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economics

Industrial Timberland Ownership and Financial Performance of US Forest Products Companies

Yanshu Li and Daowei Zhang

This study presents an empirical analysis of the relationship between industrial timberland ownership and financial performance of forest products companies in the United States. Based on the structure-conduct-performance model of the industrial organization theory, we develop and estimate a three-stage least squares model system that links timberland ownership with performance. Our results show that holding timberland improves a forest products company's profitability and lowers its systematic risk. Still, these benefits cannot overcome the costs induced by institutional arrangements, leading most forest products companies to divest their timberlands.

Keywords: industrial timberland ownership, financial performance, institutional timberland ownership, timber tax, accounting rules, industrial organization theory, structure-conduct-performance

In 2001, forest products firms owned 13% or 66 million acres of US timberland, which contributed to approximately 29% of the country's timber production (Smith et al. 2003). However, some forest products firms, including International Paper, Georgia-Pacific, and Boise Cascade Corporation, have sold more than 31 million acres of timberland in recent years, mostly to institutional investors who hire timberland investment management organizations (TIMOs) to manage the forest, whereas others such as Potlatch have converted to real estate investment trusts (REITs). By 2007, nearly 80% of timberland previously classified as forest industry land was classified as TIMOs/REITs (Smith et al. 2009). As of 2011, the top 20 corporate timberland owners owned or managed 47.6 million acres of timberland in the United States (Forisk Consulting 2011). Of them, 43.8 million acres (92.0%) were managed/owned by TIMOs/REITs.

The advantages of industrial timberland ownership were identified as favorable returns on timberland, earnings stabilization, cost control, leverage on open stumpage markets, tax advantages (before 1986 tax reform), risk reduction, and supply assurance (O'Laughlin and Ellefson 1982, Ellefson and Stone 1984, Zinkhan et al. 1992, Yin et al. 1998). In practice, there were various degrees of timberland ownership by forest products companies. At one extreme, some companies, such as the privately held Alabama River Pulp Company, Inc., did not own any timberland; at the other, Weyerhaeuser had owned millions of acres of timberland that supplied nearly one-third of its timber consumption before converting to a REIT in 2010. Clephane and Carroll (1982) find industrial timberland ownership to be critical to a firm's profitability and valuation. Yin et al. (2000) argue that owning timberland provides a valuable option to forest products companies. However, to the best of our knowledge, no study has been conducted to empirically and systematically quantify the pros and cons of industrial timberland ownership. This glaring gap in the forest economics literature needs to be filled. Otherwise, the recent demise of industrial timberland ownership in the United States might give the impression that owning timberland hinders the financial performance of forest products firms.

The purpose of this study is to examine the relationship between timberland ownership and financial performance of major forest products companies in the United States. Using data from 1988 to 2003, we find that timberland holdings have positive effects on a forest products company's profitability and reduce its systematic risk. However, institutional arrangements, especially tax and accounting rules, appear to have driven forest products companies to sell most of their timberlands. This article begins with trends in industrial timberland ownership in the United States, followed by a literature review, research method, and data. The final sections present empirical findings, discuss why forest products companies have sold or are under pressure to sell their timberlands in the United States, and conclude with some policy implications.

Industrial Timberland Holdings in the United States

Industrial timberland holdings in the United States increased slightly from 67 million acres in 1977 to 70.3 million acres in 1987

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Affiliations: *Yanshu Li (yanshu.li@fao.org), Food and Agriculture Organization of the United Nations. Daowei Zhang (zhangdw@auburn.edu), Auburn University, School of Forestry and Wildlife Sciences, Auburn, AL.*

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and then declined to 65.6 million acres in 2001 (Smith et al. 2003). Table 1 lists timberland owned and controlled by the 44 major wood-based corporations in various years. Following Clephane and Carroll (1982) and Yin et al. (1998), the US companies are divided into three groups: major companies, whose main outputs were wood and paper and allied products and that were on the Fortune 500 companies list for at least 1 year during the study period; diversified companies, those with forest products as only one of their diversified interests; and other companies, mostly smaller forest products firms that were not on the Fortune 500 list.

Consistent with the finding in Yin et al. (1998), diversified companies increased their timberland holdings, whereas major companies and other companies decreased their holdings from 1994 to 2006. Industrial timberlands held by major companies decreased from 43.1 million acres in 1994 to 25.7 million acres in 2003 and to 16.9 million acres in 2006. In the same period, other companies divested 0.8 million acres and timberlands held by diversified companies increased from 5.3 to 12.3 million acres.

There was a notable increase in controlled timberland, referring to leasing, contracting, cutting rights arrangements, and cooperation, by forest products companies (Yin et al. 1998). This is especially true for the major companies group whose controlled timberland increased from 23.7 to 102.7 million acres between 1994 and 2006. The vast majority of controlled timberland was located outside of the United States. For example, Louisiana-Pacific Corporation had 44 million acres under license agreement, and Weyerhaeuser and Bowater had approximately 30 million acres each in Canada, where most land is publicly owned. International Paper, on the other hand, controlled some timberland in New Zealand and owned timberland in Brazil.

Table 2 shows that the cumulative percentage of timberland owned by the largest 10 industrial companies in the United States remained steady in the two and one-half decades before 2007. Because firms are different sizes and have different demands for timber, a better measure is the self-sufficiency rate, which is defined as the percentage of wood taken from a firm's own land to its total wood consumption. Table 3 presents the self-sufficiency rates for these selected companies. Some companies (e.g., International Paper and Louisiana-Pacific) experienced a significant decline in self-sufficiency, whereas others (e.g., Boise Cascade) had stable self-sufficiency rates.

Literature Review

Industrial Organization Theory: Structure-Conduct-Performance

The theory of industrial organization investigates markets and the results of markets. One of the main approaches in industrial organization theory is the structure-conduct-performance (SCP) model, which is applied to industrial sectors as well as firms within a specific sector. The elements of a sector's structure include the size and number of sellers and buyers, market power, the degree of product differentiation, the cost structure, the barriers to entry, and the degree of vertical integration. Conduct (or behavior) refers to price, research and development (R&D), investments, and so forth. Performance is reflected by various efficiency measures (Slangen et al. 2008).

The original SCP approach assumes that the relationships are monocausal. New theoretical insights indicate that the SCP relationships are multicausal in nature: there is a path not only from structure to conduct but also from conduct to structure. For example, firms select the degree of product differentiation, their cost structure, and their degree of vertical integration. In addition, factors outside the sector such as exogenous demand and the government/institutional arrangements, are important. Figure 1 illustrates the SCP approach.

Our purpose here is to investigate the impact of one aspect of the forest industry structure, the degree of upstream vertical integration, on the profitability and systematic risk of forest products companies, after other structure and conduct variables are controlled for. Why would forest products companies want to do upstream vertical integration in the first place?

Industrial Timberland Ownership: Benefits and Costs

The logic behind upstream vertical integration may be supply assurance, imperfect competition, incomplete information, barriers to entry, transactional costs, and other factors (Perry 1989, Bain 1956). All these point to an imperfect market in an industry sector. Supply assurance, which forest products companies seek to gain better control over and ensure a stable supply of timber for production, for instance, would not be necessary if there was perfect competition in timber markets. Because the ratio of transportation cost to product value is high in logs, stumpage and log markets are often characterized as monopsony or oligopsony. Thus, monopsonistic or oligopsonistic rent can be generated if a firm owns timberland close to its manufacturing facilities and uses its own timber to reduce the prices of timber in open markets. This is a leverage theory of vertical integration. Murray (1995) shows that imperfect competition exists in US pulpwood markets.

Similarly, industrial timberland ownership may help a company deal with incomplete information and uncertainty. Diversification of returns, earnings stabilization, and reduced price volatility can all be seen as desired outcomes in an uncertain environment. Helfat and Teece (1987) suggest that, although vertical integration may not reduce uncertainty, it may help a firm respond to uncertainty. Because timberland and forest products production have different levels of price variability, owning both can smooth a firm's flow of returns (Blair and Kaserman 1983, Zinkhan et al. 1992). When forest products prices are high (thus timber prices are high), firms can use more of their own timber, and, conversely, firms can buy timber on open markets (Zinkhan et al. 1992). Another possibility is that when the timber prices are low (usually associated with low forest products prices), firms may buy more from their own lands to generate more revenues and stabilize earnings (Binkley et al. 1996).

Upstream vertical integration can also create an entry barrier for potential competitors by forcing them to contemplate entry at two stages of production (products and inputs) rather than one. In other words, it can raise a rival's cost by leaving the open market thin (O'Laughlin and Ellefson 1982, Salop and Scheffman 1983). Ellefson and Stone (1984) show that timberland holdings helped International Paper keep a competitor from intruding into its territory.

Transaction cost theory (e.g., Coase 1937) may explain why firms choose industrial timberland ownership rather than lease and contracts (Phillips 1997). Williamson (1975, 1986) and Klein et al. (1978) suggest that vertical integration stems from a small number bargaining problem that gives rise to opportunistic behavior such as hold-up to extract quasi-rents. The hold-up cost depends on the extent of asset specificity. Yin et al. (1998) suggest a high degree of asset specificity as a characteristic of the forest products industry. Long-term contracts can be used to avoid opportunistic behavior

Table 1. Industrial timberland holdings by company and year.

Forest products companies	1981: owned, in the United States only[a]	1994[a]		2003[b]				2006[b]			
				Owned		Controlled		Owned		Controlled	
		Owned	Controlled	United States	Other countries	United States	Other countries	United States	Other countries	United States	Other countries
				(thousand acres)							
Major companies											
Weyerhaeuser	5,930	5,587	6,014	866	5,700	291	18,800	788	29,945	700	26,800
Georgia-Pacific	4,613	6,000	0	0	0	0	0	0	0	0	0
International Paper	6,902	5,900	8,300	1,500	500	370	200	0	785	0	500
Champion International[c]	3,069	4,492					578				
Boise Cascade	3,062	2,710	2,046	0	2,046		3,337				
Scott Paper[d]	2,846	1,670					350				
Louisiana-Pacific	920	1,608	0	0	0	0	388	129	44,000	47	46,600
Union Camp[e]	1,728	1,526					32				
Westvaco/MeadWestvaco	1,275	1,453	2,219	128	1,116	135	1,406	104	0	102	0
Kimberly-Clark	668	400	0	1,000	0	0	4,700	0	4,900	0	0
Potlatch	1,415	1,500	1,500	0	1,500	0	15	18	0	0	0
Mead[f]	1,576	1,243					107				
Willamette[g]	557	1,235					0				
Chesapeake Corp.	364	328	1	0		0	0	0	0	0	0
Longview Fiber Co.	483	738	570	0	588	0	0	0	0	0	0
Federal Paper Board[h]	380	569					123				
Pacific Lumber Co.[d]	167	189					0				
St. Regis Paper[d]	3,214	0					0				
Great Northern Nekoosa[d]	2,783	0					0				
Sierra Pacific Industries[i]	522	922	1,500	0	1,500	0	0	0	0	0	0
Prentiss & Carlisle[j]	700	700	850		1,390	0	0			0	0
Deltic Timber	0	312	434	0	438	0	0	0	0	0	0
Bowater[k]	2,690	3,700	300	1,000	100	600	0	100	31,800	100	27,900
Stone Container Corp.	0	335	0	1,000	0	1,000	13,100	0	0	0	0
Subtotal	45,864	43,117	23,734	5,494	14,878	2,396	43,136	1,139	111,430	949	101,800
Other companies											
James River[l]	192	420					2,780				
Temple-Inland	1,557	1,900	1,770	0	1,800	0	0	230	0	230	0
Consolidated Papers[d]	664	673					0	0	0		
Mosinee Paper Co.[m]	89	87					0				
P.H. Glatfelter	101	110	89	0	75	0	0	0	0	0	0
Sonoco Products Co.	18	80	0	0	0	0	0	0	0	0	0
Wausau Paper Mills	43	44	120	0	118	0	0	0	0	0	0
Grief Bros.	317	319	279	40	268	0	0	0	0	0	0
Stimson Lumber	70	70	500	0	500	0	0	0	0	0	0
The Collins Co.	130	130	300		300						
Pope Resources[n]	130	73	115	0	115	0	0	0	0	0	0
Crown Zellerbach[o]	1,979	0					0				
Subtotal	5,290	3,906	3,173	40	3,176	0	2,780	230	0	230	0
Diversified companies											
ITT Rayonier	1,176	1,025	1,731	76	1,731	76	390	258	42	258	42
Tenneco Inc.[d]	442	183					820				
Manville[d]	587	543					6				
Jefferson-Smurfit[p]	859	758					226				
Plum Creek Timber Co.	1,504	2,000	8,100	0	8,200	0	0	0	0	0	0
Seven Islands Land	1,700	1,000	975	0	1,000	0	0	0	0	0	0
J.D. Irving	400	327	1,512	0	1,512	1,888	0	0	0	0	2,800
Proctor & Gamble[q]	1,040	0					0				
Subtotal	7,708	5,836	12,318	76	12,443	1,964	1,442	258	42	258	2,842
Total	58,862	52,859	39,225	5,610	30,497	4,360	47,358	1,627	111,472	1,437	104,642

[a] From Yin et al. (1998).
[b] From company annual reports (10-K).
[c] International Paper acquired Champion International on June 20, 2000.
[d] Inactive in 2006.
[e] International Paper acquired Union Camp on Nov. 24, 1998.
[f] Mead merged into MeadWestvaco Corp. on Jan. 29, 2002.
[g] Willamette was acquired by Weyerhaeuser Company on Mar. 24, 2002.
[h] Federal Paper Board merged with International Paper on Mar. 12, 1996.
[i] From Draffan (2006).
[j] From Kingsley et al. (2004). Ownership information in 1979 was used as an approximation of 1984 and that of 2000 was used as an approximation of 2003.
[k] Bowater was classified into Diversified Companies by Yin et al. (1998) and Clephane and Carroll (1982).
[l] It became Fort James in 1997. Georgia-Pacific bought Fort James in 1999.
[m] Mosinee Paper merged with Wausau Paper Mills Co. on Dec. 18, 1997.
[n] Pope and Talbot in 1981.
[o] It was taken over by James River in 1986.
[p] It was acquired by Stone Container Corp in 1994.
[q] Proctor & Gamble divested its pulp business in 1992.

Table 2. Cumulative percentage of all industrial timberlands owned by top 10 US companies: 1981, 1994, and 2003.[a]

Rank	Forest products companies	1981 (%)	Forest products companies	1994 (%)	Forest products companies	2003 (%)
1	International Paper	10	Georgia-Pacific	9	Plum Creek Timber Co.[b]	12
2	Weyerhaeuser	18	International Paper	18	International Paper	23
3	Georgia-Pacific	25	Weyerhaeuser	26	Weyerhaeuser	32
4	St. Regis Paper	30	Champion International	32	Westvaco/MeadWestvaco	35
5	Champion International	34	Bowater	38	Boise Cascade	38
6	Boise Cascade	39	Boise Cascade	42	Temple-Inland	41
7	Scott Paper	43	Plum Creek Timber Co.	45	ITT Rayonier	44
8	Great Northern Nekoosa	47	Temple-Inland	48	Potlatch	47
9	Bowater	51	Scott Paper	50	Sierra Pacific Industries	51
10	Crown Zellerbach	53	Louisiana-Pacific	52	Prentiss & Carlisle	53

[a] Because total industrial acreages are not available for 1994 and 2003, we use the constant rate of growth approach to interpolate based on the 1992 and 2001 data in Smith et al. (2003).
[b] It should be noted that Plum Creek is legally a REIT. Because it owns a sawmill, it may be seen as a forest products company. Nonetheless, we have excluded Plum Creek from our regression analysis partly because it has only existed since 1999.

Table 3. Selected wood self-sufficiency rate.

Company	1994[a]	2003[b]
International Paper	35	25
Boise Cascade	47	47
Potlatch	35	21
Louisiana-Pacific	25	5
Temple Inland Inc.	42	50[c]
Crown Pacific Partners LP	44	57
P. H. Glatfelter	22	21[d]
Kimberly-Clark		40

[a] From Yin et al. (1998).
[b] From company annual reports (10-K).
[c] From fee and lease forestland.
[d] Calculated from information available.

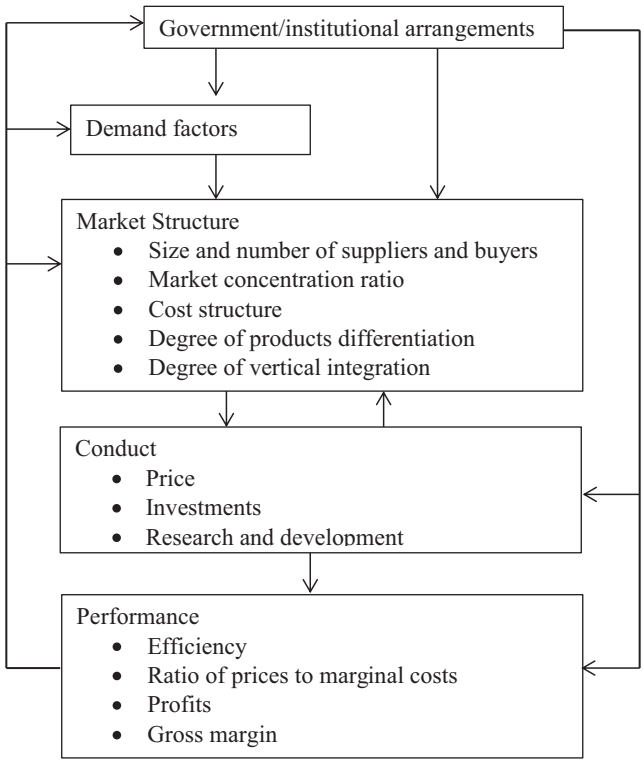

Figure 1. The SCP approach. (Adapted from Slangen et al. [2008].)

when future contingencies can be specified and estimated. However, when it is too costly or impossible to outline every future contingency, internalization (that is, direct ownership) may be more efficient. Globerman and Schwindt (1986) state that transaction considerations, especially asset specificity, are robust empirical determinants of the corporate governance structure in Canadian forest products firms. Niquidet and O'Kelly (2010) find that pulp mills in New Zealand and Sweden decrease the proportion of fiber sourced from a market with increasing fiber specificity, capital intensity, forest ownership concentration, and uncertainty.

Industrial timberland ownership may also be motivated by tax advantages and strategic considerations. Before 1986, the capital gains tax rate on timberland was 30% lower than the 48% tax rate on regular corporate income (Sunley 1976). When this favorable capital gains tax treatment was terminated in 1986, tax advantages ceased to be a reason for timberland ownership. In fact, current US tax policies that require forest products firms to pay a higher tax than other owners have imposed costs on industrial timberland ownership.

In summary, because the timber market is not perfect, industrial timberland ownership may enhance a firm's benefits and/or reduce its costs, including production costs and transaction costs. Production costs are the direct costs incurred in the physical production process. Transaction costs include costs of negotiating, monitoring, enforcing, and possibly bonding to the terms of arrangements (Collis and Montgomery 1997). On the other hand, timber production is capital intensive, and a large amount of capital can be tied to timberland (Ellefson and Stone 1984, Yin et al. 1998). In addition, because timberland and forest products production are two different businesses, conflicts may arise when companies decide whether to use their timberlands to supply their mills or to manage them as profit centers (Yin et al. 1998, Lönnstedt 2007). Finally, internal organization costs may rise when industrial timberland holdings are large.

Determinants of Companies' Financial Performance

Many studies address the factors influencing corporate financial performance in forest products and other industries. Product diversification, geographic diversification, capital expenditure, R&D investment, firm size, and main businesses are identified as major factors.

Booth and Vertinsky (1991) find that unrelated product diversification and geographic diversification decrease the return on assets of North American forest products companies. Similarly, Rumelt (1986) shows that the highest levels of profitability are achieved by firms that diversify primarily into areas that drew on common core skills or resources. Geographic diversification refers to spreading

Table 4. Companies and periods covered in the study.

No.	Company name	Symbol	SIC	Year
1	Badger Paper Mills	BPMI	2671	1988–2003
2	Boise Cascade	BCC	2621	1988–2003
3	Bowater	BOW	2621	1988–2003
4	Champion International	CHA	2435	1988–1999
5	Chesapeake	CSK	2650	1988–2003
6	Consolidated Paper	CDP	2672	1988–1999
7	Deltic Timber	DEL	2421	1992–2003
8	Federal Paper Board	FBO	2631	1988–1994
9	Fort James	FJ	2676	1997–1998
10	Georgia Pacific	GP	2611	1988–2003
11	P. H. Glatfelter	GLT	2621	1988–2003
12	International Paper	IP	2621	1988–2003
13	James River	JR	2676	1988–1996
14	Kimberly Clark	KMB	2621	1988–2003
15	Longview Fibre	LFB	2621	1988–2003
16	Louisiana Pacific	LPX	2421	1988–2003
17	Mead	MEA	2621	1988–2000
18	Mead Westvaco	MWV	2621	2002–2003
19	Mosinee Paper	MOSI	2621	1988–1996
20	Packaging Corporation Of America	PKG	2653	1996–2003
21	Pope & Talbot	POP	2621	1988–2003
22	Potlatch Corp	PCH	2621	1988–2003
23	Rayonier	RYN	2411	1988–2003
24	Scott Paper	SPP	2621	1988–1993
25	Smurfit Stone Container	SSCC	2631	1998–2003
26	Stone Container	STO	2630	1988–1997
27	Temple Inland	TIN	2653	1988–2003
28	Union Camp	UCC	2621	1988–1997
29	Universal Forest Products	UFPI	2421	1991–2003
30	Wausau Mosinee Paper Mills Corp.	WMO	2621	1998–2003
31	Wausau Paper	WSAU	2621	1988–1997
32	Westvaco	W	2621	1988–2000
33	Weyerhaeuser	WY	2400	1988–2003
34	Willamette	WLL	2621	1988–2000

SIC, Standard Industrial Classification system.

operations across countries and regions. Some studies (e.g., Daniels and Bracker 1989, Kim et al. 1993, Tallman and Li 1996) find that higher levels of international diversification lead to better performance, whereas others (e.g., Hitt et al. 1997, Lu and Beamish 2001) find that they have no impacts. Multinational firms can gain economic benefits from exploitation of various assets in international markets, such as a competitively priced labor force and access to critical resources (Kogut 1985, Deeds and Hill 1999), whereas a "liability of foreignness" (Hymer 1976) and increasing transaction costs (Tallman and Li 1996) could hamper their competitiveness. R&D investment is found to be positively related to a firm's financial performance (Booth and Vertinsky 1991, Phillips 1997, Lu and Beamish 2001). Firm size is found to have either positive (Fama and French 1993, Li and Greenwood 2004) or no impacts (Booth and Vertinsky 1991, Lu and Beamish 2001).

As for risk, Ben-Zion and Shalit (1975) show that a firm's systematic risk is negatively related to its size and dividend record and positively to its financial leverage. Booth and Vertinsky (1991) find that unrelated product diversification and geographic diversification reduce the systematic risk of North American forest products companies. R&D intensity is found to be positively related to a firm's systematic risk (e.g., Booth and Vertinsky 1991, Lu and Beamish 2001, Ho et al. 2004) because R&D-intensive firms are often high-growth firms and a large portion of their market values may be generated from the expectation of future earnings (Titman and Wessels 1988).

Estimation Methodology and Data

Companies analyzed in this study consist of all publicly traded primary forest products firms in the United States (Table 4). We excluded some companies that did not operate continuously in the whole study period and others because of lack of information on some variables in certain years. To control for the impact of the 1986 US federal tax reform, we chose 1988–2003 as our study period.

A system of regression models is used to estimate the relationship between industrial timberland ownership and various measures of a company's financial performance. Because timberland ownership decisions are based on a variety of internal factors, including a firm's performance and debt level, timberland ownership is treated as an endogenous variable in the system of model equations. Because various performance measures cover different aspects of the same firm, their disturbances may include common factors and thus may be correlated. Considerable efficiencies can be gained by estimating these equations jointly as a three-stage least squares (3SLS) model (Greene 2008, p. 381).

Dependent Variables

In this study, we use return on assets (ROA), return on equity (ROE), price earnings ratios (PE), and systematic risk ratio β as the dependent variables. ROA is defined as earnings before interest and taxes divided by total assets. It is a pure measure of the efficiency of

a company in generating returns from its assets, without being affected by management financing decisions. ROE is defined as earnings before interest and taxes divided by total equity. Because it encompasses the three main pillars of corporate management (profitability, asset management, and financial leverage) ROE demonstrates how effectively a company's management uses investors' money. PE is the ratio of current share price to earnings per share. It is useful for comparing the performance of firms within the same industry. β is estimated empirically as regression coefficients of an individual stock return on the market's return using the capital asset pricing model:

$$R_{ih} - R_{fh} = \alpha_i + \beta_i(R_{mh} - R_{fh}) + \varepsilon_{ih} \quad (1)$$

where R_{ih} is the rate of security return for stock i for month h, R_{fh} is the risk-free rate of return (measured by the yield on US T-bills), R_{mh} is the rate of return of the value-weighted market portfolio for month h, α_i is the regression parameter, and β_i is equity β for stock i.

Widely used in modern finance literature, β reflects the systematic risk associated with a firm's stock. Most annual equity β values are calculated using the previous 60 months of stock market data. Of the 430 β values calculated in this study, only 2 are estimated from less than 60 observations.

The dependent variable for the timberland ownership equation is the size of industrial timberland holdings for each company each year. This equation is estimated in the first stage of the 3SLS model and fed into the second and third stages as an independent variable for financial performance measures. Thus, timberland ownership serves as an instrumental variable to other equations. To increase comparability among firms of different sizes, the predicted areas of timberland ownership in the United States are normalized by annual sales.

Independent Variables

All independent variables either reflect the "structure" of the market or "conduct/behavior" of the firms. In addition to the timberland ownership, we have used firm size, growth rate in sales, main business (three variables), product diversification (two variables), geographical diversification (two variables), expense intensity (two variables, capital and R&D expenditures), and stumpage prices (two variables) as independent variables in the financial performance equations. For the systematic risk equation, we have added debt/asset ratios as an independent variable.

For the timberland ownership equation, we have dropped the product diversification, geographical diversification, and R&D expense intensity variables, but added debt/asset ratios, stumpage price variations, timberland returns, and other forms of timberland control. These dropped variables are not considered to be relevant to industrial timberland ownership, whereas the added variables are considered to affect either the demand side (debt/asset ratios and stumpage price volatility) or the supply side (timberland value, which represents the opportunity cost, and other forms of timberland control, which may be a substitute) of industrial timberland ownership.

Firm size is measured by a logarithm of its market equity (ME) in 1988 constant dollars rather than its total assets, because the latter is book value. ME is calculated as the product of the company's stock price and the number of shares outstanding at the end of the quarter. The variables representing annual capital expenditure and R&D expenditure are in real terms (1988 = 100) as well. Growth rate in sales is an indicator of a company adapting to market and environmental changes. The compound growth rate in sales in 1988 dollars is used as the measure.

The share of each type of product in total annual sales is calculated as an indicator of the firm's main business category. Only three variables are used (wood products share, specialty products share, and nonforest products share) to avoid multicollinearity with paper and paperboard share as the baseline.

Product diversification is measured by an entropy measure, which was proposed by Berry (1975) and has since been widely used (e.g., Palepu 1985, Hill et al. 1992, Hoskisson et al. 1993, Li and Greenwood 2004). The entropy measure permits decomposition of total diversification into different types of diversification. Total entropy (*TD*) is given by

$$\mathrm{TD} = \sum_{j=1}^{J} P_j \ln(1/P_j) \quad (2)$$

where P_j is the proportion of business activity (sale) in segment j, for a firm with J different industry segments.

Unrelated entropy (*UD*) is computed in a similar fashion using a group of segment data:

$$\mathrm{UD} = \sum_{g=1}^{G} P_g \ln(1/P_g) \quad (3)$$

where P_g is the proportion of business activity (sale) in the group of segment g for a firm with G different groups of industry segments ($G \leq J$).

Related entropy (*RD*) therefore can be estimated as

$$\mathrm{RD} = \mathrm{TD} - \mathrm{UD} \quad (4)$$

In this study, the industry segments are defined as (1) printing and writing paper, pulp, and newsprint; (2) paperboard products and packaging; (3) distribution activities; (4) specialty products and consumer products, including tissue and other specialized products; (5) wood products, consisting of lumber and plywood and other solidwood products; and (6) all other nonforest products and services. Segments 1 and 2 are classified as the group of paper and packaging products, 3 and 4 as specialty products, 5 as wood products, and 6 as nonforest products and services.

Geographic diversification is represented by the percentage of US domestic sales in total sales. Three categories of firms are created, based on three percentiles (33, 67, and 100%) and two geographic diversification dummies (high geographic diversification of 68–100% and moderate geographic diversification of 34–67%) are used.

Two variables are used to represent sawtimber and pulpwood stumpage prices, which affect a firm's earning stability and thus its systematic risk. Stumpage price data are from Timber Mart-South (1988–2003). For stumpage price volatility, we have used the coefficient of variation (COV), which is 100 times the ratio of SD and the average of real stumpage prices, as a measure. Quarterly softwood sawtimber and pulpwood prices in 1988 constant dollars are used to generate the annual SD. Because timberland holding decisions may be based on the previous year's price volatility, 1-year lagged COVs for sawtimber prices are used. We have also tried 2-year lagged COVs for sawtimber prices that are not significant and

Table 5. Parameters of the 3SLS model of financial performance and timberland ownerships of US forest products companies.

	ROE	ROA	PE	β	Timberland
Intercept	19.62[b]	5.35[a]	−69.70	3.00[c]	61.09
SE	9.52	3.05	82.33	0.35	38.35
Timberland/sales ratio (%)	0.06	0.07[c]	0.60[a]	−0.01[c]	
SE	0.04	0.01	0.31	0.00	0.00
Firm size	1.17	0.49[b]	5.71	−0.01	1.32
SE	0.71	0.22	6.16	0.02	2.05
Growth rate in sales (%)	0.11[c]	0.04[c]	0.27	0.01[c]	
SE	0.04	0.01	0.34	0.00	
Capital expense intensity	−0.15[a]	−0.09[c]	−0.40	0.01[c]	0.61[b]
SE	0.08	0.03	0.69	0.00	0.24
R&D expense intensity	−0.07	−0.02	0.66	−0.01[c]	
SE	0.12	0.03	1.03	0.00	0.00
Specialty products share	0.12[c]	0.02	−0.30	0.00	0.07
SE	0.04	0.01	0.37	0.00	0.13
Wood products share	−0.04	−0.05[c]	−1.02[b]	0.01[c]	0.62[c]
SE	0.05	0.01	0.41	0.00	0.13
Nonforest products share	−0.13	−0.19[c]	−1.88	0.02[c]	2.83[c]
SE	0.15	0.05	1.26	0.01	0.35
Unrelated diversification index	−0.02	0.00	0.56[b]	0.00	
SE	0.03	0.01	0.25	0.00	
Related diversification index	−0.07	−0.03[b]	−0.30	0.00[c]	
SE	0.06	0.01	0.49	0.00	
Geographic diversification dummy I	0.36	−0.10	−19.32	0.16[c]	
SE	2.37	0.59	20.45	0.05	
Geographic diversification dummy II	−2.16	−0.12	−34.77[a]	0.06	
SE	2.26	0.57	19.49	0.06	
Pulpwood price	−0.17	−0.02	0.15	−0.01[c]	0.55
SE	0.15	0.05	1.27	0.00	0.55
Sawtimber price	−0.08[b]	−0.03[c]	0.23	−0.01[c]	0.06
SE	0.03	0.01	0.29	0.00	0.12
Debt/asset ratio (previous year)				−0.36	−166.48[c]
SE				0.35	21.05
Sawtimber price volatility				−0.03[c]	1.38
SE				0.01	1.00
NCREIF timberland index (previous year)					0.51[a]
SE					0.28
Other forms of timberland control					−0.03[c]
SE					0.01
df			2,066		
System weighted mean squared error			1.22		
System weighted R^2			0.32		

[a] Significance at 10% level.
[b] Significance at 5% level.
[c] Significance at 1% level.

were subsequently dropped. Further, because a high correlation exists between sawtimber and pulpwood price volatility ($r = 0.49$), pulpwood price volatility is not used in the final model.

Finally, timberland value is represented by the NCREIF Timberland index, a quarterly timberland return index maintained by the National Council of Real Estate Investment Fiduciaries (n.d.). The other form of timberland control is a variable reflecting the total acreage of timberland leased by a company.

Model Specification and Data

Let index $k = 1, 2, 3, 4, 5$ denote estimation functions for ROA, ROE, β, PE, or timberland ownership model, respectively; $\mathbf{y} = (y_1, \ldots, y_5)$ is a vector of k dependent variables; $[\mathbf{X_1} \ldots \mathbf{X_5}]$ is the matrix of k sets of explanatory variables, $\mathbf{X_1}, \ldots, \mathbf{X_5}$; $\boldsymbol{\delta}$ is the vector of coefficients; and $\boldsymbol{\varepsilon}$ is the vector of disturbance. The full system of equations is

$$\boldsymbol{y} = \boldsymbol{X\delta} + \varepsilon \tag{5}$$

where

$$\boldsymbol{E[\varepsilon|X]} = 0, \text{ and } \boldsymbol{E[\varepsilon\varepsilon'|X]} = \textstyle\sum \otimes \boldsymbol{I} \tag{6}$$

The estimator is a generalized least squares estimator

$$\hat{\boldsymbol{\delta}}_{3SLS} = [\hat{\boldsymbol{X}}'(\textstyle\sum^{-1} \otimes \boldsymbol{I})\hat{\boldsymbol{X}}]^{-1}\, \hat{\boldsymbol{X}}'(\textstyle\sum^{-1} \otimes \boldsymbol{I})\boldsymbol{y}. \tag{7}$$

Financial data used in this study were collected from various sources. Monthly security returns data are from the Center for Research in Security Prices (2007), annual financial accounting data are from Compustat (Standard and Poor's 2007) and Mergent Online (Mergent Inc. 2005), as well as from annual 10-K reports, annual information on industrial timberland holding from annual reports via EDGAR (US Securities and Exchange Commission 2005), and the LexisNexis Academic Database (LexisNexis Inc. 2007).

Results

Table 5 presents the regression results of 3SLS regression. The cross-model correlation coefficients of the system are as high as ±0.67, implying that 3SLS is appropriate for this study. The system-weighted R^2 shows that the models fit reasonably well. The coefficients of the timberland ownership variable in three of the financial performance equations being significant and having

the expected signs demonstrate that it should be treated endogenously.

The estimated ROA and PE models indicate that timberland holding is positively related to a firm's profitability and investors' expectation on future earnings growth. At the same time, the significant negative coefficient of timberland holding in the β model suggests that timberland holding can reduce a firm's systematic risk. These results are consistent with Boardman et al. (1997), who use an event study and find that forest products companies owning timberland had better financial performance than other companies in the 1990s when logging restrictions were imposed on public forestland in the United States.

The results show that large firms are more likely to perform better in terms of ROA, whereas the growth rate in sales has a positive impact on ROA and ROE but increases a firm's systematic risk. The significant negative coefficients of capital expense intensity in the ROE and ROA models and positive coefficient in the β model suggest that capital intensity may reduce a firm's profitability and increase its systematic risk. On the other hand, R&D expenditure is shown to reduce a firm's systematic risk.

Further, the share of specialty products is positively associated with a firm's ROE. The shares of wood products and nonforest products are negatively associated with a firm's ROA and positively associated with its β. Related diversification is shown to reduce a forest products firm's profitability in terms of ROA and increase its systematic risk, whereas unrelated diversification may increase investors' expectations of its future earnings growth. Moderate geographic diversification is shown to reduce investors' expectations of earnings growth. Finally, sawtimber price is shown to affect a firm's ROE and ROA negatively and reduce its systematic risk. Unexpectedly, sawtimber price volatility is shown to have a negative impact on a firm's systematic risk.

The timberland model also fits well. As expected, higher financial leverage and the amount of controlled timberland are associated with lower industrial timberland holdings in the United States. Further, firms with high wood products share, nonforest products share, and high capital expenses tend to hold more timberlands than other firms. High timberland returns in the previous year have a positive impact on industrial timberland ownership.

Conclusions and Discussion

This study uses the SCP approach to establish and test empirically the relationship between timberland ownership and the financial performance of US forest products companies. The results show that timberland holdings can enhance a forest products company's profitability in terms of ROA and PE and reduce its systematic risk. In other words, timberland holdings improve a firm's profitability and ability to respond to uncertainty.

If owning timberland increases profitability and reduces systematic risk, why did most US forest products companies sell their timberlands or convert themselves to REITs? Clutter et al. (2005) note that poor shareholder returns, debt reduction, and moving into tax-advantaged ownerships all contribute to industrial timberland divesture. As for the latter, a report by Lehman Brothers (2006) shows that the difference in timber incomes between a double-taxed C-corporation (which all forest products companies are) and a tax-advantaged financial ownership such as TIMOs and REITs can be as high as 39%. Although owning timberland may be advantageous and profitable, vertically integrated forest products companies can by no means compete with TIMOs and REITs by such a big margin. Further, the US's generally accepted accounting principles (GAAP) undervalue timberland because tree growth is not considered as an increase in asset value. This lowers the value of industrial owners' assets, leaving them subject to potential buyouts (Binkley 2007, Zhang and Pearse 2011, p. 196). Both institutional arrangements—tax policies and accounting rules—undoubtedly add pressure on integrated forest products companies to monetize or sell their timberlands. Thus, the demise of industrial timberland ownership in the United States has a lot to do with institutional arrangements that have induced costs on industrial timberland owners. Indeed, an event study by Sun and Zhang (2011) shows that divesting their timberlands has unloaded the "costs" and enhanced shareholder values of these companies.

The policy implications of this study are 2-fold. First, should the differential tax treatments for timber income among different owners have been eliminated and the accounting rules adjusted, the demise of industrial timberland ownership might not have happened, at least not to the extent we have seen in the United States. In fact, Weyerhaeuser, which had resisted altering its corporate structure for many years, had hoped the 2008 Farm Bill would reduce its tax for timber income to the level of TIMOs and REITs. When the 2008 Farm Bill brought only temporary relief (forest industry firms paying the same tax rate as TIMOs and REITs only for 1 year), not a permanent reduction to its corporate timber tax, it had no other choice but to convert itself to a REIT, selling most of its forest products manufacturing facilities along the way.

Further, when such differential tax treatment among timberland owners leads to changes in landowner behavior, one can infer that the US timber tax system is not neutral. If some degree of vertical integration is a global norm (Niquidet and O'Kelly 2010), this non-neutrality of tax and the resulting industrial timberland divestiture may hinder the competitiveness of the US forest products manufacturing sector in the global marketplace. As Sedjo (2008) notes, the recent divestiture of timberlands by American industry may simply reflect a tax system that promotes less integration at the cost of less efficient firms.

As noted earlier, the firms included in this study were chosen based on data availability. An inherent problem associated with this sampling method is selection bias. With this qualification, this study has shown that upstream vertical integration is an attractive option as a reaction to market imperfection in the forest industry, and it is broken up, to a large extent, by institutional arrangements. Because some forest industry firms signed timber supply agreements/contracts with institutional investors who bought their timberlands, it would be of interest to find out how these contracts have worked from the perspectives of both timber buyers and sellers and whether institutional timberland owners behave differently in their timber supply and forest management from industrial and nonindustrial timberland owners.

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