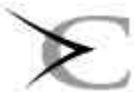


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**Environmental Performance of
Canadian Pulp and Paper
Plants: Why Some Do Well
and Others Do Not ?**

Julie Doonan, Paul Lanoie, Benoit Laplante

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Environmental Performance of Canadian Pulp and Paper Plants: Why Some Do Well and Others Do Not *?

Julie Doonan[†], Paul Lanoie[‡], Benoit Laplante[§]

Résumé / Abstract

Il est généralement reconnu que les firmes font face à des pressions internes et externes pour qu'elles améliorent leur performance environnementale. Cependant, peu d'études ont tenté d'identifier l'importance de ces différentes sources de pression *tel que les gestionnaires les perçoivent*. Dans cette étude, nous montrons que les directeurs «environnement» de l'industrie canadienne des pâtes et papiers perçoivent le gouvernement et le public comme les sources de pression les plus importantes, devant les marchés financiers et les consommateurs. Nous montrons également que l'implication de la haute direction à l'égard de l'environnement et la formation des employés par rapport à la problématique environnementale sont des déterminants importants de la performance environnementale. Cette recherche nous aide donc à mieux comprendre les déterminants de la performance environnementale et elle permet de réaffirmer le rôle crucial joué par une intervention gouvernementale vigoureuse dans le domaine.

It is generally recognized that firms face both internal and external pressure to improve their environmental performance. However, few studies have attempted to delineate the importance of those various sources of pressure as firms' managers themselves perceive them. In this study, we show that managers in the Canadian pulp and paper industry perceive government and public, but not financial and consumer markets, as the most important source of pressure. We also show that involvement of the firm's higher level management and environmental education of employees are important determinants of the firm's performance. While the paper provides a better understanding of the determinants of environmental performance, it re-asserts the crucial role of strong government regulatory intervention.

Mots-clés : Performance environnementale, Politique environnementale, Audit environnemental.

Keywords : *Environmental performance, Environmental policy, Environmental audit.*

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I. Introduction

A limited number of empirical studies have sought to understand the determinants of firms' environmental performance. In the economics literature, an essential issue of interest has been the impact of the various monitoring and enforcement actions on the environmental performance of polluters.¹ Others have examined the role that communities may play to create incentives for local industrial facilities to reduce their pollution.² Finally, a number of authors have examined whether or not the public disclosure of environmental performance may create incentives for pollution control.³

While these various empirical analyses offer key understanding of firms' environmental behavior, none of these analyses rely on information provided by firms' managers themselves. An exception of interest is Henriques and Sadorsky (1995, 1996; henceforth H&S) who conducted a survey of 750 Canadian corporations in 1992. These corporations covered a wide range of sectors, from primary to service sectors. In their model, H&S seek to determine the characteristics of firms that are likely to formulate an environmental plan. These authors find that pressure from customers and shareholders represent the two most important determinants of the formulation of an environmental plan. H&S also found that the commitment of senior management to deal with environmental issues is an important determinant of the likelihood of the existence of an environmental plan. However, interestingly, government regulation does not appear as a statistically significant source of pressure. H&S explain this result by observing that

1. See Dasgupta et al. (2001), Gray and Deily (1996), Helland (1998), Laplante and Rilstone (1996), Magat and Viscusi (1990), and Nadeau (1997).

2. See Blackman and Bannister (1998), and Pargal and Wheeler (1996).

3. Comprehensive surveys of the role of communities and information markets are presented in Cohen (1998) and World Bank (2000).

a large number of firms have indicated by surveys that government regulation is an important source of pressure. The lack of variability in the measure of government regulation thus reduces the explanatory power of this variable.

In this paper, we extend and enrich the work of H&S in two directions. First, from a policy perspective, we posit the variable of interest to be the environmental performance of the firms. Hence, we seek to understand the determinants of that environmental performance, and prefer to view the presence of an environmental plan simply as an input into the production of that performance (output). Secondly, our conceptual model differs sensibly from H&S whose statistical analysis relies on the estimation of a logit model. As described in the next section, we prefer to model the firm's environmental performance as a sequence of events whereby various sources of pressure may induce various types of activities and actions by the enterprise, activities and actions which then in turn have an impact on the environmental performance of the firm.

We test our model in the Canadian pulp and paper industry. Our interest to explain firms' actual environmental performance necessitates that we focus our analysis on a single industrial sector for which there is sufficient plant-level environmental performance data to test the model (e.g. emissions data). The pulp and paper industry possesses this important characteristic. Unlike H&S, our results reveal government regulation and public (local communities) to be important sources of pressure inducing firms to undertake actions to improve their environmental performance. This result re-asserts the important role of strong regulatory intervention. Capital markets and consumer markets do not appear as a statistically significant source of pressure.

While earlier studies have revealed capital markets reacting to environmental information,⁴ this result may indicate that firms' environmental performance is not necessarily responsive to the reaction of capital markets. However, along with H&S, we find the commitment of the higher level of management to be a significant determinant of environmental performance.

We discuss the conceptual model in further details in the next section. The estimation methodology and data are presented in Section 3, while results are presented in Section 4. We briefly conclude in Section 5.

II. Conceptual Model

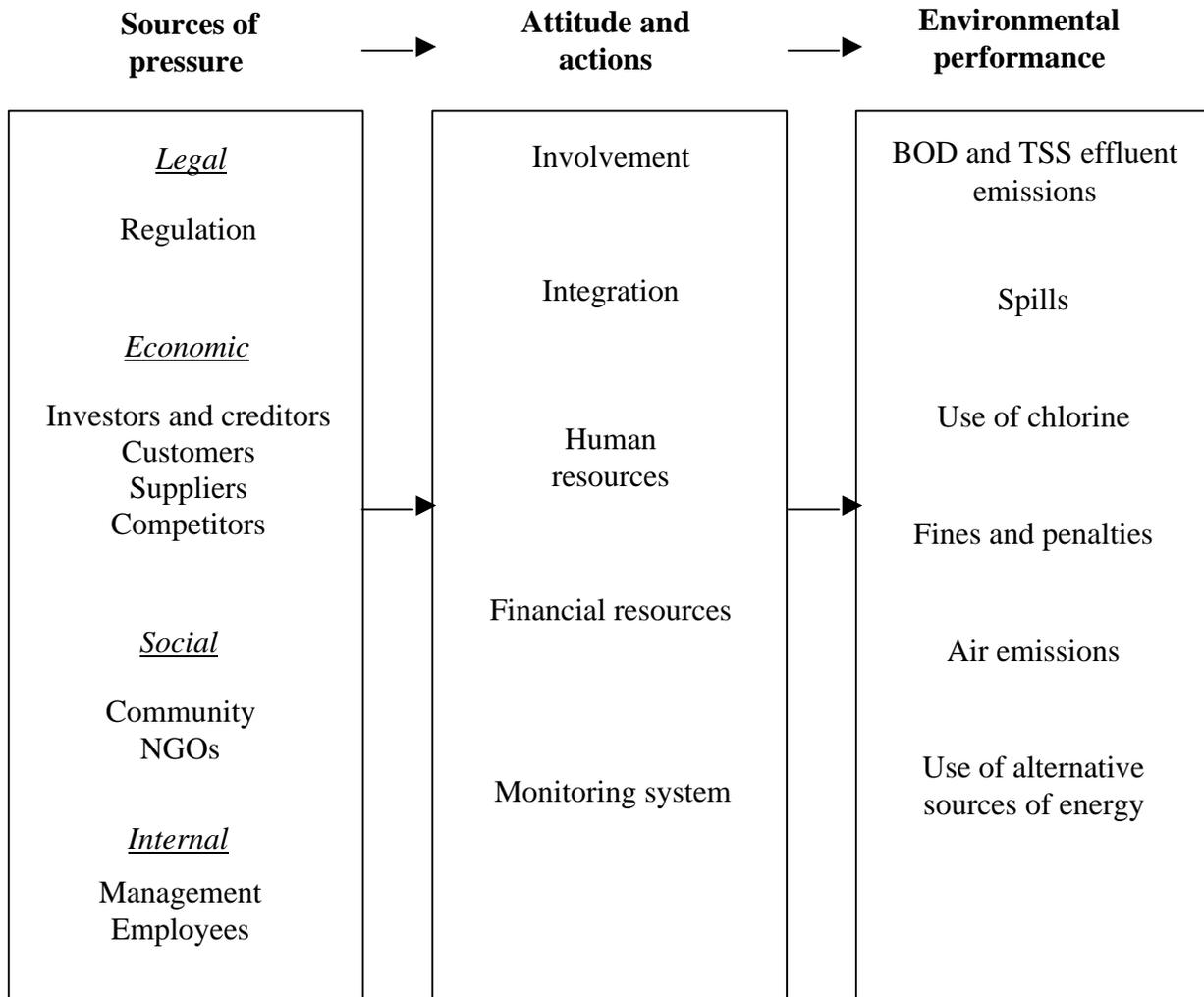
The model we develop relies on the premises that the environmental performance of an industrial facility results from actions undertaken to improve and maintain this performance. Whether or not such actions are undertaken depends in turn on pressure perceived or exercised by various stakeholders.

As illustrated in Figure 1, we group the various sources of pressure into 4 categories: legal, economic, social, and internal. The *legal* source of pressure pertains essentially to the nature of the environmental regulation faced by the enterprises. It would include not only the stringency of the regulation (e.g. effluent standards), but also the extent of implementation of the regulation. We distinguish four sources of *economic* pressure: providers of financial capital as represented by investors and creditors; customers; suppliers; and competitors. The *social* pressure is

4. See Dasgupta et al. (2000), Hamilton (1995), Klassen and McLaughlin (1996), Konar and Cohen (1996, 2001), Lanoie et al. (1994, 1998), and Muoghalu et al. (1990).

represented by community and non-governmental organizations. Finally, management and employees capture *internal* sources of pressure.⁵

**Figure 1
Conceptual Model**



5. For example, in their study of the impact of inspections on pollution emissions of pulp and paper plants in Quebec (Canada), Laplante and Rilstone (1996) found that unionised employees are very prone to inform the environmental regulator about a plant's wrongdoing with respect to the management of its waste.

If and when effective, these various sources may exert pressure on firms to undertake actions aimed at improving the environmental performance. We group these actions into 5 broad categories. *Involvement* refers to the level of involvement of the higher level of management in the environmental affairs of the company. *Integration* represents the level of integration between the environmental services and the other administrative units of the industrial facility. *Human resources* captures how human resources management takes into account environmental issues. *Financial resources* refers to the physical and financial resources devoted to the improving and maintaining the environmental performance of the facility. Finally, *monitoring system* represents the facility's environmental performance monitoring activities and system.

The environmental performance of the industrial facility is measured by a number of variables all aimed at providing information on the overall nature of that performance. These include not only pollution information such as *air and water emissions*, and *spills*, but as well information on key inputs such as the *use of alternative sources of energy* and, given the industrial sector of interest in this paper, the *use of chlorine* in the production process. The presence of *fines and penalties* also aim to provide information on the environmental performance of the facility.

In the next Section, we describe the methodology used to estimate the model presented in Figure 1, the data collection process and present a descriptive analysis of the data.

III. Methodology and Data

The model

The model presented in Figure 1 can be translated into a structural equation model of the following general form:

$$\eta = \beta\eta + \Gamma\xi + \zeta$$

where:

η is a $m \times 1$ vector of latent endogenous variables;

β is a $m \times m$ matrix of coefficients to be estimated;

Γ is a $m \times n$ matrix of coefficients to be estimated;

ξ is a $n \times 1$ vector of latent exogenous variables;

ζ is a $m \times 1$ vector of residual errors.

Specifically, the model can be written as :

$$\begin{bmatrix} INVOLVEMENT \\ INTEGRATION \\ HUMAN RESOURCES \\ FINANCIAL RESOURCES \\ MONITORING \\ PERFORMANCE \end{bmatrix} = \mathbf{b} \begin{bmatrix} INVOLVEMENT \\ INTEGRATION \\ HUMAN RESOURCES \\ FINANCIAL RESOURCES \\ MONITORING \\ PERFORMANCE \end{bmatrix} + \Gamma \text{ PRESSURE} + \mathbf{z}$$

In this linear structural equation model, the endogenous and exogenous variables are latent variables which are not directly observed, but are proxied by a series of observed indicators. These indicators are then combined through a principal component analysis (see, Stevens, 2001) to provide a representation of the latent variables. For instance, the level of *integration* of environment services into other administrative units is not directly observed. However, a series of indicators can be used (e.g. the frequency of contacts between the environment services and the other units), measured by means of surveys, and combined by means of principal component analysis to proxy this latent variable.

The structural model is estimated using the popular EQS software which is very flexible allowing for all variables except the pressure variables to be potentially endogenous.⁶ The estimated model is thus tantamount to a simultaneous equation system in which the variance-covariance matrix is adjusted to account for the fact that the latent variables are not precisely measured.

The survey

For the purpose of the analysis, almost all the information was collected by means of a survey conducted among the environment directors of all Canadian pulp and paper plants. The nature of the compliance status of the plants with respect to water emissions regulation was collected directly from the Department of environment in the Canadian provinces where the plants are located.

6. See Hoyle (1995) or Lacroix et al. (1991) for more details.

In the course of preparation of the survey, two pulp and paper plants were visited, and discussions were held with four environment directors. The relevance of the questions presented in the survey, and the wording of technical features of the survey were thus validated. Furthermore, a draft form of the questionnaire was pre-tested with 10 directors.⁷

The survey was conducted by phone during the winter of 1997. A total of 101 out of 150 directors were then reached, for a response rate of 67 %. This appears relatively good given the extensive nature of the interview which lasted approximately 45 minutes. Fifteen of these questionnaires were eliminated for too much information being missing. As a result, responses from 86 questionnaires were used for purpose of estimation.

Descriptive analysis of the data

To capture the variable *pressure*, respondents were presented with the sources of pressure described in Figure 1, and were asked which three of those were the most important sources of pressure affecting the environmental behaviour of the facilities in the course of the last five years. Respondents were also asked which of these sources had increased most over that period of time. As shown in Table 1, 70% of the environment directors of the industrial facilities responded that the government (regulation) was the most important source of pressure, followed with pressure from top management, and clients. Note that 35% and 26% of the respondents indicated public pressure and employees to be the second and third most important source of pressure respectively. Interestingly, the financial market is not identified as an important source of pressure although a number of recent studies (Lanoie et al., 1998, Konar and Cohen, 2001)

7. The complete survey is presented in Appendix 1.

have shown that capital markets tend to “punish” firms with bad environmental performance. Similarly, Henriques and Sadorsky (1995) identified the clients as a major pressure group, which is not the case here.

**Table 1
Sources of pressure**

Sources	1st	2nd	3rd	Increased the most in the last 5 years
Government	70	19	6	56
Clients	9	11	13	9
Suppliers	0	0	0	0
Investors/bankers	0	2	3	0
Ecologists	0	4	4	1
Competitors	2	1	5	0
Community, public	8	35	22	16
Employees	0	10	26	1
Top management	11	16	17	16
None	0	2	2	2

The level of *involvement* of the top management was captured by means of eight different questions aimed at collecting both objective and subjective information on this aspect. In particular, 66 % of the respondents indicated the presence of a vice-president environment, and 70 % indicated the presence of an environment committee on the board of directors.

The level of *integration* of environment across administrative units is captured through a series of questions pertaining to the following features: existence of an integrated environment management system (EMS); existence of a joint employer – employee committee on environmental issues; firm’s intention with regard to the ISO 14000 certification; frequency of

contact between the environment director and the managers of other units; consideration of environmental issues when planning major changes in the plant; and participation of employees in the elaboration of the environmental policy.

Table 2 indicates that, while 81 % of the directors express an intention to obtain the ISO 14 000 certification, only 23 % of the plants have an integrated EMS. Most plants appear to experience very frequent and formal contacts between the environment services and the other units of the plants (e.g. engineering and production), and 50 % of the plants have a joint committee on environmental issues. 45 % of the respondents indicate that employees actively participate in the development of the facility's environmental policy.

**Table 2
Integration of environmental issues**

			Yes	No	
Existence of an EMS			23 %	77 %	
Intention to obtain ISO 14000 certification			81 %	19 %	
Existence of a joint committee on environment			50 %	50 %	
Contact of environmental services with	Formal and frequent	Formal and occasional	Informal	Very few contacts	None
engineering	78 %	12 %	7 %	1 %	2 %
production	85 %	11 %	4 %	0 %	0 %
Employees actively participate in the development of the environmental policy	14 % agree totally	31 % agree somewhat	23 % somewhat disagree	32 % totally disagree	

As for *human resources*, questions were asked on whether environmental training of different types of employees, and whether or not employees' compensation and performance evaluation reflected the environmental performance of the facility. Table 3 shows that most plants provide some form of training on environmental issues to all types of workers, while approximately 30 % and 80% of the plants consider environmental performance in the compensation package and workers' performance evaluation respectively.

**Table 3
Human resources and the environment**

Categories of employees who have received an environmental training:		All employees	Some employees	None
Production employees		51 %	43 %	6 %
Foremen		71 %	28 %	1 %
New employees		52 %	29 %	19 %
Professional technicians		77 %	17 %	6 %
Managers		71 %	21 %	8 %
Environmental issue is considered in:	Agree totally	Agree somewhat	Somewhat disagree	Totally disagree
Compensation package	15 %	16 %	23 %	46 %
Workers' performance evaluation	32 %	47 %	13 %	8 %

The measure of *financial resources* is based on questions related to the date of implementation of a secondary treatment system and of an emergency basin, the evolution of the environmental services in terms of budget and number of employees, and the evolution of the research on environmental issues within the firm. Table 4 shows, that in most cases, budget and personnel devoted to the environmental services have increased during the five years preceding the survey (63 % of the plants report such increases in the personnel, and 79 % for the budget). It also appears that a large percentage of the plants have started to operate a secondary effluent

treatment system over the period 1992-97. Furthermore, a very large fraction of the plants (92 %) are involved in research activities surrounding environmental issues.

Table 4
Financial resources

Number of years since the installation of :	None	Between 1 and 5 years	Between 6 and 10 years	More than 10 years
	Secondary effluent treatment system	19 %	43 %	12 %
Emergency basin	17 %	41 %	18 %	24 %
Evolution of the resources devoted to the environment	Increase		Status quo	Reduction
	Personnel	63 %	26 %	11 %
Budget	79 %	15 %	6 %	

The environmental performance *monitoring* system relates to the evolution of the number of environmental audits, the extent to which the recommendations of the auditors have been followed, and the existence of chemical risk assessment. Table 5 shows that most plants (85 %) are involved in an auditing process. However, it would appear that recommendations emerging from this process are not necessarily followed.

Table 5
Monitoring

External auditing during the last five years	Yes	No		
	85 %	15 %		
Chemical risk assessment during the last five years	81 %	19 %		
Recommendations from audits are followed	Always	Often	Rarely	Never
	0 %	42 %	57 %	1 %

As mentioned earlier, the environmental performance is based on five ‘objective indicators’ measure of performance. This contrasts with previous studies which used much more

rudimentary environmental performance measures such as the existence of an environmental plan. First, managers were asked if the plants had been fined for non compliance with environmental regulation during the five-years period preceding the survey. Second, various provincial Departments of environment provided information on the plant's compliance rate with biochemical oxygen demand (BOD) and total suspended solids (TSS) standards for the year 1995. Third, it was found whether or not plants had contravened their atmospheric emissions standards in the course of 1995. Fourth, information was requested on the use of alternative sources of energy (like biomass or pulping liquor). Finally, information was obtained on the use of chlorine in the whitening process.

Table 6
Environmental performance

Compliance rate ^a	BOD	-0.15		
	TSS	-0.075		
Fine during the last five years	Yes	No		
	27 %	73 %		
	60 %	40 %		
Spills (during the last year)	16 %		84 %	
	Non-compliance with regulation on atmospheric emissions			
When did you stop using chlorine for whitening pulp?	Never	Between 95 and 97	Between 90 and 95	Before 1990
	24 %	22 %	42 %	13 %

^a Compliance rate is measured as: (actual average emissions – emissions standards) / emissions standards

Table 6 shows that 27 % of the plants had experienced a fine within the five-years period preceding the survey. On average, the plants were below their BOD limits by 15 %, and below their TSS limits by 7.5 %. Only 16 % of the plants asserted not complying with atmospheric

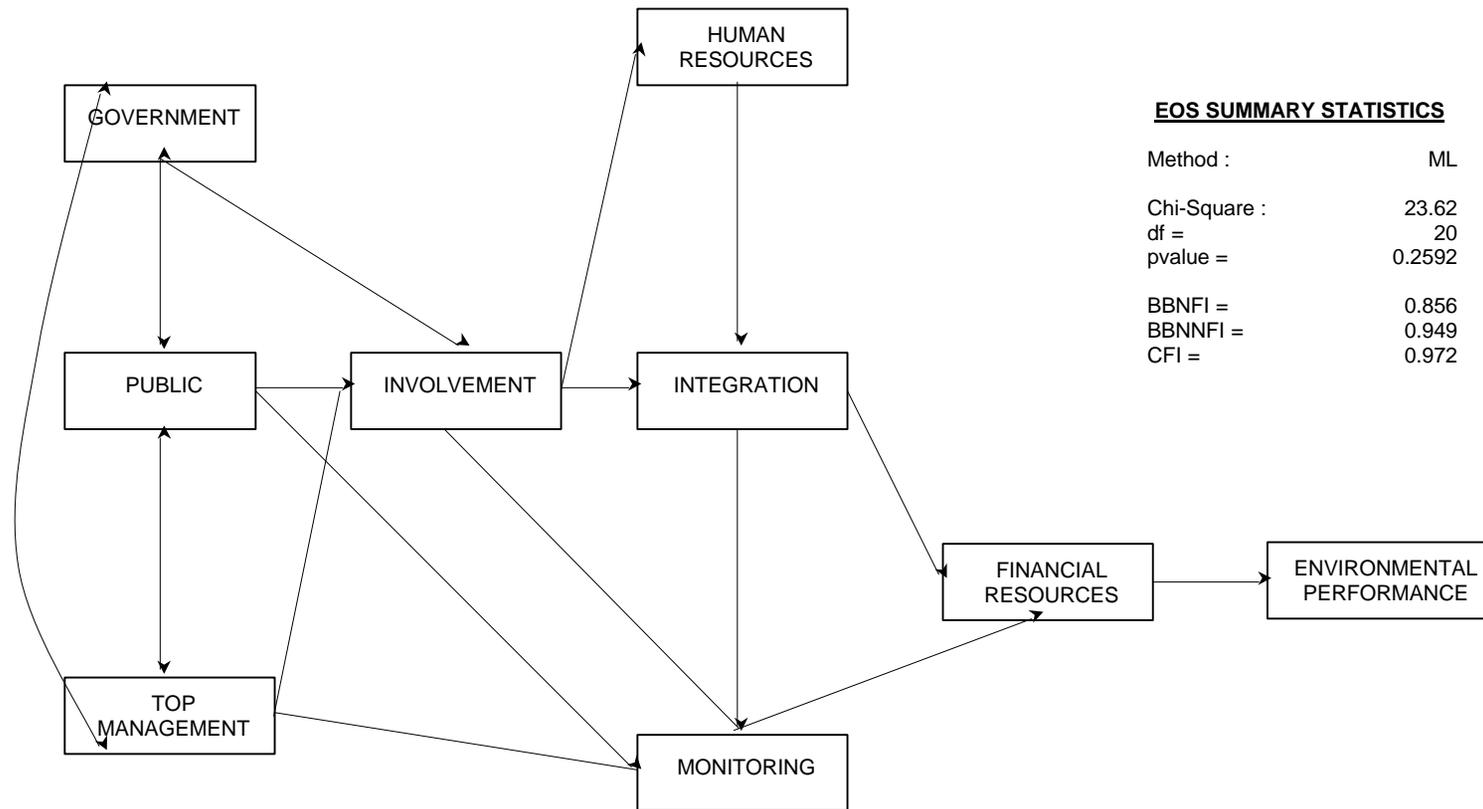
emissions regulations. A majority of the plants (65 %) report using alternative sources of energy. Finally, most plants report having ceased to use chlorine in the production of pulp since 1990.

IV. Empirical Results

Main results are presented in Figure 2. The figure represents the relationships between the latent variables which best fit the data. Given that the model is tantamount to a simultaneous equation system, the relationship between different latent variables can go in both directions as indicated in the diagram. The good statistical fit of the model is confirmed by a certain number of indicators (Hoyle, 1995). First, it is acknowledged that a model is 'significant' when the goodness-of-fit indices are greater than 0.9. Here the Bentler-Bonett index (BBNNFI = 0,949), the LISREL GFI index (GFI = 0,943), and the CFI index (CFI = 0,972) are indeed greater than the threshold. Furthermore, when we compare the estimated model with one where we constraint all the coefficients to be equal to zero, we obtain a χ^2 statistic of 0,2592, which is to be compared with a critical value of 0,1. We can thus reject the null hypothesis that the coefficients are equal to zero. The resulting model is consistent with our theoretical predictions.

First, it appears clearly that the three most important sources of *pressure* perceived by environmental directors are the government, the general public (including the neighbouring community), and the higher level of management. As mentioned earlier, financial market is not perceived as an important source of pressure on the firm's environmental performance.

Figure 2
Statistical results



The *involvement* of the higher level of management appears to be an important factor in the chain of causality that follows. It influences the way human resources management integrates environmental concerns. It also affects the level of *integration* between the environmental services and the other administrative units in the rest of the plant, and the intensity of the *monitoring* activities. It is often asserted in the management literature that the environmental involvement of the top management is a primary determinant of the environmental performance of the firms (e.g., Deschamps and Beaulieu, 1996). To our knowledge, this is the first empirical evidence that confirms this common wisdom. This study also allows us to identify by which channels the influence of the top management is exerted.

The way by which environmental issues are taken into account in the *human resources* management is an indirect driver of the environmental performance through its impact on the level of *integration*. This seems normal given that the participation of all employees in the environmental management was an important element in the earlier definition of *integration*. This result is consistent with previous results of Boiral (1998) and Dasgupta et al. (1997) who find, in particular, that the level of environmental training is associated with a better environmental performance.

The level of *integration* between the environmental services and the other administrative units has an indirect effect on the environmental performance through its impact on the *monitoring* system and on the *financial resources* devoted to the environment. This is a very interesting result given that, to our knowledge, the notion of *integration* has been developed only recently, and applied to a single case study (Deschamps and Beaulieu, 1996). Using a more

systematic sample of data, we thus present evidence and confirm the empirical significance of this variable.

The environmental performance *monitoring* system has an indirect impact on the environmental performance through its effect on the level of *financial resources*. It suggests that the recommendations emerging from the monitoring system lead the plants to devote more financial resources to pollution control. It is also interesting to note that pressure from the public influences directly the intensity of the *monitoring* activities.

Financial resources devoted to pollution control remains the most important driver of environmental performance. This is not necessarily surprising in the context of the pulp and paper industry where a large part of the environmental performance relies on the utilization of extensive and expensive pollution abatement devices such as secondary effluent treatment system.

V. Conclusion

A number of authors have examined the role and impact of inspections, communities, and markets (consumer and capital) on the environmental performance of industrial facilities. None of these studies however have sought to understand how managers themselves perceive these sources of pressure.

In this paper, building but departing from the analysis presented by Henriques and Sadorsky (1995, 1996), we provide evidence that in this age of information, the government remains the

most important source of pressure on enterprises of the pulp and paper industry to improve their environmental performance. We however also show that the public is increasingly an important source of pressure thereby justifying programmes which aim to disclose the environmental performance of industrial facilities. We confirm the crucial impact of an involved higher level of management in environmental affairs, and offer evidence that the environmental training of employees is an important determinant of the environmental performance. Further studies in the area shall reveal if these results hold more generally in other, perhaps broader set of circumstances.

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Liste des publications au CIRANO*

Série Scientifique / *Scientific Series* (ISSN 1198-8177)

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