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Innovation, Strategy and Canada's Forest Products Industry

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Cette étude identifie les changements affectant l'industrie des produits forestiers canadiens et lie ces changements aux impératifs auxquels font face les firmes canadiennes pour modifier leurs stratégies commerciales et corporatives. L'article examine le rôle des stratégies innovatrices et suggère des changements aux aménagements institutionnels qui les accommodent directement ou indirectement. Une meilleure protection des droits de propriété forestiers et un changement dans les politiques portant sur la concentration industrielle sont des façons indirectes de provoquer l'innovation. Le rôle du gouvernement dans une stratégie d'innovation efficace comprend des recherches sur l'environnement forestier alors que les laboratoires coopératifs attacheraient plus d'importance aux recherches de base ou précompétitives sur les produits du bois. Toutes les recommandations visent à accroître les incitatifs à l'innovation par les investisseurs privés en leur permettant de s'accaparer une plus grande part des rendements sur leurs investissements.

This study identifies the changes affecting the Canadian forest products industry and relates those changes to imperatives facing Canadian firms to modify their corporate and business-level strategies. The paper investigates the role of innovation strategies and suggests changes to institutional arrangements that indirectly or directly accommodate them. More secure forestry tenure arrangements and a change in policies toward industry concentration are indirect ways of inducing innovation. The government's position in an effective innovation strategy involves research focusing on forest environment while the emphasis of cooperative labs would be on basic or precompetitive research in wood products. All the recommendations act to increase the incentives of private investors to innovate by capturing a greater share of the returns of their own innovations.

INTRODUCTION

The forest products sector is vitally important to the economic health of Canada, accounting for nearly $57 billion worth of shipments in 1995, $20 billion of exports and over 700,000 jobs. Important and seemingly irreversible changes in the economic and socio-cultural environments surrounding the industry have led to calls, both from inside and outside the industry, for fundamental changes in the strategies and behaviour of Canadian forest products companies. A critical element in these

changes is an increased emphasis on innovation, and ecologically better harvesting strategies to ensure the continued competitiveness of Canadian forest products that is consistent with new environmental and international trade realities (for example, see Hayter 1987; Page and Brassard 1993).

The purpose of this study is to identify the changes that are affecting the industry and relate those changes to imperatives facing Canadian firms to alter or modify their corporate and business-level strategies. The major focus is on the role of increased innovation. First, we discuss a number of important changes affecting the industry and their implications for Canadian producers. The strategic questions that Canadian producers must address are then outlined as well as some broad responses to those questions. Public and private sector policies to accommodate the suggested strategy changes are examined and our conclusions follow.

The Changing Environment of the Forest Products Industry

While one can create a long list of changing factors influencing the industry, several specific factors are more prominent than others: sustainable forest management, increasing environmental sensibilities, direct and indirect substitutes, developments in biotechnology, and changes in export patterns.

Sustainable Forest Management

Sustainable development has been largely adopted as a policy goal by provincial and federal forest agencies both individually and collectively through the Canadian Council of Forest Ministers. The concept involves providing equal consideration to economic, social, and environmental facets of development in decision making.

Adopting sustainable forest management as a policy goal has significant implications for policies, management goals, and approaches and processes of monitoring and assessment. Management must now consider such perspectives as (i) conservation of biological diversity, (ii) maintenance of the productive capacity of ecosystems, (iii) maintenance of forest ecosystem health and vitality, and (iv) conservation and maintenance of soil and water resources. This issue is discussed further in subsequent papers in this special issue.

Increasing Environmental Sensibilities

Related to sustainable forest management is a growing militancy on the part of environmental groups and an apparently increasing receptivity on the part of the public to stronger measures for regulating the environmental practices of the forest industry. This development has several implications for the activities of forest product companies. Perhaps the most obvious is that public antagonism to the harvesting of old growth forests mitigates what is arguably one of Canada's major competitive advantages: access to high quality fibre. Because most forestlands are publicly owned, it is difficult for private firms to anticipate changing land-use patterns and respond "optimally" to the anticipated changes. Moreover, the increasing constraints placed on harvesting put upward pressure on the costs of logging more generally. To the extent that consumers increasingly prefer forest products made from recycled fibre, firms face an additional competitive disadvantage over and above direct and indirect government restrictions on timber harvests. Given the small size of its domestic economy, Canada faces a competitive disadvantage in terms of its access to low-cost waste paper.

Increasing environmental sensitivities and regulations create opportunities as well as threats to the extent that such developments are fairly ubiquitous. For example, in the pulp and paper sector, mills in other countries also face regulations that increasingly limit allowable emissions. This has resulted in growing international demand for innovations such as new end-of-pipe systems and add-on controls. To the extent that domestic producers lead in the development of new emission control processes, they enjoy the potential to sell the new technology

to others. Of course, some modifications to production processes also improve wood utilization rates and increase quality of output (Loufti and Mehlman 1995).

Direct and Indirect Substitutes

Canada's competitive advantage in high quality fibre is threatened by the emergence of direct and indirect substitutes for Canada's temperate wood feedstock. Direct competition takes the form of a potentially faster growth of supply in other regions of the world, and in shifts of regional timber supplies. The former is exhibited by increased plantation harvesting in the United States. The latter is exhibited by increased investments in timber supply in Chile and New Zealand.

Many regions have a capacity to produce wood fibre in direct competition with Canada. These potentially include softwood fibre from Russia's vast forests and softwood plantations in the United States, Chile, New Zealand, and other areas. They also include tropical regions. Many regions, particularly in developing countries, have weaker public restrictions on harvesting activities than does Canada.

During this century, plantations have become a prominent source of timber supply, and the pace of this transition has recently accelerated. Such countries as New Zealand and Brazil have become prominent in international forest products markets using only intensively managed plantations as a source of timber supply (Binkley and Forgacs 1997, p. 5). Other countries, such as Indonesia, Thailand, and Argentina, are also establishing plantation estates that are anticipated to support internationally competitive wood products manufacturing facilities.

Producers of temperate conifer wood are arguably the most relevant set of direct competitors to Canadian producers. In this regard, the former Soviet Union is of particular interest. While it has a large share of temperate forests, its capacity to exploit the natural resource is constrained by the recent economic and social collapse of the various republics. If economic and political reform in the region does take root, the former Soviet Union could become a major long-run source of increased competition. Obstacles to the emergence of this region as a major supplier include the geographic dispersion of forests, the expense of effective reforestation efforts, and a shortage of transportation capacity (Stanbury and Vertinsky 1991).

The US has a smaller timber base than Canada, and US producers in the Pacific Northwest face strong environmental restrictions on harvesting activities. However, developments in plantation growing, especially in the southern regions of the US, are increasing the potential supply of fibre from cultivated sources, although US plantation supplies are still relatively modest in contrast to offshore plantations in Chile, Brazil, and New Zealand.

Finally, the fibre resources of South America, Asia, and Africa are primarily tropical hardwood, and tropical hardwood products have until now been a relatively weak substitute for temperate wood products. However, ongoing research is seeking to increase the substitutability of hardwood and softwood products, and the ample supplies of tropical hardwoods ensure that incentives will exist to promote increased substitutability. Canada is shielded from competition from developing countries for the most part because our proximity to the US (Canada's largest export market) results in lower transportation costs.

Traditional lumber products are facing increasing indirect competition from various sources including engineered wood products that use less lumber, wood products made of lumber from rapid growth softwood plantations, and non-wood products made from steel, aluminum, plastics, and other materials (Cartwright 1993). As well, traditional paper products, such as newsprint, are becoming increasingly less important compared to specialty products such as packaging materials. Canadian capacity in 1994 accounted for around 16 percent

of global wood pulp capacity and almost 28 percent of newsprint capacity, but only around 7 percent of total capacity for paper and paperboard (including newsprint).

Biotechnology Developments

Bioengineering breakthroughs are taking place in forestry, albeit at a slower pace than in medical or agricultural biotechnology. Some developments may potentially erode Canada's traditional competitive advantages. For example, bioengineering R&D by countries such as Brazil may improve the strength of their fibre and their low production of high-quality papers using fibres from fast-growing plantations. Other developments may enhance opportunities facing Canadian producers. Examples include the application of biotechnology to environmental remediation and protection, and the development of pesticides for forestry and wood products with "built-in" characteristics, such as termite- and fire-resistance.

Changes in Export Patterns

These various developments obviously cannot be expected to affect all sectors of the industry identically. Indeed, it is not obvious from available data that Canadian producers, except newsprint producers, have experienced any major impact. Table 1 shows Canada's share of world exports in different sectors. To the extent that export shares reflect, in some meaningful way, the "competitive status" of home-country producers, the market decrease in Canada's share of newsprint exports is noteworthy.

It has been suggested that a major reason for this decline was an inability to attract the capital required to invest in new technology and upgrade older Canadian mills. The import dependence of some of our major markets, particularly the US, declined as new technologies made it possible to use previously underutilised tree species for newsprint production. This reduces some of the resource-related sources of comparative advantage. Investors in competing forest countries constructed new newsprint capacity that was more efficient than Canadian capacity. Softwood lumber, on the other hand, shows an opposite trend. Canada's share of global trade has increased substantially since the mid-1960s. Again, much of this growth may be attributed to technological change. New small-log processing technology was introduced that was particularly well suited to the Canadian resource, thereby, to some extent, enhancing our advantage in resource abundance. The technology provided an opportunity to produce wood chips for use in the pulp and paper sector. The core technology was enhanced by the introduction of CT scanners, computer optimizers, and automated handling systems. Significant economies of scale were associated with this new technology and, as a result, average mill size has increased dramatically.

TABLE 1
Trends in Canada's Share of World Forest Product Exports, by Volume, 1965-1994 (Percent)

Product Group	*1965-1974*	*1975-1984*	*1985-1994*
Newsprint	70.0	64.6	55.7
Softwood lumber	35.9	44.6	50.7
Wood pulp	31.0	34.2	32.3
Printing and writing paper	7.2	8.6	13.3
Wood-based panels	6.6	6.6	8.6
Other paper and paperboard	5.4	7.1	6.9

Source: Natural Resources Canada, Canadian Forest Service (1994).

While one can question the rate at which ongoing developments might erode the competitive position of Canadian firms, it seems judicious to conclude that the developments cited, on balance, support the idea that Canadian producers should move away from their traditional focus on low value-added products that rely heavily on access to a commercially advantaged, high-quality fibre. These developments emphasize the need to use technological innovation to compete in higher value-added activities. The next section identifies the strategic issues associated with this proposed refocusing of industry efforts.

Strategic Issues

The premise that Canadian forest product companies should "re-engineer" themselves raises the issue of how strategy should be modified. Strategy changes can proceed on two broad levels. *Corporate strategy* is concerned with selecting the sectors or activities in which the firm will compete. Firms have two broad and mutually exclusive alternatives: niche strategies, to compete in a relatively narrow set of activities, or diversification strategies, to compete across a broad range of activities. The classic study setting out alternative corporate and competitive strategies is by Porter (1980). *Competitive or business unit-level strategy* is concerned with how the firm should compete in the activities in which it chooses to participate. Two generic strategies have been identified in the literature: cost leadership and product differentiation. Cost leadership denotes the quest for competitive advantage by being the lowest cost producer and selling at prices below those of one's rivals. Product differentiation denotes competitive advantage by producing new products that are more highly valued by the market than existing products, while charging premium prices for those new products.

Innovation can be integral to either a cost leadership or product differentiation strategy. There is no theoretical reason why cost leadership and product differentiation must be mutually exclusive strategies, although Porter (1980) maintains that few firms are able to implement both strategies successfully. Under cost leadership, the main focus of innovation is to identify new production or distribution processes that are cheaper than existing ones. Cost-reducing innovation thus generally emphasizes the presence of engineering skills and close links between equipment manufacturers and the firm's production facilities. In contrast, product differentiation innovation tends to emphasize the availability of research skills, as well as close links between the R&D section and the marketing department. The organizational strengths that make a firm a great product innovator are unlikely to be the same as those that make a firm a great cost-cutter.

To gain a perspective on how industry participants viewed the strategic choices facing Canadian forest products companies, personal interviews were undertaken in Spring 1997 with 13 private and public sector organizations.[1] These interviews sought to elicit the organization's views of how the industry's environment was changing, how Canadian industry should respond to the changes, and what needed to be done to ensure that necessary changes would successfully occur. Since we agreed that we would not identify our respondents individually, there is no attribution of specific responses.

We detected no general agreement among our survey participants as to the specific sectors and activities in which Canadian producers should compete. The only consensus that we could clearly identify is that Canadian firms should move toward higher value-added activities.[2] This leaves open the question of whether Canadian producers should compete across a range of higher value-added activities or focus on a few higher value-added niche activities.

Identification of the "optimal" portfolio of businesses that any specific company should hold depends upon, among other things, the internal strengths and weaknesses of that company. Given

wide variations in strengths and weaknesses across companies, it is impossible to be prescriptive on the issue of a corporate strategy for Canada's forest industry. Nonetheless, several observations seem relevant. First, producers in small countries typically must specialize in a relatively narrow range of activities to compete successfully against producers located in other large countries, especially in industries characterized by economies of scale. Second, there are typically economies of specialization associated with innovation, including learning-by-doing. This further suggests the wisdom of Canadian producers specializing in specific sectors or activities rather than competing across a broad range of sectors. Third, retaining the benefits of innovation in the form of increased profits, which, in turn, support increased capital investment and employment creation, implies that innovators enjoy some market power. With market power, or the ability to influence price by changing supply, producers will need to share less of any innovation surpluses with consumers. Also, with fewer competitors, the innovator's surplus is less likely to be eroded by imitation on the part of competitors. Producers based in small countries are likely to enjoy market power only in specialized market niches.

We also detected no consensus among industry experts as to the appropriate competitive (or business-unit level) strategy that Canadian firms should emphasize. As noted above, one possible emphasis is on cost-reduction and price leadership. Another is on product differentiation or new and improved products that can command above-average prices in the marketplace.

Again, it is beyond the scope of this study to offer a detailed prescription of the preferred competitive strategy. Our broad assessment of both the external environment and the strengths and weaknesses of the industry as a whole lead us to conclude that a stronger emphasis on product differentiation advantages may be appropriate on a going-forward basis. One reason is that Canada's position as a small consumer of products suggests that much of the benefits of cost-reducing innovations will (with competition) be passed through, at least in the long run, to foreign consumers. New products are arguably more difficult to duplicate than cost-reductions and the associated innovation profits less readily competed away.

Cost-reducing innovation is especially promoted by close links between producers and equipment suppliers. It has been noted by a number of survey respondents, as well as by Hayter (1987), that Canada has relatively few domestic equipment manufacturers. On the other hand, an emphasis on product differentiation can build upon Canada's fundamental inherent strength: relatively abundant sources of high-quality fibre. Enhancing the beneficial characteristics of domestic fibre offers a specific product differentiation focus. Finding new markets for these beneficial characteristics provides a complementary focus.

Several respondents also pointed out that changes in computer-communications technologies are making it increasingly possible for manufacturers to customize products for specific consumers by enabling the manufacturers and consumers to exchange detailed technical and marketing information at a distance. This further accentuates the potential advantages of a product-differentiation-based competitive strategy.

Our interviews generated several additional insights into the possible emphasis of product-differentiation strategies. The companies we interviewed stressed that product-differentiation innovation is occurring in both the wood and paper segments of the industry, although firms differed somewhat on the underlying philosophy of new product innovation. Specifically, one or two emphasized that incremental and constant product improvements are sufficient to maintain market share. Such product improvements could focus on accentuating existing strengths derived from Canada's high-quality fibre stock, for example, paper strength, brightness, and lightweight. One or two others stressed the need for

more fundamental market breakthroughs so that imitation by rivals would not quickly erode first-mover advantages.

In fact, it has been found that "modest" product differentiation advantages are capable of yielding relatively large commercial benefits to innovators (Kamien and Schwartz 1980). Hence, a distinction between modest and "fundamental" breakthroughs may not be particularly relevant in categorizing alternative product-differentiation strategies. More relevant might be the focus of such strategies. In this context, the perspective of respondents from research organizations tends to complement that of the forest companies. The research organizations also emphasize a focus on research-enhanced product properties that augment the qualities inherent in northern softwood fibre.

Promoting Product Differentiating Innovation

Both our interviewees and experts from outside the industry (Hayter 1987) have identified a significant Canadian "innovation gap." That is, the Canadian industry is seen as being less innovative that its major counterparts in the United States, Sweden, and Finland. One primary indicator that critics point to in defence of this thesis is the relatively low R&D intensity of the Canadian industry. Table 2 reports industrial R&D expenditures for wood products and paper and allied products. It shows that the bulk of industry R&D expenditures goes for paper and allied products, although the share of R&D spending in each of the two broad segments of the industry has been relatively constant over time.

Obviously, nominal expenditures in R&D over time provide a misleading picture of trends in real R&D capacity. Roberts (1991) showed that the cost of conducting R&D in the wood industry and the paper and allied industry increased by 307 percent and 277 percent, respectively, between 1970 and 1987, which was faster than input inflation in the overall economy. The implication is that real R&D spending in the sector over time is lower than suggested by the data in Table 2.

TABLE 2
Industrial R&D Expenditure in Canada ($ millions)

Year	*Wood Products*	*Paper and Allied Products*	*Total R&D*
1980	13	47	60
1981	14	54	68
1982	13	54	67
1983	14	52	66
1984	17	56	73
1985	19	62	81
1986	21	70	91
1987	18	72	90
1988	19	83	102
1989	17	95	112
1990	17	91	108
1991	19	98	117
1992	20	94	114
1993	23	102	125
1994	24	102	126
1995	24	110	134

Source: Authors' compilation based on data from Statistics Canada. The figures are business enterprise expenditures funded both privately and publicly and include expenditures by Forintek and Paprican.

While we cannot compare real R&D expenditure intensities across countries, comparisons of nominal expenditure intensities are probably reliable, since the costs of R&D inputs are arguably comparable across countries. In this regard, in Finland, the expenditures on R&D by the largest five companies as a percentage of sales range from 0.5 percent to 1.0 percent; for the four largest Swedish paper companies it ranges from 0.6 to 1.4. US producers of paper and allied products spend about 1.1 percent of their net revenues on R&D (National Science Foundation 1995), and we estimate that the R&D expenditure to sales ratio for Japanese pulp and paper producers is slightly lower at 0.9 percent. In contrast, Statistics Canada reports intramural R&D

as a percentage of company revenues to be around 0.4 for Canadian producers of paper and allied products (Globerman *et al.* 1997).[3]

The relatively lower Canadian spending on R&D is paralleled by a relatively lower employment of industrial R&D personnel. For example, in 1993, total R&D personnel in the Canadian forest products industry was around 1,200, whereas it was slightly over 12,000 in the comparable US industry. This difference is substantially greater than the corresponding difference in production capacities.

As Binkley and Forgacs (1997) note, international comparisons of R&D expenditures can be misleading inasmuch as sectoral concentration will influence R&D intensities. For example, US R&D intensities decrease significantly when consumer products companies such as Kimberly-Clark and Scott Paper are excluded. Binkley and Forgacs also note that comparisons of R&D intensities may mislead since they understate differences between Canadian and foreign companies in absolute R&D expenditures. This is because Canadian forest products companies are small by world standards. For example, not one Canadian company was represented among the 40 largest companies in the pulp and paper industry worldwide in 1995. To the extent that successful innovation is characterized by large indivisibility, absolute R&D expenditures may be more relevant than R&D intensities.

R&D expenditures are inputs to and not outputs from the innovation process. An assessment of the innovation performance of Canadian companies might therefore more appropriately focus on one or more output measures of innovative performance. Data are available for one such measure: patenting.[4] The number of registered Canadian and US patents by nationality of patent-holder for various years is shown in Table 3 for paper products. Wood products patents do not have a clearly defined classification and will not be addressed. It is unclear (without further investigation) why US-registered patents

TABLE 3
Number of Canadian and American Patents in Paper Products and Paper-making Categories, 1990-1996

Category	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*
Canada: (Inter'l Class D21)[a]							
Canada-held	8	12	13	7	6	7	7
United States-held	52	57	46	56	42	48	55
Finland-held	21	18	18	21	12	20	16
Sweden-held	26	14	12	15	12	10	4
Held by these 4	107	101	89	99	72	85	82
Total Canadian patents	118	132	124	142	98	109	104
United States: (US Class 162)[b]							
Canada-held	6	7	19	11	16	7	21
United States-held	174	177	214	196	169	187	207
Finland-held	50	34	39	27	17	26	43
Sweden-held	32	17	13	18	12	23	25
Held by these 4	262	235	285	252	214	243	296
Total American Patents	365	318	378	373	333	354	412

Authors' compilation.
[a] Source: Canadian Patent Database
[b] Source: US Patent and Trademark Office Database

are upwards of four times the number of patents registered in Canada. In both countries, Canadians account for a relatively small share of total patents in the paper and paper products segment of the industry. For example, of the total American patents held by Canadian, American, Finnish, and Swedish patent holders, Canadians held around 7 percent (in 1996). This is approximately equal to Canada's total share of world production of paper and paperboard (including newsprint) in 1991; however, US patentholders held almost 70 percent of the total patents registered to the four countries compared to a share in world production (in 1991) of US producers of paper and paperboard equal to around 30 percent.[5]

Another indicator of technological intensity is the rate at which new technologies are adopted for use. Unfortunately, comprehensive data on this indicator are unavailable for international comparisons. Using case studies, Hayter (1987) suggests that Canadian wood products companies have been slower to adopt new technologies than their foreign rivals. A case study of a specific innovation (special presses) suggested that Canadian paper manufacturers were slower to adopt this innovation than their foreign competitors (Globerman 1975). Finally, a recent survey of the adoption of advanced manufacturing techniques in Canadian manufacturing industries indicated that firms in the wood products and paper industries were slower to adopt these techniques than firms in other industries (Baldwin and Sabourin 1993). We hasten to note, however, that this does not necessarily mean that Canadian companies are less competitive than their foreign counterparts. Indeed, the (historical) relatively large share of Canadian production exported to other countries contradicts the notion that Canadian producers are uncompetitive. Canadian producers have simply built their competitive success on access to high-quality fibre and an engineering focus on being cost efficient in the production of "commodity" products. In this context, a relevant policy issue is whether Canadian producers can become more "technology intensive" as their traditional sources of competitive advantage are eroded, as many experts anticipate.

In summary, R&D and patent data suggest that Canadian producers are less innovation-intensive than their foreign competitors. To the extent that increased innovation is critical to the future success of Canadian producers, attention must be focused on policies to enhance the innovative capabilities and efforts of the Canadian industry.

Promoting Innovation in the Canadian Forest Products Industry

Most of our interviewees identified the relatively low level of R&D performed in Canada's forest products industry as a major barrier to innovation (see also Hayter 1987). While it is undoubtedly true that R&D performance is a necessary component of innovation, including the rapid adoption of innovations developed abroad, it does not necessarily follow that Canadian forest industry policy should emphasize substantial increases in R&D expenditures. One reason is that the rate-of-return to R&D expenditures in Canada's forest products industry may be no greater (at the margin) than other investment outlets including silviculture and reforestation. A second is that the major beneficiaries of Canadian R&D expenditures may be foreigners.

Mohnen, Jacques, and Gallant (1996) examine the role of R&D in Canada's pulp and paper and wood industries. Over the sample period 1963 to 1988, they find that R&D earns a net real after-tax annual rate of return of 1.6 percent in the pulp and paper industry and of 7.8 percent in the wood products industry. Moreover, they find no evidence of R&D externalities between the two forest product industries and a minimal impact on total factor productivity growth.

Mohnen, Jacques, and Gallant conclude that estimates of the returns to R&D are low compared to those reported in the literature for other industries. They note that their estimates do not include increases in consumer surplus from lower prices; however, since 82 percent of pulp and paper shipments

and 68 percent of wood products shipments are directly or indirectly exported, a good deal of consumer surplus thus benefits foreign and not Canadian consumers. They interpret their results as suggesting that Canadian forest products industries are not in special need of government R&D support in the form of grants or tax incentives.[6]

Bernstein (1994) estimates private and social rates-of-return to R&D in the Canadian and US forest products sector. The estimated private rate-of-return in the Canadian paper and allied products sector is 12.7 percent, while the domestic R&D spillover (in the form of a rate-of-return) is 21.6 percent. But the estimated international spillover (that is, the rate-of-return on Canadian R&D realized by foreign producers) is an astounding 92.1 percent. Thus, R&D carried out in the Canadian paper and allied products sector does create spillovers within the Canadian industry, but the spillover benefits to US-based firms dwarf the spillover benefits captured by Canadian-based firms.

For US firms, the estimated private rate of return is 18.5 percent, substantially higher than the private rate of return for Canadian R&D. The estimated domestic spillover (in the form of a rate of return) is 66.5 percent, again substantially higher than the internal spillover in Canada. The estimated spillover to Canada is a modest 14.2 percent. Thus, the bulk of the benefits of R&D performed by the US industry is captured domestically, whereas the bulk of the benefits of Canadian R&D are captured outside the country.

Canada's small role as a consumer of forest products clearly suggests that a substantial share of any benefits from cost-reducing innovations will be passed on to foreign consumers. Moreover, empirical evidence suggests that the benefits of R&D that are "internalized" by Canadians may be relatively small (as a rate of return) compared to the opportunity cost of the resources utilized. These observations caution against a simple policy recommendation for a substantial increase in R&D expenditures by the industry. Rather, they point to the need for promoting a higher internal rate of return to R&D performed by Canadian firms.

Several suggestions have been made to enhance the returns to domestic R&D expenditures. Hayter (1987) argues that relatively high levels of foreign ownership ensure that returns to R&D, and R&D expenditures, will be relatively low in Canada. This is allegedly because foreign-owned firms will centralize R&D in their home-country affiliates and not allow their foreign affiliates to exploit technological breakthroughs. Rather, they will concentrate production of new products in the parent company.

This criticism of foreign ownership is a long-standing one among Canadian economic nationalists. While the evidence (from many industries) suggests that foreign ownership is associated with lower R&D intensity in host countries, other things constant, it also suggests that the presence of foreign-owned affiliates improves the productivity of domestically owned firms in the same industry, in part by encouraging a faster adoption of new technology (Globerman 1979). None of our interviewees identified foreign ownership as a barrier to performing commercially successful R&D in Canada. Indeed, some mentioned the beneficial role of large US-owned companies, particularly in serving as a conduit to technological developments in the US.

Interviewees mentioned the need for closer links among the various participants in the domestic industry, including research labs, equipment manufacturers, and production facilities. The importance of industrial clustering to innovation has been well documented in empirical studies (Porter 1990). What is less obvious is how to encourage closer integration among different stages of the innovation "value-added" chain.

Some interviewees (as well as Hayter 1987) argue that the presence of equipment suppliers is very important to enhancing the innovative capability of the Canadian forest products industry. However, it

is not obvious that the simple domestic presence of equipment suppliers is any guarantee of above-average performance in industrial innovation. For example, both Finland and Sweden have relatively large equipment supply sectors. While the estimated rate of return to R&D for Finland is higher than that for Canada, the estimated rate of return to R&D for Sweden is below that for Canada (Mohnen, Jacques, and Gallant 1996). Obviously, the "quality" of the interaction also matters.

It does not seem sensible as a starting premise for the Canadian government to subsidize the relocation of equipment manufacturers to Canada. As noted, the emergence of robust computer communication networks is making it increasingly possible for suppliers and their customers to be virtually co-located and thereby exploit some of the synergies that are possible in sharing personnel and so forth. Moreover, enhanced innovative capability on the part of Canadian forest products companies will itself encourage some relocation of equipment supply capacity to Canada.

Interviewees also mentioned the need for production mills in Canada to acquire more scientific and technical expertise to better interact with the R&D efforts in corporate and cooperative R&D facilities. The lower degree of scientific and technical expertise in Canadian mills compared to Scandinavian and German mills has been noted by others (Omni Continental 1994). There does seem to be a reasonable *a priori* argument for increasing the scientific and technical skill levels within Canadian mills, particularly if Canadian producers intend to increase their emphasis on developing new products, as successful product innovation will have to be harmonized with process developments in the mills to some extent.

The Canadian companies we interviewed complained that it is difficult for them to attract skilled scientific and technical workers to mills located outside major urban areas. Innovative employment programs and attractive compensation packages may be required. The design and implementation of such programs certainly seems feasible, with Scandinavian efforts in this regard likely to be informative.

Our interviews did not suggest that major changes in the research activities of the federal government or the cooperative research labs were advisable. Specifically, it seems appropriate for government research to continue to focus on forestry and environmental matters, for Forintek to focus on pre-competitive research affecting the wood products segment, and for Paprican to focus on pre-competitive research affecting the paper segment. While there were strong cautions against government and cooperative labs doing company-specific R&D, it was acknowledged that better feedback from corporations to those labs might help focus pre-competitive research on areas that more likely facilitate product differentiation breakthroughs at the company level.

A frequent complaint heard about Canadian forest products companies is that they take a "short-run" view of the industry and do not have a "culture of innovation." One possible explanation for this phenomenon, if valid, is the relatively insecure access that companies have to fibre supplies. Investing in changes to wood fibre attributes requires some expectation that the innovator will have access to fibre supplies over a significant period. Otherwise, the benefits of the technological change may well be obviated or internalized by producers who gain cutting rights in future periods. Given such risks, it is obvious that incumbent producers will have weak incentives to undertake R&D and related activities to "engineer" changes in wood products.

One way in which a more "secure" property rights regime can be put in place is by allowing more private ownership of timber stands in Canada. Insecurities about access to fibre supplies associated with reductions in the allowable cut to address environmental concerns can be mitigated by designating certain areas as dedicated to timber production, with long-term and inalienable cutting rights granted to producers (see Sahajananthan, Haley, and Nelson 1998).

Government environmental policies have a major impact on forestry R&D by imposing requirements that companies must meet, in part, by technological developments. As noted above, idiosyncratic environmental requirements make it less likely that the technological responses of Canadian firms will be commercially exploitable on international markets. While this does not suggest that environmental policy in Canada should be subservient to commercial policy, it adds consideration to cost-effectiveness evaluations of alternative environmental policies.

Finally, government policies toward industrial reorganization and profitability of the industry might merit reconsideration. The provincial government in British Columbia, for one, has traditionally not encouraged increases in the concentration of ownership of fibre supply, or potential mergers and acquisitions that could lead to a smaller number of production facilities and loss of employment in specific towns or regions. Increased concentration of ownership at all levels of the industry may be a necessary concomitant to increased innovation. For example, R&D spending is relatively concentrated in Canada's top ten forestry firms (Table 4). R&D performance is generally characterized by economies of scale, and Canadian firms are generally smaller than their foreign competitors (Globerman and Vertinsky 1995).

As a method for collecting resource rents, the stumpage fee regime will become even more controversial than in the past if Canadian companies do put greater emphasis on value-added activities. In this case, it will become increasingly difficult to separate resource rents from innovation rents. If returns to innovation are intentionally or unintentionally appropriated by the Crown, say in high stumpage fees, innovation will certainly be discouraged. It may be necessary to rethink the ways in which governments in Canada extract revenues from the forest resource.

Conclusions

There is widespread agreement that Canadian forest product companies must put greater emphasis on innovation to compete successfully given ongoing and expected changes affecting the industry. There is less agreement on precisely what the innovation focus of Canadian companies should be and on how to promote a climate of innovation. The industry must address important issues of corporate and competitive strategy that will condition the "optimal" choice of policies to promote innovation. Whatever the precise focus of these strategies, it is likely that significant changes in institutional arrangements will need to be made to encourage a more innovative environment.

Table 4
Intramural R&D Expenditures by Top Ten Canadian Forestry Firms, 1991-1995

	1991	*1992*	*1993*	*1994*	*1995*
Current expenditures	48.9	42.7	46.4	44.7	47.2
Capital expenditures	4.9	5.5	8.1	6.2	6.7
Total	53.8	48.2	54.5	50.9	53.9
% of total industry R&D expenditure	74%	70%	69%	65%	63%

Source: Provided by Statistics Canada

Some of the necessary changes may have no obvious direct link to innovation strategies, for example, forestry tenure arrangements and policies towards mergers and acquisitions. Others may have more direct links to R&D expenditures and performance. For example, training programs to improve the scientific and technical skill levels of mill workers may justify some government financial support; however, we see little need for new major R&D funding subsidies to forest product companies. The R&D funding environment in Canada's private sector is already quite generous by international standards. Arguably more important is enhancing the incentives of shareholders to approve substantial and risky commitments to innovation activities. This latter development may require a major change in the way public policy treats access to and ownership of natural resources such as the forests.

Finally, governments in Canada arguably have a very important role in financing and undertaking forestry research. As forestland owners, governments have a duty to promote research that increases the productivity of the resource and its potential value. Governments must also focus on the ecology and health of forests and seek to increase non-timber values at minimum cost. Such research may help Canada to defend its access to foreign markets that are increasingly demanding proof of sustainable forest stewardship.

What has happened to federal expenditures on forestry R&D? They have declined in real terms by $14.35 million over the period 1982 to 1997, with much larger reductions in the Canadian Forest Service's programs being partially offset by increased spending by NSERC. The new forest sector R&D program supported by Forest Renewal BC has offset declines in provincial government spending elsewhere. Yet, total real government R&D spending on the forest resource is in long-term decline. In an era of fiscal austerity, the challenge to policymakers is to design financing schemes and other incentives that will encourage greater R&D in forestry.

Notes

[1]The following organizations were interviewed: Canfor; Canadian Forest Service; Canadian Pulp and Paper Association; Domtar; Forintek; Industry Canada; MacMillan Bloedel; Ministry of Natural Resources, Quebec; Network of Centres of Excellence Programs; Noranda Technology Center; Paprican East; Paprican West; and UBC Pulp and Paper Research Centre.

[2]A move toward higher value-added activities frequently implies higher costs of production. Obviously, if costs increase relatively more than revenues, the move would be unprofitable. The notion here is that more often revenues will increase proportionally more than costs.

[3]These comparisons do not include expenditures by government, research cooperatives, and universities. In Canada, forest products research cooperatives account for almost 40 percent of total forest-products, sector-related research; however, similar cooperatives also exist in Sweden, Finland, and Japan.

[4]A number of criticisms can be raised against the use of patent statistics as measures of innovation intensity (Globerman 1998). For purposes of making broad international comparisons, such criticisms are of modest relevance.

[5]Canada accounted for only 3 percent of US patents registered to the four sample countries in 1991, while the US accounted for around 75 percent. Production data are unavailable for Sweden and Finland. Using export data as a base suggests that they are more intensive patentors than Canada. Specifically, Swedish-held patents in the US accounted for around 8 percent of patents held by the four countries (US, Canada, Sweden and Finland), while Swedish exports accounted for around 10.5 percent of total world exports in 1991. The respective comparable percentages for Finland were 15 percent and 13 percent, while for Canada the percentages were 7 percent and 20.7 percent.

[6]However, Mohnen, Jacques, and Gallant (1996) understate the social returns to R&D by ignoring research benefits associated with quality change and by implicitly assuming that industry cost would not have been increasing, over time, in the absence of R&D.

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