

# The economic effect of forest policy changes in British Columbia: an event study of stock-market returns

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**Abstract:** In 1987 the government of British Columbia (B.C.) made substantial changes in its forest policy, including "clawing back" 5% of the volume committed on all of its replaceable licenses and shifting of reforestation costs to the licensees. Analysis of the reaction of stock prices to the announcement of these policy changes reveals that the policy had a negative, but not statistically significant impact on B.C. forest products companies taken as a whole. Those medium-sized B.C. forest products firms that own little private land and operate mainly in B.C. suffered small but statistically insignificant losses. The policy changes apparently did not affect large B.C. forest products firms and non BC-based forest products firms. The results may arise because (i) as a result of restrictions on log exports the volume reductions were simply reallocated within extant timber markets, (ii) timber from the replaceable licences is fully priced, (iii) the adjustments were small when compared with the overall market capitalization of the firms involved, and (iv) there was general financial euphoria in the late 1980s. These findings should not be extended to larger policy adjustments or to the problem of evaluating the impact of province-wide reductions in allowable harvest levels.

**Résumé :** En 1987, le gouvernement de la Colombie-Britannique a effectué des changements substantiels à sa politique forestière, entre autres en retirant 5% du volume alloué sur tous les permis renouvelables et en refilant les coûts de reboisement aux permissionnaires. L'analyse de la réaction à l'annonce de ces changements de politique sur le prix des actions montre que ceux-ci ont eu un effet négatif, mais l'impact sur les compagnies forestières dans leur ensemble a été statistiquement non significatif. Les entreprises forestières de moyenne envergure qui possèdent peu de propriétés privées et qui opèrent principalement en Colombie-Britannique ont subi de faibles pertes mais celles-ci se sont avérées non significatives statistiquement. Les changements de politique n'ont pas affecté les grandes entreprises de Colombie-Britannique de même que celles qui n'avaient pas leur siège social dans la province. Ces résultats peuvent provenir du fait que (i) malgré les restrictions relatives aux exportations des volumes de billes, ceux-ci ont pu être réalloués à l'intérieur des marchés de bois existants, (ii) le bois provenant des permis renouvelables témoigne d'un prix adéquat, (iii) les ajustements étaient faibles en comparaison de la capitalisation des entreprises impliquées et (iv) la fin des années 1980 a été marquée par une euphorie financière générale. Ces résultats ne devraient pas être extrapolés à des ajustements de politique plus considérables ou au problème de l'évaluation de l'impact, à la grandeur de la province, des réductions des niveaux de possibilité de récolte.

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## Introduction

By 1906, privatization of forest land in British Columbia (B.C.) had virtually ceased, and to the present time the provincial government has retained ownership of over 95% of the province's forest land. The government transfers

harvesting rights to the private sector through a complex set of licenses. These licence documents articulate the government's forest policy. As a result, the details of the agreements change from time to time as public values and the political agenda shift. Such was the case on 15 September 1987, when the government announced its "new forest policy." The new policy

- (1) shifted from the government to the licensee the financial responsibility for reforestation and any silvicultural investments needed to get young stands to a "free-to-grow" stage (these activities are collectively called basic silviculture),
- (2) transferred 5% of the annual allowable cut (AAC) from all replaceable licences (tree farm licences, forest

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- licences, timber sale licences, and timber sale harvesting licences)<sup>2</sup> back to the government for reallocation to its Small Business Forest Enterprise Program, (3) imposed a 5% AAC "tax" every time a licence was transferred, with the resulting AAC reallocated to the Small Business Forest Enterprise Program, and (4) increased stumpage and other forest charges from \$580 to an estimated \$680 million annually.

These changes represented the most significant adjustments to the province's forest policy since the 1976 Pearse Royal Commission and the subsequent Forest Act in 1978.<sup>3</sup> Media reports at the time described the impacts of these changes on B.C. forest products firms as severe. Companies holding significant volumes of timber under licence were reportedly "very dismayed" (Financial Post 1987). The financial press reported that the stock prices of publicly traded B.C. forest firms fell as a result of the announcement of the new policy (Financial Post 1987; Vancouver Sun 1987).<sup>4</sup> But did they?

In theory, stock prices reflect the best available information about all the factors affecting the expected earnings of a firm, including the costs of regulatory activities. As a consequence, changes in stock prices measure the

cost of changes in regulations. B.C.'s new forest policy imposed two kinds of costs: the direct pecuniary costs of higher operating expenses and the less tangible costs associated with reductions in investor confidence about B.C.'s regulatory climate. Since B.C. firms sell their products into large, international markets where there are many competitors, they could not pass the added costs of these regulations on to their customers.

This paper estimates the impact of the forest policy changes on common stock prices for a sample of forest products companies. This investigation reveals investors' perceptions of the new B.C. forest policy while controlling for financial risk and other market-wide effects. The first section below outlines the event-study methodology used in this analysis. The second section discusses how the new forest policy might affect different firms and describes the sample of firms used in this study and the statistical results. The final section comments on the policy implications of these results.

## Methodology

Financial economists use event studies to determine the impact on shareholder returns and expected firm profitability of specific financial decisions (e.g., Desai and Stover 1985; Zinkhan 1988) and changes in regulations (e.g., Schwert 1981; Binder 1985a, 1985b; Boardman et al. 1992). Suppose that an event that might affect the future earnings of one firm or a group of similar firms occurs at time  $T_0$ . Event studies measure the change in stock prices after  $T_0$  while controlling for all other factors that could influence the market valuation of the firm. This change in stock price measures the impact of the event.

Two statistical methods are available for this kind of analysis. The older, more common, residual-analysis method requires two steps. The first step uses a financial asset pricing model to estimate the "normal" return on the stock during a period antecedent to the event of interest. This model incorporates market and perhaps other risk factors. The second step compares, over the postevent period, the actual stock return with the return predicted by the asset pricing model. The deviations between actual and predicted returns provide a measure of the event's impact. The second, one-step method uses multiple regression analysis to estimate simultaneously the parameters of the asset-pricing model, and dummy variables to capture the changes in the returns in the postevent period. Each of these methods is described more fully below, and each is used to estimate the impact of the 1987 forest policy changes.

### Residual analysis

For simplicity of exposition, suppose that there is only a single event. Residual analysis partitions daily observations on stock prices into two periods and uses the data from the "nonevent period" to establish a bench mark for what would be expected during the "event period" in the absence of the event. The remaining data (i.e., the data with the event) are used to estimate "abnormal" and "cumulative abnormal" returns by comparing what actually happened with the bench mark.

<sup>2</sup> In the past the B.C. government has also issued nonreplaceable timber licences. These licences give the holder the right to harvest the timber standing at the time the licence was issued. After that harvest the land reverts to the crown. Timber licences were not affected by the policy changes discussed in this paper.

<sup>3</sup> On 14 April 1994 the provincial government announced its Forest Renewal Plan. This plan raised stumpage fees by about \$400 million/year and dedicated these new revenues to enhancing forest-sector productivity and easing the transition for workers and communities injured by changes in harvest levels resulting from land-use decisions. This policy change occurred after the present analysis was prepared, and apparently did have a significant effect on stock prices (C.S. Binkley and D. Zhang, to be published), but is not discussed further here.

<sup>4</sup> The 16 September 1987 edition of the *Vancouver Sun* reported

Investor's reaction was negative to the BC government's plans to reduce the annual harvest of most of the province's forest companies and to increase the price of timber it leaves them.

The Toronto Stock Exchange's pulp and forest products sub-index, dominated by BC-based firms, was down 52 points—or about one percent—in early trading. The index recovered somewhat by mid-session and was off by 39.09 points to 3,359.69.

The 21 September 1987 edition of *The Financial Post* reported

'We were dismayed, I mean very dismayed' says Michael Apsey, president of the Council of Forest Industries of BC, the industry association. The dismay was shared by the stock market. Shares of major BC companies—all of which are currently reporting record earnings—declined on the news of the new policy.

The bench mark must control for financial risk and market-wide effects. Although there are several alternatives, the capital asset pricing model (CAPM) developed by Sharpe (1964) and Lintner (1965) is the most common, simple, and robust method to do so. The CAPM specifies a linear relationship between the returns on an individual asset and the returns to a value-weighted portfolio of all assets<sup>5</sup>:

$$[1] \quad R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

where

$R_{it}$  is the rate of return on stock  $i$  on day  $t$  (calculated as  $\ln[(P_{it} + \text{DIV}_{it})/P_{it-1}]$ , where  $P_{it}$  is the closing price of stock  $i$  on day  $t$ , and  $\text{DIV}_{it}$  is the dividend (if any) for stock  $i$  distributed on day  $t$ )

$R_{mt}$  is the rate of return on the market portfolio on day  $t$

$\alpha_i, \beta_i$  are regression parameters

$\varepsilon_{it}$  is a random disturbance term, assumed to be normally distributed as  $N(0, 1)$  and stochastically independent of the explanatory variable  $R_{mt}$

The first step of the residual analysis method is to estimate the regression parameters of [1] using nonevent period  $(0, T_0)$  data. The second step uses the estimated parameters of [1] to predict the normal returns over the postevent period. The daily abnormal returns ( $\text{AR}_{it}$ ) over the event period are the difference between the actual return for a security and the return that would be anticipated on the basis of [1]:

$$[2] \quad \text{AR}_{it} = \hat{\varepsilon}_{it} = R_{it} - \hat{R}_{it}, \quad t > T_0$$

Since the daily returns are in continuous form, the cumulative abnormal returns ( $\text{CAR}_{it}$ ) can be simply constructed as

$$[3] \quad \text{CAR}_{it} = \sum_{t>T_0} \text{AR}_{it}$$

If the event had no impact on the returns for the security, then the expected value of  $\text{CAR}_{it}$  should be zero. When the nonevent period is large (so that  $\text{CAR}_{it}$  has a normal distribution), the test statistic for the hypothesis that  $\text{CAR}_{it} = 0$  is a familiar Student's  $t$ -statistic. The variance of  $\text{CAR}_{it}$  is generally assumed to be the same as that of the nonevent period, perhaps with some adjustment. (see Collins and Dent (1985), Dann and James (1982), Desai and Stover (1985), Theil (1971), Boardman et al. (1992) for different adjustment methods).

The application of residual analysis to a set of  $N$  firms involves aggregation of  $\text{CAR}_{it}$  and computation of the relevant variance. After estimating all the parameters of [1] for each of the  $N$  firms during the nonevent period and computing

<sup>5</sup> Another form of the capital asset pricing model is

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{it} - R_{ft}) + \varepsilon_{it}$$

where  $R_{ft}$  is a risk-free rate (say, 1-month T-bill rate). This model is more useful in monthly and annual studies where  $R_{ft}$  changes over time. When  $R_{ft}$  is constant, this model will reduce to eq. 1. The traditional model was not used, since the day-to-day  $R_{ft}$  is not available and  $R_{ft}$  changes very little during the 147-day estimation period.

the  $\text{CAR}_{it}$  values, the mean  $\text{CAR}_i$  of the  $N$  firms may be calculated as a weighted average of all the  $\text{CAR}_{it}$ . The variance of  $\text{CAR}_i$  may be computed either as the weighted average of the variances of each firm or as the residual variance of a weighted portfolio of the  $N$  firms in the nonevent period (Collins and Dent 1984; Desai and Stover 1985). The choice of weights is not clear (Dann and James, 1982).

Note that this estimation procedure implicitly assumes that there is no contemporaneous cross correlation among equations (firms), an assumption that probably is not valid in industry-wide regulatory events. Also, the choice of weights for each firm needed to calculate the variance of  $\text{CAR}_i$  is largely arbitrary.

A variant of residual analysis overcomes the latter of these problems by replacing the individual firms with a portfolio of all firms (Thompson 1985). Hypothesis testing can be conducted with the estimated residual variance of the portfolio. The estimate of the variance is consistent, permitting asymptotically valid inferences to be drawn about true underlying population parameters even if the portfolio weighting scheme is invalid (Thompson 1985). As a consequence of this result, the simplest approach is to form the portfolio using equal weights for each firm. This avoids the computational burden of searching for the appropriate weights (such as the inverse of individual firm's residual variance) but does not bias the statistical inference.

### Multiple regression analysis

The residual analysis method (along with the portfolio variant) assumes that there is no contemporaneous cross correlations among firms. This assumption may not be valid. It is conceivable, if not likely, that industry-wide events such as the change in B.C.'s forest policy affect many firms similarly. The undetected presence of such correlation leads to incorrect inferences from the standard hypothesis tests because the variances of the estimated parameters may be biased (Collins and Dent 1984; Binder 1985a, 1985b). This shortcoming of residual analysis can be overcome in multiple regression analysis.

A multiple regression analysis begins by parameterizing the abnormal returns in the individual return equations:

$$[4] \quad R_{it} = \alpha_i + \beta_i R_{mt} + \gamma_i D_{it} + \mu_{it}$$

using the dummy variables  $D_{it}$ , where  $D_{it}$  equals one during the event periods and zero otherwise.  $\mu_{it}$  is a random error that is independent of  $R_{mt}$  and has a normal distribution of  $N(0, 1)$ .

Note the identity of  $\varepsilon_{it}$  in eq. 1 and  $\mu_{it}$  and  $\gamma_i D_{it} + \mu_{it}$  in eq. 4, during a nonevent period and an event period, respectively. In eq. 4,  $\gamma_i$  measures the average abnormal return for firm  $i$  during the event period.

When the explanatory variables in the return-generating process are the same for each of the  $N$  firms, the multiple equations

$$[5] \quad \begin{aligned} R_{1t} &= \alpha_1 \beta_1 R_{mt} + \gamma_1 D_{1t} + \mu_{1t} \\ R_{2t} &= \alpha_2 \beta_2 R_{mt} + \gamma_2 D_{2t} + \mu_{2t} \\ &\vdots \\ R_{Nt} &= \alpha_N \beta_N R_{mt} + \gamma_N D_{Nt} + \mu_{Nt} \end{aligned}$$

can be estimated jointly as a seemingly unrelated regression model (Zellner 1962; Theil 1971).

This approach allows the individual abnormal returns and residual variances to differ across firms. It also accommodates nonzero contemporaneous covariances of the disturbances across equations. Note that the multiple regression analysis produces no gain in the efficiency of the estimated coefficients and residual variances (Theil 1971, chap. 7). The advantage of the approach lies in hypothesis testing, since heteroscedasticity across equations and contemporaneous dependence of the disturbances are explicitly incorporated into the hypothesis tests. This avoids the statistical problems that arise in residual analysis.

### Hypotheses, data, and results

The changes in forest policy probably had very different impacts on different kinds of firms. The new policy increased the amount of timber available to those small firms that are eligible to bid for timber under the Small Business Forest Enterprise Program. At the same time, these firms do not bear the responsibility for silviculture. Clearly they should gain from the policy change. Unfortunately, because public stock markets list none of the small firms, we cannot draw any empirical conclusions about the impact of the policy change on firms eligible for the Small Business Forest Enterprise Program. As a consequence, all of our empirical results refer to those firms that are not eligible for the Small Business Forest Enterprise Program. For simplicity in the discussion below we refer to these firms collectively as large firms, although many of them would be considered small when compared with their international competitors.

The large firms shouldered the costs of reforestation and faced higher stumpage fees. Both changes imply a significant additional financial burden, and this burden should be fully capitalized into lower stock prices at the moment extra costs become a certain obligation.

The large firms also immediately lost 5% of their licensed AAC, and faced the additional prospect of losing 5% of the AAC associated with any licence they wished to sell or otherwise transfer. The effect of these changes may be neutral or negative for the class of large firms and may differ considerably among firms. The impact of the AAC reductions depends on whether the provincial stumpage system collects the full rent of the timber. If there is no residual profit from logging, then the only loss associated with a loss of AAC would be the possible reduction in the utilization of fixed capital such as sawmills or pulpmills as the firm's lost AAC was diverted elsewhere. However, because B.C. bans the export of logs harvested from crown lands, the AAC was not necessarily lost to domestic timber markets, but rather was simply reallocated to other B.C. firms, many of which simply brought the timber back to market either themselves or through intermediaries. Conceivably then, the marginal reallocation of AAC associated with the 1987 change in forest policy might have little financial impact on large firms. Thus, the main null hypothesis of this paper is that the aggregate abnormal return for the entire sample of firms during event period equals zero. Rejecting this hypothesis would mean that the policy change hurt shareholders of the large firms.

Because the postevent stock prices are a function of both the nature of the policy change and each firm's individual

circumstances, the effect of the change in forest policy might not have been uniform among firms. It might harm firms that are heavily dependent on timber supplied from replaceable crown licences. In contrast, it is conceivable that the new forest policy could benefit (or at least not harm) those firms owning rights to close substitutes (i.e., private lands and timber licences, neither of which was affected by the new forest policy). Firms that have diversified themselves in the other provinces of Canada would be in a better position than those who have all of their forest operations in B.C. To examine this possibility, the second null hypothesis is that abnormal returns for each of the companies individually equal zero.

The initial sample includes the 15 B.C. and 6 non-B.C. forest products firms listed in the Toronto Stock Exchange (TSE) Western Data Base. We dropped 4 B.C. firms from the analysis that had merged with or were acquired by other companies within a year prior to the event date. The 11 firms remaining for this study are Canadian Forest Products, Canadian Pacific Forest Products, Crestbrook Forest Industries, Doman Industries, International Forest Products, Macmillan Bloedel, Slocan Forests Products, Scott Paper, Weldwood, Westar Timber, and West Fraser Timber. The non-B.C. group consists of Abitibi-Price, Cascades, Consolidated Bathurst, Domtar, Donohue, and Tembec. These firms represent various mixes of softwood lumber, newsprint, and market pulp businesses.

### Portfolio approach

We first tested the hypotheses using the portfolio approach. In the light of characteristics of the firms and the possible policy impacts we defined four portfolios: B.C. firms taken as a whole (called "B.C. firms" below), non-B.C. firms, and two subdivisions of the B.C. firms based on the probable impact of the forest policy change. Medium B.C. companies own little timber land, hold little timber volume under timber licences, and operate mainly in B.C. As Table 1 shows, these firms cut only 2.2% of their timber from private lands and timber licences in 1987.<sup>6</sup> As a consequence, the forest policy changes examined in this paper should have affected this group more than any other. Seven companies compose this group: Crestbrook Forest Industries, Doman Industries, International Forest Products, Slocan Forest Products, Weldwood, Westar Timber, and West Fraser Timber. Large B.C. companies are the integrated forest products companies that own most of the private industrial forest

<sup>6</sup> The real distinction of interest is the distribution of source of timber delivered to mills of these firms. Forest products firms in B.C. purchase certain timber through the open market (e.g., Vancouver log market) and through private contracts. Because the relevant data are not publicly available, the distribution of timber harvested under different tenures is used as a proxy to measure the total source of timber supply available to a firm. The implicit assumption is that all of timber harvested by a firm will go to that firm's mills and all of the firms have the same proportion of timber that comes from open market and contract. In reality this may not be strictly valid. Thus the criteria we have used to distinguish the medium B.C. and large B.C. firms might introduce some error into our analysis. We do not believe this is consequential.

**Table 1.** Harvesting volume distribution of B.C. forest products firms in 1987.

Firm	Private and timber licence (%)	Tree farm licence (%)	Other tenures (%) <sup>a</sup>
Medium B.C.	2.16	12.47	85.84
Crestbrook Forest Industries	1.78	8.37	89.85
Doman Industries	0.00	0.00	100.00
International Forest Products	6.95	0.00	93.05
Slocan	0.00	12.69	87.31
Weldwood	4.33	19.35	76.32
Westar Timber	2.05	46.91	51.04
West Fraser Timber	0.03	0.00	99.97
Large B.C.	31.30	58.33	10.37
Canfor <sup>b</sup>	29.21	60.49	10.30
Canadian Pacific Forest Products	38.24	31.20	30.56
MacMillan Bloedel	51.29	46.21	2.50
Scott Paper <sup>c</sup>	2.42	97.58	0.00
B.C. firms as a whole	12.39	29.15	58.46

Note: Source: Timber Harvesting Branch, B.C. Ministry of Forests, Victoria.

<sup>a</sup>Forest Licences, timber sale harvesting licences, timber sale Licences, and others.

<sup>b</sup>Figure of 1992 estimated by the company.

<sup>c</sup>It is classified as a large B.C. firm (although it neither owns much private industrial forest lands nor holds lots of crown timber through timber licence in B.C.).

**Table 2.** Parameter estimates for the return equations.

Explanatory variables	Portfolio			
	B.C. firms	Medium B.C.	Large B.C.	Non-B.C.
$R_{mt}$	1.2402 (9.4880)	1.2809 (8.1680)	1.1689 (7.4891)	0.9099 (8.102)
Constant	0.0007 (0.7389)	0.0005 (0.4663)	0.0009 (0.8817)	-0.0010 (-1.2351)
Adjusted $R^2$	0.3831	0.3104	0.2739	0.3069
Durbin-Watson statistic	1.8493	1.9575	1.9727	1.6516

Note:  $n = 147$ ;  $t$ -statistics are in parentheses.

lands and timber licences in B.C. and are diversified outside of B.C. As seen in Table 1, these firms collectively received 31.3% of their timber from private lands and timber licences in 1987. Reduced access to crown timber will tend to reduce the profits of these firms, but increased prices for their own timber and the improved relative competitive position of their operations outside of the province should increase their profits. As a consequence of these countervailing effects, the net impact of the forest policy changes cannot readily be anticipated. Four companies compose this group: Canadian Forest Products, Canadian Pacific Forest Products, Macmillan Bloedel, and Scott Paper.

We estimated the market model over the nonevent period for each of the four portfolios. The daily return to each portfolio is the nonweighted average of daily returns to

each security in the portfolio. The TSE 300 price return index was used as the market index:

$$[6] \quad R_{pt} = \alpha_p + \beta_p R_{mt} + \varepsilon_{pt}$$

where

$p = a$ , B.C. forest products firms as a whole

$= b$ , medium B.C. forest products firms

$= c$ , large B.C. forest products firms

$= n$ , non-B.C. forest products firms

The sample consists of 147 observations, beginning on 2 February 1987 and ending on 1 September 1987, 2 weeks prior to the announcement date. Observations prior to 1986 were dropped to eliminate the impact of the 15% countervailing duty threatened by the United States

**Table 3.** Performance of stock around the announcement date of forest policy change.

Day	B.C. firms			Medium B.C. firms			Large B.C. firms			Non-B.C. firms		
	Percent of AR	Percent of CAR	<i>t</i> -statistics of CAR	Percent of AR	Percent of CAR	<i>t</i> -statistics of CAR	Percent of AR	Percent of CAR	<i>t</i> -statistics of CAR	Percent of AR	Percent of CAR	<i>t</i> -statistics of CAR
-8	-1.602	-1.602	-1.505	-1.943	-1.943	-1.521	-1.005	-1.005	-0.791	-0.082	-0.082	-0.089
-7	0.334	-1.273	-0.846	-0.046	-1.988	-1.101	1.000	-0.016	-0.009	-0.115	-0.197	-0.152
-6	1.300	0.010	0.005	1.587	-0.432	-0.195	0.796	0.780	0.354	0.921	0.723	0.456
-5	-0.397	-0.387	-0.182	-0.952	-1.380	-0.540	0.574	1.359	0.535	-0.633	0.084	0.046
-4	-0.317	-0.702	-0.295	-0.555	-1.927	-0.675	0.100	1.461	0.514	-0.356	-0.272	-0.133
-3	-0.119	-0.820	-0.314	0.231	-1.701	-0.544	-0.730	0.720	0.231	-1.563	-1.831	-0.817
-2	0.742	-0.084	-0.030	0.941	-0.776	-0.230	0.394	1.117	0.332	2.080	0.211	0.087
-1	-0.355	-0.439	-0.146	-0.850	-1.619	-0.448	0.512	1.635	0.455	0.946	1.159	0.448
0	-0.002	-0.441	-0.138	0.283	-1.341	-0.350	-0.501	1.126	0.295	-0.155	1.002	0.365
1	-0.643	-1.081	-0.321	-0.723	-2.055	-0.509	-0.503	0.618	0.154	-0.540	0.456	0.158
2	-0.653	-1.727	-0.489	-0.520	-2.565	-0.605	-0.885	-0.273	-0.065	-0.192	0.264	0.087
3	-0.026	-1.752	-0.475	-0.170	-2.730	-0.617	0.226	-0.047	-0.011	-0.409	-0.147	-0.046
4	0.021	-1.731	-0.451	0.142	-2.592	-0.563	-0.189	-0.237	-0.052	0.157	0.010	0.003
5	-0.195	-1.923	-0.483	-0.416	-2.997	-0.627	0.191	-0.046	-0.010	-0.964	-0.954	-0.279
6	-0.176	-2.096	-0.508	0.174	-2.829	-0.571	-0.789	-0.835	-0.169	0.300	-0.657	-0.185
7	-0.292	-1.810	-0.425	0.402	-2.438	-0.477	0.099	-0.737	-0.145	-0.474	-1.128	-0.308
8	-0.570	-2.370	-0.540	-0.742	-3.162	-0.600	-0.268	-1.002	-0.191	-0.298	-1.422	-0.377
9	-0.506	-2.864	-0.634	-0.951	-4.083	-0.753	0.271	-0.734	-0.136	0.636	-0.795	-0.205
10	-0.111	-2.972	-0.640	0.296	-3.798	-0.682	-0.825	-1.552	-0.280	0.405	-0.394	-0.099
11	-0.380	-3.341	-0.701	-0.503	-4.282	-0.749	-0.165	-1.714	-0.301	0.078	-0.317	-0.077
12	1.777	-1.622	-0.332	2.396	-1.989	-0.339	0.695	-1.031	-0.177	1.077	0.756	0.180
13	1.594	-0.054	-0.011	1.131	-0.880	-0.147	2.404	1.347	0.226	0.991	1.755	0.409
14	0.792	0.737	0.144	0.891	0.003	0.000	0.619	1.975	0.324	1.781	3.568	0.813

in the middle of 1986 and subsequently imposed on 30 December 1986. Observations in January 1987 were also dropped to avoid the possible "January effect." The terminal date of the sample period is 2 weeks prior to the announcement date. Equation 6 was estimated by ordinary least squares (OLS), and Table 2 reports the results.

The OLS assumptions appear to suit the circumstances. Normality of the residuals cannot be rejected for any of the four portfolios. Furthermore, the tests for heteroscedasticity (B-P-J tests and ARCH tests) reveal that the models are not misspecified. However, the Durbin-Watson statistics are inconclusive for the non-B.C. sample and fail to reject (at the 5% level) the null hypotheses of no serial correlation of estimated residuals for the other three portfolios.<sup>7</sup>

<sup>7</sup> The equations in [6] are a "seemingly unrelated regressions" model. Correlation of contemporaneous residuals across equations is expected. However, since each equation has the same explanatory variables, OLS provides efficient parameter estimates. Serial correlation of the residuals in a CAPM may be indicative of thinly traded stocks. To control for thin trading, the equations in [6] were also estimated by including one period lead and lag of the market return index (Scholes and Williams 1977). Since the coefficients of the lead and lag of market return index are not significant at the 10% level, the lead and the lag were dropped. Despite the significant Durbin-Watson statistics, equations estimated with first-order autocorrelation correction differed little from those reported in Table 2.

The parameters from eq. 6 inserted in eq. 3 (with the subscript *i* referring now to a portfolio rather than an individual firm) provide estimates of the cumulative abnormal returns for the four portfolios for a 23-day event interval.<sup>8</sup> Assuming no serial correlation and that the null hypothesis of no effect is true, the variance of  $CAR_{it}$  can be estimated as (Boardman et al. 1992)

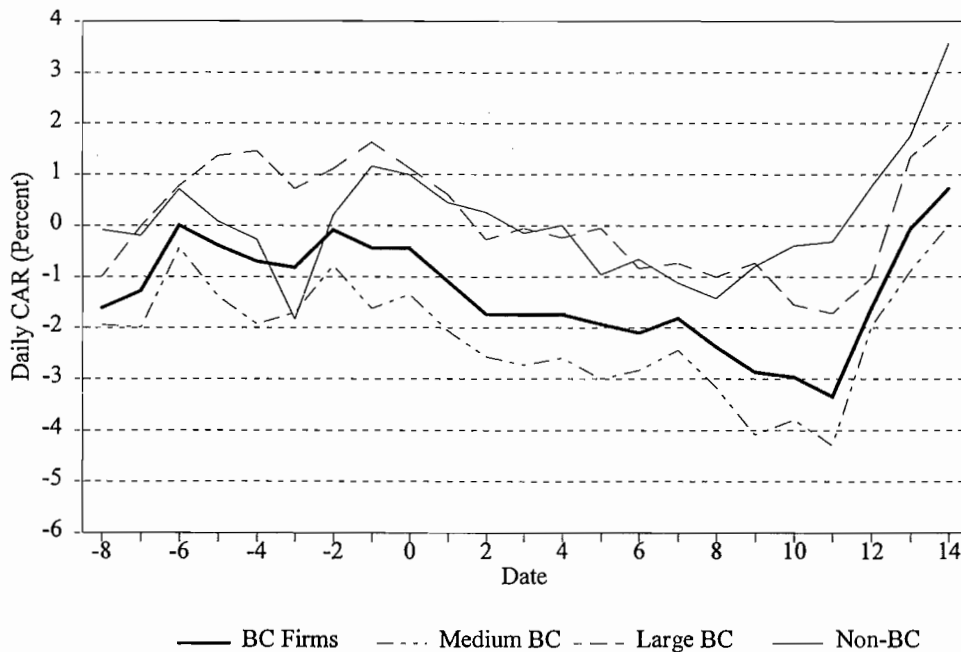
$$[7] \quad \text{Var}(CAR_{it}) = \text{Var}(CAR_{i,t-1}) + \text{Var}(\varepsilon_{it}) \\ + \text{Var}(CAR_{i,t-1})\text{Var}(\varepsilon_{it})$$

where  $\text{Var}(\varepsilon_{it})$  is the estimated residual variance of the no-event period. Table 3 reports the  $CAR_{it}$  and their test statistics, and Fig. 1 depicts these data graphically.

The  $CAR_{it}$  for the 23-day postevent interval for B.C. firms as a whole are negative but not statistically significant at the 10% level. The negative sign of  $CAR_{it}$  prior to the event date indicates that information might have been leaked to investors. Also, the negative sign of  $CAR_{it}$  following the event date means that investors viewed the new information contained in the policy announcement as negative. Interestingly, initially the medium B.C. and large

<sup>8</sup> There is little agreement in the literature regarding when the event "window" should open and for how long it should last. Desasi and Stover (1985) start the window at -20 (i.e., 20 days before the date of the event). Dann and James (1982) start at -10. Zinkhan (1988) and Boardman et al. (1992) use -5 as the starting day. We examined starting dates including -10, -8, -6, -4, -2, -1, and 0, with no qualitative difference in the results reported here.

Fig. 1. Stock-market performance around the announcement date of forest policy change.



B.C. portfolios moved in opposite directions. Medium B.C. firms had negative  $CAR_{it}$  in 22 days of the 23-day event interval, although none of the  $CAR_{it}$  were significantly different from zero at the 10% level. The  $CAR_{it}$  for large B.C. firms have positive signs in 10 days of the 23-day event interval but, again, do not differ significantly from zero. The  $CAR_{it}$  for non-B.C. firms shows the same pattern. The new B.C. forest policy apparently had little impact on large and non-B.C. forest products firms. In summary, (i) the new forest policy was a seemingly negative, but not statistically significant event for B.C.'s forest products firms taken as a whole; (ii) the medium B.C. firms suffered from the policy, while the large B.C. firms possibly gained from it, although the noise in the data is sufficiently large that the impacts are not statistically significant.

#### Multiple regression approach

The multiple regression approach estimates a system of 11 equations for each of the B.C. firms (eq. 5). Table 4 provides the results. The Breusch-Pagan Lagrange multiplier test statistic for diagonal covariance matrix is 239.62. This statistic rejects the null hypothesis of no contemporaneous correlation across equations at the 5% level. As a consequence, accounting for the contemporaneous dependence across equations, the multiple regression method provides more efficient hypothesis tests than does the portfolio approach. Nevertheless, the results of the two approaches are quite similar. Eight of the 11 dummy variables that capture the effect of the policy changes are negative, and the other three are positive. None of them are significantly different from zero at the 10% level. Not surprisingly, neither the hypotheses (i) that the total abnormal return for all of the firms equals zero nor (ii) that all of the abnormal returns equal zero can be rejected at the 5% level (the Wald  $X^2$  test statistics are, respectively, 0.27 and 7.88 with 1 and 10 df).

#### Conclusions and discussions

Many seasoned observers regarded the 1987 changes in B.C.'s forest policy as harmful to B.C. forest products companies. In contrast, careful examination of stock-market returns suggest that the new forest policy created a small but statistically insignificant loss for medium-sized B.C. firms and had no impact on large B.C. firms or on Canadian forest products firms that operate outside B.C.

Careful reasoning may explain the apparent contradictions between our analysis and the anecdotal evidence. First, because B.C. bans the export of most unprocessed logs, the reallocation of 5% of the AAC in major licences probably had little impact on the supply-demand equilibrium in B.C. timber markets. The timber that was expropriated from the large forest products companies probably found its way back to B.C. timber markets as small business operators sold or traded it. As a consequence, those firms that lost their AAC could recapture at least a portion of it. This is consistent with Gillespie's (1991) finding that large firms that are ineligible for the Small Business Forest Enterprise Programs bypass the restriction by surrogate bidding, a practice where the ineligible, large firms provide financial backing to strengthen the bids of eligible ones.

Second, timber in B.C. may be fully priced regardless of the source of the timber. That is, the timber companies pay the same price for the same kind of timber, no matter how they obtain it, whether from the various licences, from open-market log purchases, or from private land (Uhler 1991; Sterling Wood Group Inc. 1986; Heaps 1988). During the years he studied (1969-1984), Uhler (1991) found that timber priced under forest tenures was not below competitive levels in at least three of six forest regions in B.C., which together account for 50 to 60% of timber harvested in the province every year. Sterling Wood Group Inc.

**Table 4.** Parameter estimates using the multiple regression method.

Firm	$R_{mt}$	Constant	Dummy <sup>a</sup>	$R^2$
Medium B.C.				
Crestbrook Forest Industries	1.5631 (6.6822)	0.0017 (0.9938)	-0.0059 (-1.1573)	0.2249
Doman Industries	1.6885 (4.2414)	-0.0006 (-0.2243)	0.1210 (1.391)	0.1042
International Forest Products	0.9921 (2.5333)	0.0011 (0.3804)	-0.0039 (-0.4572)	0.0402
Slocan	2.0658 (6.445)	0.0011 (0.4664)	-0.0026 (-0.3723)	0.2053
Weldwood	0.3585 (1.5490)	0.0004 (0.2609)	-0.0046 (-0.9123)	0.0208
Westar Timber	1.3307 (3.9393)	-0.0010 (-0.3910)	-0.0020 (-0.2771)	0.0883
West Fraser Timber	1.1715 (4.9604)	0.0006 (0.3873)	-0.0056 (-1.0920)	0.1408
Large B.C.				
Canfor	1.4995 (5.4390)	0.0020 (1.0021)	-0.0005 (-0.0904)	0.1541
Canadian Pacific Forest Products	1.0774 (4.8329)	0.0006 (0.3788)	0.0018 (0.3606)	0.1247
MacMillan Bloedel	1.4416 (6.1130)	0.0014 (0.8269)	-0.0060 (-1.1813)	0.1970
Scott Paper	0.5654 (3.3234)	-0.0001 (-0.5471)	0.0024 (0.6477)	0.0638

Note: *t*-statistics are in parentheses.

<sup>a</sup>Daily abnormal return.

(1986) showed that once the logging costs, grade, and species mix differences are taken into account, the price paid for timber by tenure holders is equivalent to that paid by competitive bidders under the Small Business Programs. This is simply another way to say that timber is fully priced under all of the various tenure arrangements.

Third, even if timber prices on provincial licences are set at levels that collect the full rent over the long run, short-run market swings could conceivably create value in AAC under these licences. In the short run, the price that a firm is willing to pay for marginal timber reflects just the firm's variable operating costs and not the long-run costs associated with depreciation or capital replacement. But even this possible short-run benefit of AAC under provincial licences appears to be small for the period studied. A controversial study by CWC Canadian Western Capital Ltd. (1991) estimated that the gross residual value of logs transacted in the Vancouver log market, before stumpage or royalty, was \$16.95/m<sup>3</sup> for all species and all grades in the market peak 1987–1989 period. In the same period,

the average stumpage price in Vancouver Forest Region was \$9.30/m<sup>3</sup>. Therefore, the maximum estimate of the net short-run uncollected rent for Vancouver Forest Region licensees was about \$7.65/m<sup>3</sup>. Using this figure, a 5% AAC reduction costs each of the seven medium B.C. firms (with an average total AAC of  $2.69 \times 10^6$  m<sup>3</sup>/year for each firm) about \$1 million/year. This figure, an overestimate of the direct financial impact of the AAC reduction, probably is not large enough to have had a statistically significant effect on the stock price of firms with total annual revenues averaging over \$400 million (Price Waterhouse, Forest product industry survey, various years) during this period.

While the short-run effects of the 1987 forest policy changes appear to have been small, the long-run effects are less clear. In the first place, the policy was implemented in a time of strong and rising markets and firm profitability. The general euphoria of the late 1980s may have masked the short-run effects. The impact of the cost increases may not have been fully understood until the



market declines, which followed a few years later. In the second place, by unilaterally breaking the licence agreements, the government undoubtedly increased the regulatory risk of operating in B.C. This added risk should have been capitalized into lower stock prices for *all* B.C. firms, and perhaps to a lesser degree into the stocks prices of all Canadian firms. As a result, using the TSE index as a benchmark for market risk might mask the impact of the policy changes on forest companies.

The results of this paper should be interpreted with caution and applied only in the context of the specific policy changes examined. This study measured only the marginal effects of one specific set of forest policy changes, the most important being a reallocation of AAC from major licensees to the Small Business Forest Enterprise Program and a transfer of responsibility for so-called "basic" silviculture from the government to the major licensees. Although we found the marginal effect of these changes to be small, the effects of a much larger reallocation of AAC could be proportionally much larger. This study gives no evidence on this issue. For example, based on the findings of this paper one cannot infer that another 5 or 10% AAC reallocation would have little impact on investment in the B.C. forest industry. Furthermore, the 1987 forest policy changes reallocated the AAC among licensees but did not reduce its overall level. The impact of an overall reduction in provincial AAC would be far different from the impact of the 1987 policy changes. Policy makers apparently do have some room to regulate the forest resource users without affecting investment activities in the industry, but the scope for such changes surely has limits.

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### References

- Binder, J.J. 1985a. Measuring the effects of regulation with stock price data. *Rand J. Econ.* **16**: 167-183.
- Binder, J.J. 1985b. On the use of the multivariate regression model in event study. *J. Finan. Account. Res.* **23**: 370-383.
- Boardman, A., Vertinsky, I., and Whistler, D. 1992. Modelling the impacts of regulatory changes on stock prices: protecting the spotted owl. Faculty of Commerce, University of British Columbia, Vancouver.
- Collins, D., and Dent, W. 1984. A comparison of alternative testing methodologies used in capital market research. *J. Finan. Account. Res.* **22**: 48-81.
- CWC Canadian Western Capital Ltd. 1991. Managing British Columbia's forest resources: structural alternatives, financial considerations and valuation estimates. *In* Background paper for B.C. Forest Resource Commission. Vol. 4. CWC Canadian Western Capital Ltd., Vancouver, B.C. pp. 1-64.
- Dann, L.Y., and James, C.M. 1982. An analysis of impact of deposit rate ceilings on the market values of thrift institutions. *J. Finan.* **37**: 1259-1275.
- Desai, A.S., and Stover, R.D. 1985. Bank holding company acquisitions, stockholder returns, and regulatory uncertainty. *J. Finan. Res.* **8**: 145-156.
- Financial Post. 1987. BC hikes for tax bite. 21 Sept.
- Gillespie, D.W. 1991. Small business forest enterprise program/woodlot program. Report to B.C. Minister of Forests. Webber and Company, Kamloops, B.C.
- Heaps, T. 1988. An econometric analysis of log production in coastal British Columbia. Forest Economics and Policy Analysis Research Unit, University of British Columbia, Vancouver. Work. Pap. 108.
- Lintner, J. 1965. The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *Rev. Econ. Stat.* **47**: 13-37.
- Scholes, M., and Williams, J. 1977. Estimating betas from non-synchronous data. *J. Finan. Econ.* **5**: 309-327.
- Schwert, G.W. 1981. Using financial data to measure effects of regulation. *J. Law Econ.* **24**: 121-158.
- Sharpe, W.F. 1964. Capital asset prices: a theory of market equilibrium under conditions of risk. *J. Finan.* **19**: 425-442.
- Sterling Wood Group Inc. 1986. Comments on US Department of Commerce October 1986 preliminary determination. Supplementary joint report to Canadian Forest Industries Council, Vancouver, B.C.
- Theil, H. 1971. Principles of econometrics. John Wiley & Sons, New York.
- Thompson, R. 1985. Conditioning the return-generating process on firm-specific events: a discussion of event study methods. *J. Finan. Quant. Anal.* **20**(2): 151-168.
- Uhler, R.S. 1991. Canadian public timber policing and the great subsidy debate. *In* Canada - United States trade in forest products. Edited by R.S. Uhler. UBC Press, Vancouver, B.C. pp. 73-93.
- Vancouver Sun. 1986. Premier says other will follow if BC hikes its stumpage rate. 9 Sept. Vancouver Sun, Vancouver, B.C.
- Vancouver Sun. 1987. Forestry policy fuels stock sell off. 16 Sept. Vancouver Sun, Vancouver, B.C.
- Zellner, A. 1962. An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *J. Am. Stat. Assoc.* **57**: 348-368.
- Zinkhan, F.C. 1988. The stock market's reaction to timberland ownership restructuring announcements: a note. *For. Sci.* **34**(3): 815-819.