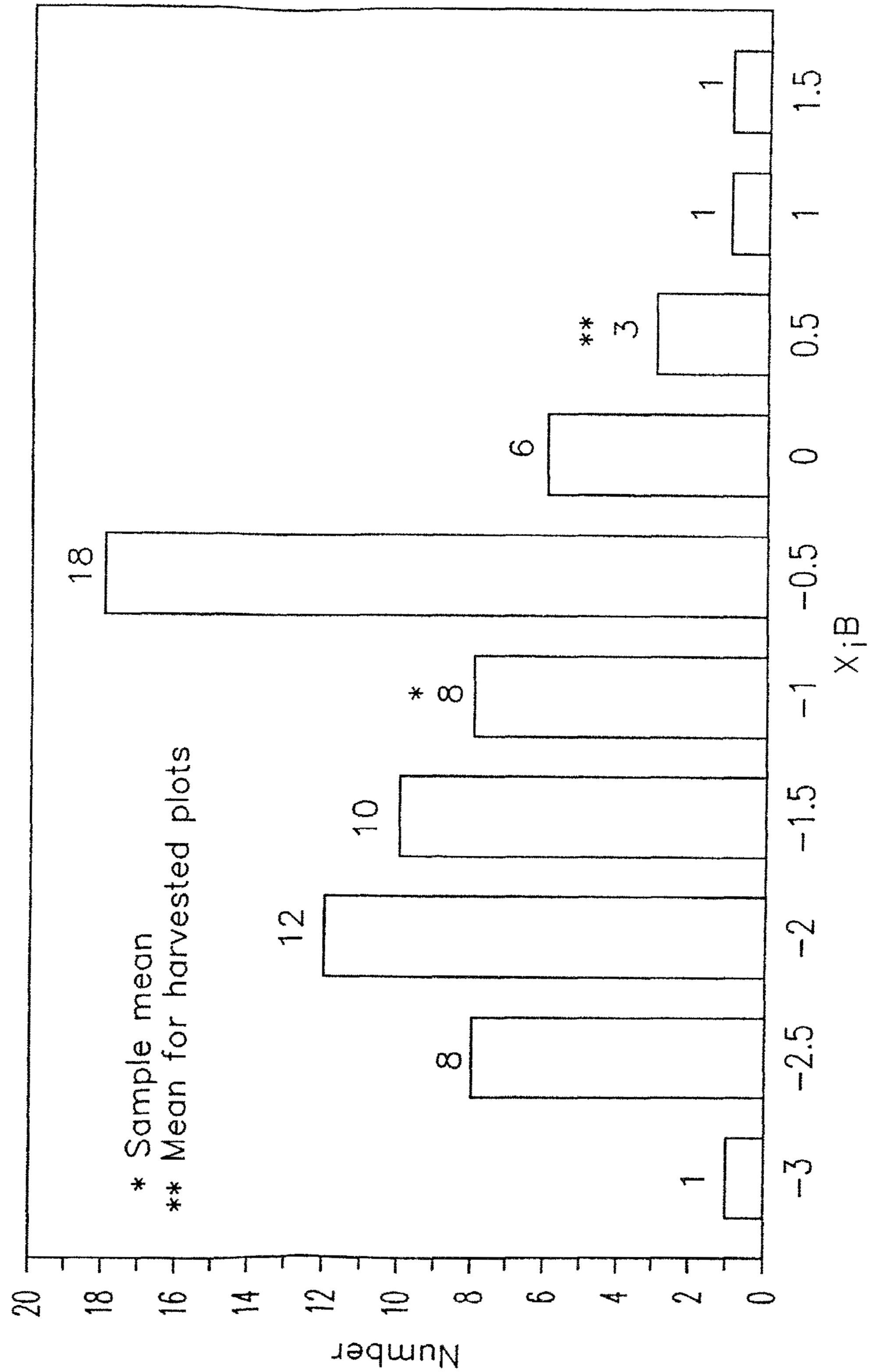

Figure 2. The X_iB distribution for the cross-sectional sample.

Table 4.--Decomposition of Tobit Results

	31st Percentile $X_iB = -1.750$	Sample mean $X_iB = -1.098$	Harvested plot mean $X_iB = 0.038$
Harvest[a] (Mbf)	.001	.016	.293
Probability of harvest (proportion)	.005	.054	.522
Conditional harvest[b] (Mbf)	.219	.290	.561
Marginal harvest response	$.005B_k$	$.055B_k$	$.522B_k$
Portion of marginal response resulting from:			
Per-acre harvest	8%	14%	38%
Probability of harvest	92%	86%	62%

[a]Estimated per-acre harvest across all plots at this point in the X_iB distribution.
[b]Estimated per-acre harvest for plots at this point in the distribution that are actually harvested.

Using the model to simulate the effect of a continuation of past trends in the explanatory variables can provide additional insight. Northeastern forests are maturing; sawtimber volumes in New Hampshire have increased 26 percent since 1973 (Frieswyk and Malley 1985). Timber quality has also improved, with grade 1 and 2 sawlogs comprising 27 percent of the pine sawtimber and 36 percent of the hardwood sawtimber in 1983. However, species composition is also changing. Red maple growing stock has increased by 137 percent since 1960 and is now the most abundant hardwood in New Hampshire. The affluence levels of landowners has increased. In 1983, almost three-quarters of New Hampshire's individually owned forest land was held by owners who completed education beyond high school.

The assumptions for the simulation were: average sawtimber volumes will be 15 percent higher over the next decade, the proportions of white pine and red oak will decrease by 10 percent, average education levels will increase by 0.25 years, and the proportions of "professionally" employed owners and real stumpage prices will remain constant. The simulations and comparisons were computed at the sample mean and measure harvest behavior for an 11-year interval.

The expected harvest dropped 22 percent, to 12.3 board feet per acre; the expected probability of harvest was reduced from 5.5 to 4.4 percent; and the conditional harvest declined from 290 to 283 board feet per acre. Additional analyses indicate that a 3 percent increase in real stumpage prices would be required to maintain harvests at current levels, under these assumptions. Of course, other options, such as programs designed to enhance growth or improve species composition, might be used to avert the need for increased stumpage prices.

SUMMARY

Forest characteristics, which generally were lacking in previous empirical work, were important determinants of harvest behavior. High per-acre volumes and the presence of commercially valuable species were positively correlated with timber harvesting. Concerns that an increasingly affluent population of landowners may be less likely to harvest timber were supported. Timber harvesting was negatively correlated with both income and education. Several other owner characteristics, such as, age, retirement status, tenure of ownership, whether the owner was raised in a rural or urban environment, and in-state residency, were not significantly correlated with timber harvesting.

Interest rates were negatively correlated with the propensity to harvest timber. This suggests that the positive influence expected from an increase in the opportunity cost of growing timber was out-weighed by other factors. Since interest rates are negatively correlated with housing starts and consumption of other wood products, they may proxy for the effort buyers exert at securing stumpage.

Positive coefficients and relatively high elasticities were estimated for the effect of stumpage prices. However, these results were not statistically significant at the 10-percent level. The opposing income and substitution effects may be canceling one another or the true effect may be obscured by problems of measurement and multicollinearity, inherent in these types of analysis.

Although prospects for timber harvesting should be enhanced as timber volumes increase, a net reduction in availability is anticipated due to changes in species composition, and the expectation that an increasingly affluent landowning population will be less interested in timber harvesting. Any changes in timber availability are expected to result primarily from a decrease in the number of acres from which timber is offered for sale and to a much lesser extent from changes in per-acre harvesting intensity.

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