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Using Price Data to Consider Risk in the Evaluation of Forest Management Investments

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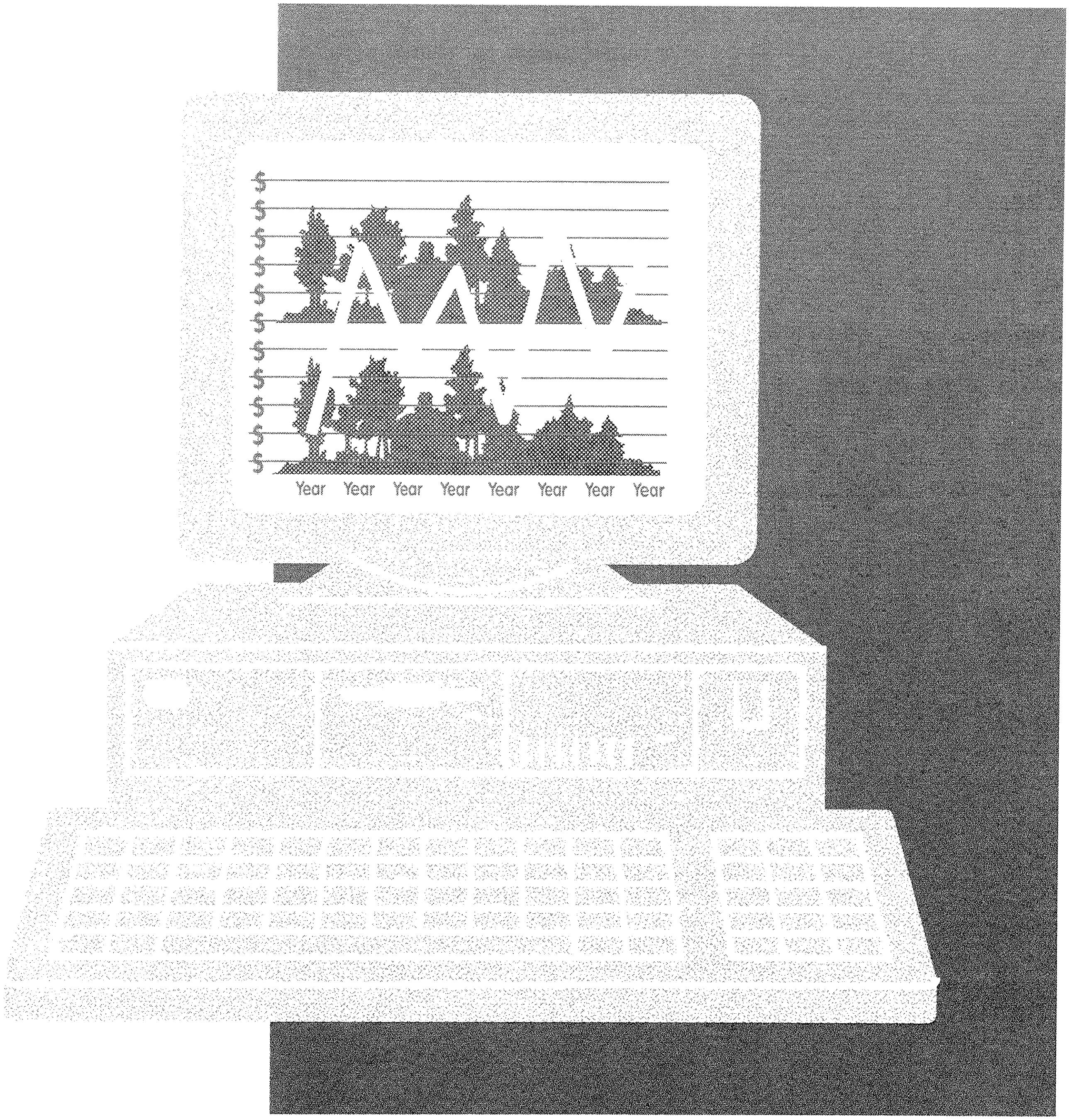

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Standard investment decision theory (Brealey and Myers 1984) has long incorporated methods for considering risk in the management of investment portfolios of stock, bonds, and other securities. Various approaches to considering risk have been used—all based on the rate and variability of returns to various holdings in the portfolio. The risk of a well-diversified portfolio depends on the market risk of the securities in the portfolio. The market risk is a measure of how sensitive the security is to market movements. This sensitivity is usually called the security's beta. A security that rose or fell by 2 percent as a result of a 1 percent change in the market would have a beta of 2. One that changed by 0.5 percent with a 1 percent change in the market would have a beta of 0.5. In general, the higher the beta, the higher the risk.

This financial analysis methodology uses time series data on the rate and variation of returns to various stocks, bonds, and securities to quantify risk and develop portfolios of investments that best satisfy the investor's needs in obtaining satisfactory returns at acceptable levels of risk.

Risk in Forestry Investments

Although forest economists have long been concerned with recognizing and quantifying risk in forestry investments (see, for example, Dowdle 1962, Marty 1964, Arvanitus and O'Regan 1967, Thompson 1968, and Hamilton 1970), only a recent few have employed the financial management methodology described above. Forestry investments have several distinctive aspects that complicate their evaluation with conventional financial analysis methods. The most frequently cited of these aspects are the immobility of standing timber, the length of the production period, and standing timber's dual nature and production flexibility. Further, some important forest products are producer goods and the demand for them is derived. Also, forest production is associated with numerous externalities, both positive and negative (Gregory 1987). All these distinctive aspects contribute to the most serious problem associated with using time series data for forestry investment decisions using conventional finance methodology for dealing with risk. Time series data and records of return to timber management investments are very poor relative to those available for more conventional financial instruments. Even the most carefully modeled studies (Thomson 1987) that entail cost accounting and growth and yield projections for different timber species obtain most of their variation in returns from annual variations in prices because they treat yields deterministically. Thus, many studies use price data as a proxy for returns to forestry investments.

The few recent studies of risk in forestry investments employ portfolio analysis. Mills and Hoover (1983) and Mills (1988) used portfolio analysis to show that forest land investments appear more desirable when included as diversifying elements in mixed portfolios of various financial assets even though traditional investment analyses often indicate these investments offer low rates of return and are fairly risky if held singly. Redmond and Cubbage (1988) measure market risk, which they define as the deviation in stumpage prices as contrasted with an investment proxy for all investments (stock index) from a mean value over time. Their findings show that stumpage prices are somewhat countercyclical to the general economy and that investments in stumpage could improve many portfolios of mixed financial assets.

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Thomson (1987) addressed the financial risks of growing commercial timber crops in the Midwest and the South. Four midwestern and four southern species were considered. He computed a beta between the Standard and Poor's Composite Index (the market) and returns to each species and found the betas were not statistically significant at the 95 percent level. He then presented a portfolio of minimum risk (for desired rate of return) for the South, the Midwest, both combined, and all combined with the market. This work may contain the first examples of portfolio analysis that considers only alternative timber investments, rather than some combination of timber and nontimber financial assets, although Thomson does have some examples that include the market.

Thomson's findings, as well as those of Mills and Hoover (1983), Mills (1988), Redmond and Cubbage (1988), and Zinkhan (1988), indicate that the market risk, or sensitivity of forestry investments to changes in the general financial market, is minimal. All found that betas developed by regressing timber or timberland investment returns or prices on returns to the Standard and Poor's Composite Index were generally small, negative, and statistically insignificant. This suggests that some other index might be more appropriate to develop betas indicating the relative risk of alternative forestry investments independent of general financial markets.

In a previous study Thomson and Baumgartner (1988) showed that regressing estimated return data for each of eight timber species on an index consisting of the unweighted average of the annual price change for each species yielded significant betas. These betas provided insights into the efficient portfolios of combinations of the eight species. Further, they showed that returns estimated from price variations alone closely corresponded to the beta values obtained using actual returns. This paper further explores the potential and problems of this technique using three additional sets of price data to estimate risk, return, and efficient portfolios of alternative timber species and products in Illinois, Indiana, and Ohio.

The Data

The Indiana price series (Hoover 1987) was reported in real delivered log prices (1967=100) for 1957-1987. Prices for nine species of saw logs and three species of veneer logs were analyzed. The saw log species chosen were number 1 logs, including red oak, white oak, black oak, hickory, soft maple, hard maple, ash, cottonwood, and black walnut. The veneer log species chosen were select grade, 18-20 inch d.b.h., including black walnut, white oak, and red oak. The index used was the unweighted average annual price change of all selected saw log species.

The Illinois price series (McCurdy and Olmstead 1987) was reported in real stumpage prices (1967=100) for 1967-1986, except for red oak veneer, which was only reported for 1975-1986. Average prices for nine species of saw logs, three species of veneer logs, and mixed hardwood pulpwood were analyzed. The saw log species chosen included red oak, white oak, black oak, hickory, soft maple, hard maple, ash, cottonwood, and black walnut. The veneer log species chosen included black walnut, white oak, and red oak. The index used was the unweighted average annual price change of the saw log species.

The Ohio price series (Kingsley and DeBald 1987) was reported in real stumpage prices (1967=100) for 1964-1985. Prices for nine species of saw logs were analyzed, including ash, basswood, black walnut, black cherry, hard maple, red oak, soft maple, white oak, and yellow poplar. The annual price used was either the seventh month or annual average of the real stumpage prices. The index used was the average annual price change of all species in this data set.

Methods

A series of returns of the form $R_t=(P_t/P_{t-1})-1$ [where R_t = return in year t] and [where P_t = price in year t] was calculated for each species and product and for the average of sawtimber prices using price time series data from each State. Then individual price returns (dependent variables) for each species or product were regressed on average sawtimber price returns (independent variable) to compute the beta using the market model:

$$R_{i,t} = a + bR_{m,t} + e$$

Where:

$R_{i,t}$ = the price return on species i in period t
a = alpha or intercept parameter
b = beta or slope parameter
$R_{m,t}$ = the return on average sawtimber prices in period t
e = random error term

A portfolio based on rates of return to price for the various species and products was constructed for each set of price returns.

The portfolio problem is (Francis and Archer 1979):

Minimize $X_i X_j$

Subject to: $X_i E(R_i) > = R^*$

$X_i = 1$

Where:

X_i's are the portfolio weights
$_{ij}$ is the covariance between annual returns for investment i and j and
$E(R_i)$ is the expected return from investment i

The objective is to minimize the risk (defined as variance of returns), subject to earning a given level of return (R^*), while requiring that the portfolio weights sum to 1. Calculations were made using the QPROG software (Saigal 1986).

Results

The results of the Illinois price return regressions and portfolios are shown in tables 1 and 2. Mean price returns were highest for red and white oak veneer logs and red oak and ash sawtimber. All four of these products had betas indicating that they were somewhat less risky than the average for all sawtimber, and they appear in many of the efficient portfolios for rates ranging from 3 to 13 percent return. The red oak veneer returns and risk figures may be suspect because they were only reported for the years 1975-1986 but all other products were reported for the years 1967-1986. This more recent period (1975-1986) included an increase in the popularity of red oak that is still continuing. White oak, black oak, hickory, sugar maple, and cottonwood did not enter any efficient portfolios at rates of price return from 3 to 13 percent. Note that with the exception of black oak, which had a return of 4.2 percent, all these species had returns of less than 2 percent per year and betas indicating higher than average risk.

Portfolios in the lower risk and return range of 3 to 5 percent generally include black walnut, red oak, maple, and ash sawtimber; white oak veneer; and mixed hardwood pulpwood. Returns of 6 to 8 percent with increasing risk are obtained with a less diverse portfolio containing red oak and ash sawtimber and red and white oak veneer. The highest return-risk portfolios are dominated by red and white oak veneer.

The results of the Indiana price return regressions and portfolios are shown in tables 3 and 4. Returns to price in Indiana ranged from 7.6 percent for black oak sawtimber to 3.9 percent for cottonwood. All the veneer species experienced higher rates of price return than did any sawtimber species. Black oak sawtimber had the highest return of the sawtimber species but also the highest risk. It only appears in a minor way in the 9, 10, and 11 percent return portfolios. Although white oak and ash sawtimber showed reasonable price returns, they had above average risk and did not appear in any of the portfolios at rates from 5 to 13 percent. Black walnut sawtimber had a moderate to good return and a very low risk. It appears prominently in all except the highest return portfolios. Black walnut veneer with a high return and the lowest risk (negative beta) formed an important component of every portfolio.

Table 1.—*Mean returns, standard deviations, betas, t values, and R squares for the index[1] and selected Illinois timber species and products price returns regressed against the index*

Species	Mean price return	Standard deviation	Beta	t statistic	R squared
	- - - *Percent/year* - - -				
Sawtimber					
Red oak	5.69	12.91	0.844	4.21	0.5586
Ash	4.90	16.52	.978	3.44	.4579
Black oak	4.21	18.00	1.175	4.20	.5570
Black walnut	2.00	14.51	.711	2.53	.3141
Sugar maple	2.00	16.06	1.114	4.87	.6286
Hickory	1.82	14.07	1.117	8.11	.8246
White oak	1.12	15.85	1.064	4.48	.5890
Soft maple	.62	16.25	.959	3.42	.4549
Cottonwood	.29	14.30	1.038	5.56	.6887
Veneer					
Red oak	13.81	53.56	.846	.43	.0205
White oak	8.03	21.43	.639	1.36	.1162
Black walnut	2.34	22.52	.430	.84	.0477
Pulpwood					
Mixed hardwoods	3.33	22.13	.532	1.07	.0750
Index[1]	2.52	11.07	1.000	—	—

[1] Index equals the unweighted average price return of the selected sawtimber species.

Table 2.—*Illinois portfolio weights in percent for various rates of price return and risk (standard deviation)*

		Sawtimber[1]			Veneer				Pulpwood
Return percent	(Percent standard deviation)	Black walnut	Red oak	Soft maple	Ash	Red oak	White oak	Black walnut	Mixed hardwoods
3.0	9.4	7.5	5.9	36.3	5.3	—	16.3	7.6	21.3
4.0	9.6	14.2	25.4	25.4	0.7	—	19.9	—	14.4
5.0	10.5	12.6	44.5	11.4	0.5	—	23.1	—	7.8
6.0	12.0	7.8	62.3	—	—	—	27.7	—	2.1
7.0	14.2	—	54.6	—	1.5	5.1	38.7	—	—
8.0	17.2	—	25.0	—	8.8	14.4	51.9	—	—
9.0	20.7	—	—	—	11.9	23.2	64.9	—	—
10.0	24.9	—	—	—	—	34.1	65.9	—	—
11.0	31.0	—	—	—	—	51.4	48.6	—	—
12.0	38.5	—	—	—	—	68.7	31.3	—	—
13.0	46.6	—	—	—	—	86.0	14.0	—	—

[1] White oak, black oak, hickory, sugar maple, and cottonwood sawtimber did not enter into any portfolio.

Table 3.—*Mean returns, standard deviations, betas, t values, and R squares for the index*[1] *and Indiana timber species and product price returns regressed against the index*

Species	Mean price return	Standard deviation	Beta	t statistic	R squared
	--- *Percent/year* ---				
Sawtimber					
Black oak	7.60	13.74	1.487	9.71	0.7709
Red oak	7.17	11.35	1.264	11.19	.8173
Black walnut	6.56	14.65	.412	1.24	.0520
Ash	6.40	11.96	1.181	7.09	.6420
Hickory	5.56	9.64	.925	6.57	.6067
White oak	5.49	11.93	1.328	11.12	.8153
Soft maple	4.72	8.52	.866	7.73	.6809
Sugar maple	4.72	11.20	.733	3.22	.2821
Cottonwood	3.86	10.45	.800	4.25	.3916
Veneer					
White oak	13.21	34.51	1.118	1.44	.0691
Red oak	11.20	30.90	1.368	2.04	.1290
Black walnut	9.55	28.95	-.108	-.16	.0009
Index	5.79	7.98	1.000	—	—

[1] Index equals the unweighted average price return of the sawtimber species.

Table 4.—*Indiana portfolio weights in percent for various rates of return and risk (standard deviation)*

		Sawtimber[1]							Veneer		
Return percent	Risk percent	Black walnut	Red oak	Black oak	Hickory	Silver maple	Sugar maple	Cotton-wood	Red oak	White oak	Black walnut
5.0	6.3	18.8	—	—	28.4	19.1	19.5	5.4	—	—	8.8
6.0	6.4	21.3	—	—	35.8	12.2	19.1	—	—	0.7	11.0
7.0	7.1	26.2	18.7	—	21.3	—	14.3	—	1.0	5.5	13.0
8.0	8.6	29.5	38.5	—	—	—	3.7	—	2.7	10.6	15.0
9.0	11.0	24.1	20.0	9.1	—	—	—	—	6.9	19.3	20.9
10.0	14.6	15.7	—	16.9	—	—	—	—	11.5	29.0	27.0
11.0	18.8	4.2	—	6.7	—	—	—	—	17.1	39.0	33.1
12.0	24.0	—	—	—	—	—	—	—	11.9	61.6	26.4
13.0	32.4	—	—	—	—	—	—	—	—	94.3	5.7

[1] White oak and ash sawtimber did not enter into any portfolio.

The lowest risk-return portfolios contained black walnut, hickory, silver maple, sugar maple, and cottonwood sawtimber; and black walnut veneer. A moderate (9 percent) return at moderate risk was obtained with a portfolio containing black walnut, red oak, and black oak sawtimber; and red oak, white oak, and black walnut veneer. The highest risk-return portfolios were dominated by white oak and black walnut veneer.

The results of the price analysis and portfolios based on Ohio data (tables 5 and 6) show a much different picture. Price returns are much lower than those in Illinois and Indiana and are, in fact, slightly negative for four of the eight sawtimber species considered. Portfolios based only on those species showing positive returns are limited to ash, red oak, and black walnut. Although white oak had a positive return to price (higher in fact than ash), it had a substantially higher risk relative to return and did not appear in any efficient portfolios. The Ohio portfolios would offer low rates of return and risk and be composed of ash, black walnut, and red oak.

Table 5.—*Mean returns, standard deviations, betas, t values, and R squares for the index*[1] *and Ohio timber species price returns regressed against this index*

Species	Mean price return	Standard deviation	Beta	t statistic	R squared
	- - - *Percent/year* - - -				
Sawtimber					
Red oak	2.15	7.34	0.932	5.99	0.6539
Black walnut	2.14	15.59	.661	1.22	.0730
White oak	1.49	9.74	1.197	5.49	.6133
Ash	1.16	6.23	.803	6.29	.6753
Cherry	-.12	10.46	1.195	4.63	.5298
Soft maple	-.40	7.54	.876	4.80	.5482
Basswood	-.82	10.54	1.129	4.07	.4659
Yellow poplar	-.89	9.92	1.012	3.73	.4224
Index	.40	6.22	1.000	—	—

[1] Index equals the average price return of all the species listed.

Table 6.—*Ohio portfolio weights for various rates of return and risk (standard deviation)*

Return percent	Risk percent	Sawtimber[1] Ash	Black walnut	Red oak
1.00	5.6	49.5	13.3	37.3
1.25	5.6	49.5	13.3	37.3
1.50	5.6	49.5	13.3	37.3
1.75	5.6	40.3	14.9	44.9
2.00	5.9	15.0	19.3	65.8

[1] White oak sawtimber had a positive rate of return but did not enter into any portfolio. Cherry, soft maple, basswood, yellow poplar, and hard maple all had negative rates of return and were not included in the portfolio analysis.

Discussion

The results show that substantial differences occur in the price returns and portfolios for Illinois, Indiana, and Ohio. Why these differences occur was not addressed in this paper. Some differences are probably due to differences in the time frames considered and the fact that the Indiana data were reported in delivered log prices rather than stumpage. These factors will receive further study. However, the compiler of the Ohio data (Kingsley 1987) thinks the differences in price are real, and reflect differences in the quality of the timber marketed in the three States. At any rate it shows the importance of using data from as close to home as possible to employ the subject techniques and the longest time series available because portfolio theory has its roots in the analysis of long-term periodic variations in returns.

Although analysis of price variations can be useful in analyzing the risk of alternative forestry investments in different species and products, we should acknowledge some of its obvious limitations. The technique is only one aspect to consider in making a forest management investment decision. Ideally, a forest manager would use data reflecting the annual amount and variability of physical returns to growth for the individual tree species in an existing stand as well as price data to determine total risk, return, and efficient portfolios. Although the growth return data reflecting annual variation could be developed for individual stands, they are not generally available for broader general areas. Some information on biophysical risks not yet apparent from the historical return series would also be included. Non-timber values such as wildlife should also be considered because these can be very important to forest managers but are very difficult to price, particularly in terms that would reflect variability. Even the quality of available timber price data differs widely among States and regions.

We are trying to obtain better total return data by studying the relative importance of growth and price to total return. However, we think that at the present time, price return data reflect an important component of risk and return and can provide a quick, easy initial estimate of the relative market risk and return of alternative forestry investments and of efficient portfolios of alternative species and products.

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Shows how existing information on the historic prices of various timber species and products can be used to provide a measure of the market risk, return, and efficient portfolios of alternative forestry investments using examples from three midwestern States.

KEY WORDS: Timber investments, risk and return, portfolio analysis