



Rising to the Kyoto challenge: Is the response of Canadian industry adequate?

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A major weapon in Canada's CO₂-emissions reduction arsenal is reliance on moral suasion and voluntary action. In this regard, the Voluntary Challenge and Registry (VCR) program constitutes a major effort to encourage industrial firms to reduce their greenhouse gas emissions. In this paper, we begin by providing a critical review of Canadian climate change policy and Canada's international commitments. We then investigate the effectiveness of Canadian policies by analyzing a survey of industrial firms, examining factors that determine firms' familiarity with, participation in and commitment to the VCR program, and their stated potential to reduce emissions by 2008–2012 (Kyoto's commitment period). Results indicate that voluntary programs are unlikely to make a significant contribution to emissions reduction, with industrial firms indicating that, on average, they plan to reduce emissions by some 1–2% below their 1990 level under the current policy approach, much lower than Canada's 6% reduction target.

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I. Introduction

This paper investigates how Canadian firms perceive the costs and benefits of actions to reduce CO₂ emissions, and their assessment of the contribution they could potentially make to the Kyoto Protocol target. Our analysis is based on a survey of transportation, manufacturing and resource extraction firms. Focusing on efforts made or planned by individual firms, we shed new light on the costs of mitigation from the perspective of individual businesses, rather than from the macro-economic (top-down) or technological (bottom-up) perspectives.

We investigate the extent of knowledge that firms have about the climate change issue and examine the degree of voluntary commitment to mitigate global warming. We study participation in, and the impact of, the Voluntary Challenge and Registry (VCR) Program, which was started in 1995 and privatized in 1997 (Enhanced Voluntary Action Issue Table, 1998). We use involvement with the VCR as an indicator of the propensity of firms to join voluntary carbon-emission reduction initiatives. We postulate and empirically test four models to explain different degrees of commitment to the VCR Program and carbon emission reduction as a function of firms' characteristics and the attitudes of their executives.

The paper proceeds as follows. In Section II, we briefly describe the background of Canada's mitigation efforts in relation to the Kyoto Protocol. Then, in Section III, we model firms' voluntary

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efforts to reduce CO₂ emissions; in Section IV, we discuss our questionnaire and provide some descriptive statistics from that survey. The results of model estimation are presented in Section V, and implications for Canada's industrial climate-change policy are discussed in Section VI.

II. Background

On December 11, 1997, the third Conference of the Parties (COP) to the United Nations' Framework Convention on Climate Change (FCCC) adopted the Kyoto Protocol. On average, industrialized (or Annex I) countries agreed to reduce CO₂ emissions by 5.2% of the 1990 level by the commitment period 2008–2012, although most countries, and importantly the United States, still need to ratify the Protocol. Canada committed to reduce CO₂-equivalent greenhouse gas (GHG) emissions by 6% of its 1990 emissions.

Political debate continues as to whether Canada's commitment is reasonable or not. Financial analyst Diane Francis (1999), for example, refers to the Kyoto commitment as an excessive pledge: 'in order to meet the emission cuts by 2010, one-third of our economy would have to be shut down or, alternatively, all our thermal power plants would have to be converted to nuclear plants at enormous cost.' She argues that scientific evidence concerning global warming is not sufficient to warrant taking such drastic measures. On the other hand, Chris Rolfe (1998), an environmental activist, praises the Kyoto Protocol as 'a step ahead', but warns that additional measures are needed to reduce significantly the rate of climate change. He claims that the Kyoto accord will not have a significant effect on the size of the Canadian economy or its growth.

The Kyoto agreement is a political one, the latest in a line of commitments and targets regarding CO₂ emissions (House of Commons, 1997). In 1988, at the World Conference on the Changing Atmosphere in Toronto, Canada made a commitment to reduce its GHG emissions by 20% of their 1988 level by 2005. In 1990, Canada's *Green Plan* stated, 'Canada's goal is to stabilize national emissions of CO₂ and other greenhouse gases at the 1990 level by the year 2000.' Again, in 1992, at the Earth Summit in Rio de Janeiro, Canada, along with other countries, made a voluntary commitment to reduce greenhouse gas emissions to the 1990 level by 2000. To date, none of these commitments have been met.

Already in 1995, the first COP to the FCCC concluded that the Rio commitments were insufficient. A process, known as the Berlin Mandate, was started that would lead to a strengthened international accord with legal instruments. The Kyoto Accord reached at the third COP was a result of that process. Just one month before the Kyoto conference, a joint meeting of the Canadian Council of Ministers of Energy and Environment was held in Regina. With the exception of the Minister from Quebec, the ministers consented that 'it is reasonable to seek to reduce aggregate greenhouse gas emissions in Canada back to 1990 levels by approximately 2010' (House of Commons, 1997:5). Subsequently, in response to international pressure, the federal government announced that Canada's position at Kyoto would be to reduce CO₂ emissions by 3% of the 1990 level by 2010, followed by a further reduction to 5% below the 1990 level by 2015. At Kyoto, however, Canada agreed to a 6% reduction.

The different positions that Canada has taken over time reflect the consequences of a political process (internal and external) rather than careful assessment of the economic and social costs and benefits, and full analysis of the scientific aspects of the choice. Setting a target for CO₂-emission reductions requires consideration of the range of options for mitigation, and the costs, benefits and risks related to these options relative to other response options, such as adaptation and research.

In 1990, Canada produced 601 megatonnes (Mt) of CO₂-equivalent GHG emissions (Natural Resources Canada, 1999). By 1997, after a period of economic expansion, Canada's greenhouse gas emissions had increased by 13% to 682 Mt. In 1998, the industrial sector and oil and gas production together contributed 33% of total GHG emissions (Government of Canada, 2000).¹

To estimate the trend of GHG emissions to the year 2020, the Federal Government formulated an economic model based on assumptions regarding population growth, GDP growth, oil prices, et cetera, and later updated it (Environment Canada, 1997; Natural Resources Canada, 1999). Simulations with this model indicate that, under current policies (policy-as-usual), the level of CO₂ emissions will exceed 1996 emissions by 15% by 2000, by 27% by 2010 and by 41% by 2020. One of the reports concludes that, 'although the policy response, to date, has had an impact, a considerably greater effort

¹ Industry accounts for 15% of GHG emissions, oil and gas for 18%, transportation for 25%, electricity generation for 17%, agriculture and forestry for 10%, and buildings for 10%.

would seem to be required, within a very short time frame, to achieve the [original FCCC] stabilization objective' (Environment Canada, 1997:52).

After the Kyoto Conference, in April 1998, the federal, provincial and territorial Ministers of Energy and Environment began a process to develop a national implementation strategy (Environment Canada, 1998). This led to the creation of sixteen Issue Tables dealing with analysis and modeling, transportation, electricity, Kyoto mechanisms, technology, carbon sinks, credits for early action, public education and outreach, agriculture and agri-food, the forest sector, buildings, industry, enhanced voluntary action, municipalities, science and adaptation, and tradable permits. These Issue Tables are forums where multi-stakeholder processes take place and their outputs, in the form of Options Papers, are meant to aid Ministers of Energy and Environment in formulating an implementation strategy. The outcome of this process is *Action Plan 2000* (Government of Canada, 2000), which builds on the 1995 National Action Program on Climate Change (NAPCC). Like NAPCC, *Action Plan 2000* avoids the use of more drastic measures such as carbon taxes. Main components of the Action Plan strategy include:

- (1) The Voluntary Challenge and Registry program;
- (2) A national communication (education) program that encourages voluntary action by individuals, industry and non-profit organizations;
- (3) Mission-oriented, government-sponsored research into energy efficiency, alternative fuels, and CO₂ capture and storage;
- (4) International action through the Clean Development Mechanism (Canadian-funded projects that reduce GHG emissions in developing countries) and Joint Implementation (especially projects in economies in transition); and
- (5) Reliance on terrestrial carbon sinks.

Action Plan 2000 relies on these measures to reduce CO₂-equivalent GHG emissions by an amount equal to a third of the difference between the policy-as-usual emission level (27% increase) and the Kyoto commitment level (6% reduction) by 2008–2012. The remaining two-thirds of the difference is left to future policy measures. Specifically, *Action Plan 2000* anticipates that industry will account for 15% of the targeted reduction in the *Plan*, while the entire energy sector (oil and gas plus electricity) is expected to account for 20% of targeted reductions. Because of the importance of terrestrial carbon sinks, agriculture and forestry are expected to contribute 20% and international

projects 25% of targeted emissions reductions by 2008–2012 (Government of Canada, 2000:4).

III. Modeling voluntary CO₂-emission reduction

Participation in the VCR program involves the following three steps: knowledge of the existence of the VCR program, which we designate as 'familiarity' with the program; submission of a *Letter of Intent*, which confirms commitment to limit or reduce GHG emissions; and submission of an *Action Plan* (not to be confused with the Government's *Action Plan 2000*), which defines the specific ways in which the commitment will be met (Enhanced Voluntary Action Issue Table, 1998). We use the results of an industry survey to derive four models that explain the degree of involvement of a company in the VCR program and the GHG emission-reduction goals a firm perceives to be realistic. Familiarity with the program and involvement in each of the VCR stages (participation and submission of an action plan) are analyzed using probit regression models (with binary dependent variables). In a fourth model, ordered probit regression is used to model those firm characteristics that might explain the emission-reduction targets that firms believe they can realize.

Modeling participation in voluntary emission reduction schemes

Assume that the manager of a firm maximizes utility as a function of the firm's profits, its characteristics and her own intrinsic values. Profits and firm characteristics might be thought of as 'hard' variables, while the manager's values are 'soft' variables. To predict whether a firm or manager knows about the existence of the VCR program (Model 1), we employ a simple probit regression model. Smaller firms are probably less likely to know about the VCR program, while managers who are not attuned to environmental and climate change concerns are also less likely to have heard about the program. We investigate those hard and soft variables that predict familiarity. The probit model is given as:

$$\text{(Model 1) Prob(Firm } k \text{ is familiar with the VCR program)} = \Phi[\beta'_1 X_k],$$

where Φ is the cumulative distribution function for the standard normal distribution, X_k is a vector of firm k 's characteristics and its manager's values (the hard and soft variables, respectively), and β_1 is a vector of coefficients to be estimated.

Once a manager knows that the VCR program exists, she may take action to become involved in the program, but only if the (perhaps political and goodwill) benefits of somehow participating exceed the perceived costs of doing so. Assume that the manager of firm k has the following utility function: $U(X_k) + \eta_k$, where $U(X_k)$ is the net utility the manager gets from becoming involved in the VCR, and η_k are unobservable factors assumed to be normally distributed with mean zero and unit variance. The utility maximizing decision rule for firm k is based on the net utility of its manager:

- (1) $U(X_k) + \eta_k > 0 \Rightarrow$ firm k gets involved in the VCR (letter of intent, action plan).
- (2) $U(X_k) + \eta_k \leq 0 \Rightarrow$ firm k does not get involved in the VCR (no letter of intent or action plan).

Assume that utility is a linear function:

- (3) $U(X_k) = \beta'_j X_k$,

where X_k is a column vector of firm and manager characteristics and β_j ($j=2, 3$ as discussed below) is a column vector of coefficients to be estimated. From (1) and (3), the firm gets involved in the VCR if and only if $\eta_k > -\beta'_j X_k$.

Models 2 and 3¹ differ only with respect to the extent that a firm gets involved in the VCR program. Some firms perceive that they have achieved the political and good will benefits that they desire (marginal benefits are at least as great as marginal costs) simply by filing a letter of intent; for other firms, perceived benefits continue to exceed costs at least up to the point where they submit an action plan for their firm. Thus,

$$\text{(Model 2) Prob (Firm } k \text{ participates in the VCR)} = \Phi(\beta'_2 X_k).$$

$$\text{(Model 3) Prob (Firm } k \text{ has submitted VCR action plan)} = \Phi(\beta'_3 X_k).$$

In our survey, we asked firms about their perceived ability to reduce GHG emissions by 2008–2012; categorical responses were requested. Assume the manager of firm k chooses an emission-reduction target (G_k) based on the costs to the firm of reducing emissions, and perceptions about the political and goodwill benefits, as well as the personal benefits to the manager. By choosing a level of G_k , the manager maximizes utility, $U(G_k, X_k)$, where X_k consists of the hard and soft

variables characterizing the firm and its manager.² Upon maximizing U and solving, the following reduced-form equation for G_k is obtained, to which an error term is added:

$$(4) G_k = h(X_k) + \varepsilon_k \text{ with } \varepsilon_k \sim N(0, 1).$$

Assume that $h(X_k)$ is linear and, since the dependent variable G_k is observed as a categorical variable corresponding to ranges of emission-reduction goals, an ordered probit model is used (Maddala, 1983):

$$\text{(Model 4) } G_k = \beta'_4 X_k + \varepsilon_k.$$

The dependent variable, G_k , is the underlying response variable and takes on ranges from G^1 to G^6 : G^1 indicates that a survey respondent felt that the firm could do no better than permitting CO₂ emissions to increase by more than 10% from 1990 to 2010; G^2 indicates an increase of less than or equal to 10% between 1990 and 2010; G^3 indicates no change from 1990; G^4 indicates a reduction in emissions of less than 5%; G^5 indicates a reduction of the range between 5% and 7%; and G^6 a reduction in emissions exceeding 7%.³

Explanatory variables

Both hard and soft variables likely have an impact on the degree of involvement in voluntary climate change mitigation. In this study, we use (1) firm size, (2) sector, (3) location (region in Canada), (4) attitudinal variables that measure corporate culture and personal beliefs with respect to the environment, and (5) perceptions of societal pressures from stakeholders. The first three variables are hard, while the latter two categories of variables are for the most part soft. We hypothesize that firm size determines, to a large extent, the capability of the organization to address GHG emissions, in terms of budgets, human resources and specialized organizational skills. Larger firms may enjoy economies of scale in implementing projects such as energy-saving investments. Therefore, larger firms are more likely to be involved in the VCR program and perceive higher emission-reduction goals to be realistic. Arora and Cason (1995, 1996), and DeCanio and Watkins (1998), found a positive correlation between firm size (number of employees)

² U is assumed to be continuously differentiable in all variables and concave in G_k .

³ A panel of government and industry experts that was consulted in designing the survey suggested the categories of estimated feasible reductions of CO₂ emissions.

and participation in the US EPA's 33/50 program and Green Lights program, respectively.⁴

Energy intensities of industrial sectors may affect the benefits and costs of reducing carbon emissions, and the decision to get involved in the VCR program. For instance, firms in energy-intensive sectors may have more opportunities for energy saving investments, and may be more willing to participate in the VCR and perceive higher emission-reduction goals as realistic. Similarly, firms in energy-intensive sectors are more likely to be targeted through regulations on carbon emissions in the future, and thus may be more willing to take meaningful voluntary initiatives to preempt regulation. For the USA, Arora and Cason (1995, 1996) identified a significant and positive correlation between the intensities of toxic releases and transfers (in absolute and relative terms) of a firm and the firm's participation in the 33/50 Program.

Regional effects are important in Canada because energy and natural resources fall under provincial jurisdiction.⁵ Further, Canadian firms experience different regulatory environments, tax regimes and attitudes towards business because of the different political parties that form governments in the various regions. DeCanio and Watkins (1998) found regional effects to be important in explaining participation in the Green Lights program, for example.

Respondent's attitudes towards environmental issues, which reflect corporate culture, may also influence a decision about whether to get involved in voluntary environmental protection initiatives and the goals firms choose (Winn, 1995). For example, perceived responsibility within the firm for climate change may positively affect commitment to a voluntary emissions control program. Ecocentric attitudes of a manager, or pessimistic views about the efficacy of technological solutions in preventing or adapting to climate change, are likely to lead to voluntary emission reduction initiatives. Managers are also affected by their perception of costs and benefits of climate change mitigation. Thus, if managers think that

emission reduction does not harm competitiveness, they are more likely to involve their firms in climate change initiatives. Similarly, if respondents view carbon emission reductions beneficial to the firm, they are more likely to join such programs.

Social pressure on private firms, particularly large ones, comes from environmental groups, the media, local communities, industry associations, governments, financial institutions, shareholders, boards of directors, customers and employees. Pressure may be positively or negatively correlated with the probability that a firm voluntarily participates in the climate change mitigation process. For example, Henriques and Sadorsky (1996) found that the formulation of an environmental plan is positively correlated with perceived concerns from customers, shareholders, government regulators and local communities, but negatively correlated with other lobbying groups' pressures.

IV. Survey of industrial firms: descriptive statistics and analysis

We surveyed a weighted random sample of 1 000 managers of Canadian companies from a list prepared by Dun & Bradstreet, which is a leading provider of international business information.⁶ The sampling criteria were to include companies with more than 100 employees whose principal activities were transportation, manufacturing or resource extraction, and CEOs were to be targeted to the largest extent possible. The total number of usable responses was 147 for an overall response rate of 15%. This response rate is typical of surveys of industrial firms. The response rate for firms with more than 1 000 employees was 36% and about 22% for companies with more than 200 employees. As expected, the response rate for the smaller companies was low (9%). Summary statistics for all variables used in the model are provided in Table 1, while response rates according to firm size, sector and region are provided in Table 2.

The survey consists of three parts. The first includes statements designed to measure the attitudes of managers towards the environment in general and climate change mitigation in

⁴The 33/50 Program is a voluntary EPA program that encourages firms voluntarily to reduce releases and transfers of 17 toxic chemicals. The Green Lights program is another voluntary EPA program aimed at encouraging firms to use energy-conserving lighting in buildings.

⁵The economies of the two western provinces (British Columbia and Alberta) are resource-intensive. These provinces produce the lion's share of Canadian oil and natural gas. The prairies rely heavily on agriculture while the central provinces claim the major share of Canadian manufacturing. The Maritime Provinces depend on natural resources and currently are developing offshore energy resources (natural gas and oil).

⁶Questionnaires were mailed out in May and June 1988, and responses were received from June 1988 to September 1988. A copy of the survey instrument is available from the authors upon request.

Table 1. Description of model variables

Variable and description	Obs.	Mean	SD
DEPENDENT VARIABLES			
Knowledge about VCR	147	0.35	0.48
VCR Letter of intent	147	0.22	0.42
VCR Action plan submitted	147	0.14	0.34
Stated GHG reduction goals (ranges coded from G ¹ for least to G ⁶ for highest ability to control emissions) ^a	134	—	—
EXPLANATORY VARIABLES			
Firm size measured by number of employees	147	560 ^b	510
<i>Sector variables</i>			
Energy-intensive firm=1; 0 otherwise ^c	147	0.39	0.49
Firm in transportation sector=1; 0 otherwise	147	0.04	0.20
<i>Regional variables (Maritimes included in intercept)^d</i>			
Central Canada=1; 0 otherwise	147	0.54	0.50
Prairies=1; 0 otherwise	147	0.09	0.28
West=1; 0 otherwise	147	0.32	0.47
<i>Attitudinal variables (coded from 1 = low to 5 = high)</i>			
Degree to which a manager accepts the firm's responsibility for climate change mitigation efforts	147	3.83	1.31
Degree to which a manager accepts personal responsibility for climate change mitigation efforts of his/her company	143	3.65	1.15
Strength of opposition to modification of the natural environment	144	3.15	1.31
Degree to which the respondent was pessimistic about the prospect of technological solution to climate change	131	3.06	1.21
Perceived beneficial impacts of climate change mitigation on firm's competitiveness	136	2.26	1.05
Perceived benefits of goodwill generated from green behaviour	132	3.48	0.96
<i>Pressure (degree of influence) variables (coded from 1 = not at all to 5 = total)</i>			
Perceived influence of environmental groups	134	1.74	0.87
Perceived influence of the media or local communities	136	2.56	0.98
Perceived influence of industry associations	136	2.88	1.04
Perceived influence of governments	137	3.08	1.02
Perceived influence of financial institutions	128	1.96	1.14
Perceived influence of shareholders or board of directors	131	3.22	1.34
Perceived influence of customers	138	2.91	1.17
Perceived influence of employees	138	3.07	1.05

^aG¹ >10% increase in emissions, 1990 to 2010 (11 responses); G² 1–10% increase (13); G³ no change (42); G⁴ <5% reduction (32); G⁵ 5–7% reduction (22); G⁶ >7% reduction in emissions (14).

^bRespondents indicated the ranges of number of employees. We assigned a point value to each range as follows; <150 employees in response as 150; 151–200 (175); 201–250 (225); 251–500 (375); 501–750 (625); 751–1 000 as (875); 1 001–1 500 as (1 250); >1 500 (1 500).

^cFirms in these sectors are coded as energy intensive: metal mining, oil & gas extraction, chemicals & allied products, paper & allied products, petroleum & coal products, metal and stone & clay.

^dMaritimes includes Newfoundland, Nova Scotia, New Brunswick & Prince Edward Island; Central Canada includes Ontario & Quebec; Prairies includes Manitoba & Saskatchewan; West refers to Alberta & British Columbia.

particular. Respondents were asked to rate each statement on a 5-point Likert scale.

The second part asked respondents to identify realistic carbon emission-reduction goals that could be achieved by 2010 (% reduction compared to 1990). This section also inquired about knowledge about and (level of) participation in the VCR. Respondents were also asked about the degree to which stakeholder groups influenced their company's actual or potential response to climate change initiatives. They were asked to provide a list of specific measures a firm could take to control CO₂ emissions and indicate the ones taken by their firm. The final section asked details about firm size (sales and number of employees) and their sector.

The voluntary challenge and registry (VCR) program

Participation in the VCR program is used as an indication of a firm's propensity to undertake voluntary climate change efforts. The VCR program is government-sponsored and encourages businesses and non-profit organizations to take actions to reduce CO₂ emissions. The total number of participants in this program, including companies and public institutions, increased from 465 in 1995 to 708 in 1998. In 1998, 17% of participants had submitted action plans (VCR, 1999). In our sample, 35% of firms (51) indicated that they know about the VCR, 33 of those actually participate in

Table 2. Involvement in the VCR program

Category	Survey response			Knowledge about ^a	Letter of intent ^b	Action plan ^c	Indicating >5% reduction
	Sent	Ret'n	Rate				
ALL FIRMS SIZE	1 000	147	15%	35%	65%	61%	26%
Small (≤200 employees)	573	52	9%	14%	57%	50%	20%
Medium (201–1000 employees)	339	63	19%	38%	42%	56%	21%
Large (> 1000 employees)	88	32	36%	63%	95%	74%	47%
SECTOR							
Energy-intensive	153	57	37%	53%	77%	65%	30%
Non energy-intensive	745	84	11%	23%	53%	50%	25%
Transportation	102	6	6%	33%	0%	0%	0%
REGION							
Maritimes	41	7	17%	29%	50%	0%	50%
Central Canada	694	80	12%	25%	80%	63%	23%
Prairies	52	13	25%	69%	56%	60%	17%
West	213	47	22%	43%	55%	64%	31%

^aPercentages of firms familiar with the VCR out of sample firms.

^bPercentages of firms participating in the VCR out of firms that know about the VCR.

^cPercentages of firms that have submitted action plans out of firms participating in the VCR.

the VCR, and 20 of the participating firms have submitted an action plan. Information about the relationship between the characteristics of firms and knowledge about the VCR program is provided in Table 2. Knowledge about the VCR was higher for energy-intensive firms and larger firms, as it was for firms outside central Canada (Ontario and Quebec). The latter is surprising as central Canada is the industrial heartland of the country.

Perceived potential for meeting the Kyoto target

Companies were also asked what they consider to be a realistic target for CO₂ emissions reduction for 2010.⁷ The results do not inspire confidence that Canadian industry will be able to meet the Kyoto target (a 6% reduction). Less than 30% of the firms surveyed felt that they would be able to reduce emissions by 5% or more below the 1990 level by 2010 (Table 2, last column). Only one in four firms responded that emission-reduction targets greater than 5% were realistic. The overall, simple average target considered realistic was a reduction in emissions of about 1% in 2010 compared to 1990.⁶ Larger firms seem better able to

comply with Kyoto-type requirements than small and medium size firms. If the number of employees is used to weight responses, a 1.7% reduction is feasible. This should be interpreted as an upper boundary on emissions reduction under a policy-as-usual scenario, since it is reasonable to assume that firms that did not respond to our survey are probably less interested in climate change mitigation and are therefore more likely to resist emission-reduction programs. Further, non-responding firms may, on average, be smaller and less able to reduce emissions.

Energy-intensive firms appear better able to meet the target than other firms, although the proportion able to meet the target remains low. If one examines responses on a regional basis, firms in the Maritimes (Newfoundland, New Brunswick, Nova Scotia and Prince Edward Island) and the West (Alberta and BC) feel they are more likely to attain the Kyoto target than firms in central Canada and the Prairies (Manitoba and Saskatchewan), with the proportion able to do so not exceeding 50%. Again firms in central Canada indicated that they were less able to comply with the Kyoto requirements than firms located in the Maritimes and West. This does not bode well for current Canadian policy as the majority of industrial firms are located in Ontario and Quebec.

Measures to control CO₂ emissions

We asked what kinds of specific actions firms are taking or planning to take in order to control their CO₂ emissions (see Table 3). At present,

⁷ We asked respondents to indicate their realistic goals out of six alternatives (>10% increase; 1–10% increase; no change; <5% reduction; 5–7% reduction; >7% reduction). To derive a mean value for the 134 companies that responded to this question, we assigned 'mid-point' values of +10.0% (for >10% increase), +5.0% (1–10% increase), 0% (no change), -2.5% (<5% reduction), -6.0% (5–7% reduction), and -7.0% (>7% reduction).

measures involving transactions such as 'joint implementation' (Grubb *et al.*, 1999) and offset trading are still in their infancy. Hence, we would expect firms to rely mainly on in-house measures that aim to enhance energy efficiency. This is confirmed by the results in Table 3, where in-house actions, namely (a), (c) and (d) in the table, make up 63% of the total counts.

Competitiveness and lobbying

Lastly, we asked how firms perceive reduction of CO₂ emissions in terms of their effect on competitiveness, as well as their willingness to resort to lobbying for concessions (Table 4). Regional differences are critical factors in reaching or upsetting a nation-wide consensus, because of the nature of Canada's federal political system. Firms in Alberta and BC are more likely to see CO₂-emissions reduction strategies as potentially damaging to their competitiveness, internationally and domestically, and are more likely to lobby for concessions.

Table 3. Initiated or planned specific measures to control CO₂ emissions

Measures	Counts ^a	%
(a) Limit or reduce emissions from our own regular, overall operations	74	31%
(b) Enter into partnership with other company(ies), relying on improvements in that company to meet the commitments of both	18	8%
(c) Increase use of biomass	31	13%
(d) Increase use of co-generation	46	19%
(e) Rely on offsets not related to regular activities (e.g. purchase carbon sequestration offsets)	12	5%
(f) Do not know	58	24%
Total	239	100%

^aMultiple choices were allowed.

Table 4. Perceptions about CO₂ emissions reduction: competitiveness and lobbying (mean values)^a

Statements	Maritimes	Central	Prairies	West
If companies in other countries are not forced to meet the same or higher demands to reduce CO ₂ emissions, our competitiveness will erode significantly.	2.86	2.23	2.77	1.69
Reducing CO ₂ emissions will be very costly for our firm compared to others in our industry in Canada.	4.00	3.82	2.78	3.29
Our firm will consider lobbying the government for concessions on when or how we meet CO ₂ emission targets.	3.17	3.60	2.89	2.92

^aThe rating scale is: 1=strongly agree; 2=agree; 3=neutral; 4=disagree; 5=strongly disagree.

V. Probit model estimation results

The probit regression results (using maximum likelihood estimation) are provided in Table 5.⁸ For knowledge about and participation in the VCR program (Models 1, 2 and 3), the dependent variables are binary, while it is categorical for Model 4 (see also Table 1). Model 1 seeks to explain why some firms are more likely to know about the VCR than others, while Models 2 and 3 represent increasing degrees of commitment to voluntary action (letter of intent and filing of an action plan). In contrast, Model 4 seeks to explain the stated ability of firms to achieve emissions reduction, perhaps reflecting the combined effects of technological and economic possibilities and incentives for emissions reduction. The explanatory variables are common to all four models and are defined in Table 1. The binary probit models correctly predict 81%, 87% and 89% of the observations, respectively. For all four models, the hypothesis that all coefficients are jointly equal to zero is rejected at the 1% level of significance by the likelihood-ratio tests.

Firm size positively affects the probability that a firm knows about the VCR program (Model 1), the probability it has submitted a letter of intent (Model 2), and the probability that it has submitted an action plan (Model 3). Size is also positively correlated with higher goals for emissions reduction (Models 4). Similar size effects have also been identified in the literature on corporate environmentalism (Frankel, 1998, Chapter 4; Windatt, 1999), and are confirmed again by this study.

Energy-intensive firms tend to be more knowledgeable about and likely to participate in the VCR

⁸ As suggested by a reviewer, we estimate all models by: (1) including all variables, (2) including only the 'hard' variables, and (3) including only the 'soft' variables. The results when only hard or soft variables are included are similar to those when the hard and soft variables are included in a combined regression, so only the combined results are presented.

Table 5. Model estimations: probit regressions and ordered probit regressions^a

Explanatory variable	Model 1 knowledge about the VCR	Model 2 submission of letter of intent	Model 3 submission of action plan	Model 4 potential for emission
Firm size (employees)	1.00*** (3.84)	1.72*** (5.08)	2.54*** (4.02)	0.46* (1.74)
REGIONAL & SECTOR DUMMY VARIABLES				
Energy-intensive firm	0.57** (2.05)	1.00*** (2.91)	0.89** (1.97)	-0.29 (-1.31)
Transportation sector firm	-0.24 (-0.31)	-6.08 (-0.07)	-6.41 (-0.04)	- ^d -
Central Canada	-0.03 (-0.06)	0.24 (0.32)	5.10 (0.04)	-1.10 (-1.44)
Prairies	1.49** (1.97)	1.03 (1.19)	6.63 (0.05)	-0.99 (-1.20)
West	0.57 (0.91)	0.37 (0.48)	5.60 (0.04)	-0.89 (-1.15)
ATTITUDINAL VARIABLES				
Corporate responsibility	0.21 (1.62)	0.15 (1.01)	-0.03 (-0.14)	0.06 (0.59)
Personal responsibility	0.02 (0.16)	-0.01 (-0.04)	-0.31 (-1.39)	-0.32** (-2.46)
Opposition to modifying environment	-0.11 (-1.05)	-0.05 (-0.40)	0.18 (0.97)	-0.06 (-0.66)
Pessimism about technological change	0.10 (0.80)	0.19 (1.37)	-0.09 (-0.51)	0.17* (1.77)
Competitiveness enhanced by mitigation efforts	0.26* (1.72)	0.03 (0.15)	-0.06 (-0.25)	0.27*** (2.68)
Green benefit to mitigation efforts	0.30 (1.58)	0.36 (1.45)	0.58* (1.74)	0.11 (0.73)
Pressure from environmental groups	-0.24 (-1.18)	0.07 (0.32)	-0.42 (-1.08)	0.25 (1.64)
Pressure from media/communities	-0.39*** (-2.17)	-0.38* (-1.75)	-0.26 (-0.88)	0.28** (2.06)
Pressure from industry association	0.26 (1.57)	0.17 (0.88)	-0.10 (-0.35)	-0.08 (-0.56)
Pressure from government	-0.03 (-0.15)	-0.22 (-1.12)	-0.54*** (-2.01)	0.00 (0.02)
Pressure from financial institutions	0.12 (0.80)	-0.02 (-0.11)	0.37 (1.62)	0.18 (1.45)
Pressure from shareholders/board	0.11 (0.75)	0.15 (0.78)	0.60* (1.81)	-0.03 (-0.17)
Pressure from customers	0.06 (0.34)	0.34 (1.45)	0.26 (0.85)	0.01 (0.04)
Pressure from employees	-0.06 (-0.28)	-0.38 (-1.49)	-0.25 (-0.77)	0.08 (0.35)
Constant	-3.98*** (-3.25)	-4.39*** (-2.86)	-9.76 (-0.07)	0.65 (0.66)
Log-likelihood function	-62.20	-44.34	-27.06	-201.00
Log-likelihood (0)	-94.89	-78.28	-58.47	-223.75
No. classified correctly (Dep.var.=0)	84/96	108/114	122/127	N/A
No. classified correctly (Dep.var.=1)	35/51	20/33	9/20	N/A
R-square (Maddala)	0.36	0.37	0.35	N/A
R-square (Cragg-Uhler)	0.50	0.56	0.63	N/A
Likelihood Ratio test statistics (df)	65.38 (20)	67.88 (20)	62.82 (20)	45.5 (19)
Significance level (Chi-square)	0.00	0.00	0.00	0.00
Observations	147	147	147	134

^aMissing explanatory variables are replaced with means. Asymptotic *t*-statistics are provided in parentheses: *, ** and *** denote, respectively, statistical significance at 10%, 5% and 1% levels. In Model 4 estimation, the number of employees was used as weighting factor.

program (Models 1, 2 and 3), but the (dummy) variable representing energy-intensive firms is not significant in explaining the potential level of emissions reduction (Model 4). This indicates that firms in the energy-intensive sector may not perceive higher opportunities for emissions control than other firms, or that they are unwilling at this time to act upon such opportunities. Energy-intensive firms may simply be involved with the VCR because they want to be seen as good corporate citizens (e.g. concern about public image and to mitigate against possible future tightening of regulations).

With the exception of the dummy variable for the Prairies in Model 1, location does not seem to affect the likelihood that firms participate in the VCR program or their stated ability to reduce GHG emissions.

Attitudinal variables related to the degree of acceptance of corporate and personal responsibility for climate change mitigation (i.e. the responsibility that executives have to ensure that their firms improve their climate change mitigation effort) have limited explanatory power, with no significant coefficients explaining firms' knowledge about or participation in the VCR program. Unexpectedly, personal responsibility for mitigation was (statistically) negatively related to the potential for emissions reduction (Model 4). This result is puzzling. Our tentative explanation is that companies with executives who feel less responsible for mitigation efforts are more likely to give optimistic answers to the question about their firm's ability to reduce CO₂ emissions over the next decade, because they have not seriously considered the costs of doing so. Alternatively, managers who are intimately familiar with their responsibility over mitigation efforts tend to understand the real challenges and are, therefore, more realistic about emissions reduction. An attitudinal variable related to the respondent's view on the relationship between humans and nature (opposition to modifying the environment) also had limited explanatory power.

The variable indicating a pessimistic attitude toward technological solutions to global warming has a significant and positive coefficient only in the model regarding the emissions reduction target (Model 4), as expected. The fact that environmental attitudes do not seem to explain propensity for taking action may reflect the complexities involved with climate change and the high degree of perceived uncertainty surrounding the issue. The only significant variable (pessimism about technological solutions) represents the urgency that managers may feel about reducing GHG emissions

today when they do not expect advances in technology to eventually solve the problems of global warming.

Not surprisingly, the two variables representing the respondents' positive views on the relationship between mitigation efforts and business performance (the enhancing of competitiveness and the green benefit variables) had, in general, statistically significant positive effects in all four models, reflecting the growing recognition among managers of the potentially high economic impact of the Kyoto commitment. Those firms which recognize that by reducing CO₂ and other greenhouse gas emissions their company may reduce costs (e.g. through better utilization of energy) and those firms which see market benefits (e.g. getting a green premium) are more likely to have a higher propensity to reduce greenhouse gas emissions voluntarily. Thus they are also more likely to participate in programs that provide information about emission reduction and help recognize their achievements in addressing environmental concerns.

Perceptions about pressure from environmental groups appear to have a positive effect on the potential for emissions reduction (Model 4), but no effect in explaining knowledge about or involvement in the VCR program. Pressure from the media or the community had a significant negative impact on firms' knowledge about and participation in the VCR program (Models 1 and 2), but a significantly positive impact on the potential for emissions reduction (Model 4). This is consistent with work by Henriques and Sardosky (1999), who, based on a survey of large corporations in Canada, concluded that 'reactive firms view the media as important and proactive firms do not, [because] if an environmental crisis were to occur, reactive firms would not (and proactive firms would) be able to demonstrate due diligence' (p. 95).

As expected, pressure from an industry association has a positive effect on the probability that a firm is familiar with the VCR program (Model 1). Government pressure has a significantly negative relationship to the likelihood of a firm's submission of an action plan (Model 3) and no effect on perceived reduction potentials. It is possible that, since government pressure is more likely to be felt by firms with below average emissions performance, such firms are less likely to identify targeted achievements or see much rationale for voluntary action. It is also possible that the current reliance on education and moral suasion by government to achieve voluntary emissions reduction is not a very effective means for increasing industry efforts.

Pressures from business stakeholders, such as financial institutions, shareholders and the board of directors, are positively correlated with a firm's submission of an action plan. Pressures from customers and employees are not statistically significant in any of the four models.

VI. Conclusions and policy implications

To what extent is Canadian industry prepared to control its CO₂ emissions? While Canada's industrial and fossil fuel production sectors are projected to increase CO₂-equivalent emissions by 31% by 2010 (Natural Resources Canada, 1999), the firms in this study indicated that they could probably reduce emissions by some 1–2% on average. Why then are the sector's emissions projected to rise if action by firms responding to our survey is taken into account in the projections? Clearly, our survey covers only existing firms, and, more particularly, larger firms (>100 employees). Thus, we fail to count emissions from new or growing firms. Further, due to potential sampling biases (firms who have thought about climate change or are familiar with the VCR are more likely to have responded to our survey), this value (a 1–2% reduction) appears to be an optimistic estimate reflecting only an advanced segment of firms in terms of GHG emissions reduction.

On the other hand, because these figures were obtained under current conditions, in the absence of strong regulations or economic policy instruments, these figures may be interpreted as realistic goals under the assumption that firms would invest or operate on a policy-as-usual basis. In terms of specific actions, as shown in Table 3, not many firms in our sample are considering cooperation with other organizations through domestic or international (Clean Development Mechanism or Joint Implementation) offsets. Since there is a wide variance in the level of reduction they regard as realistically achievable at this moment, economic policy instruments such as emissions trading may create opportunities to reduce industrial costs of controlling CO₂ emissions through the equalization of marginal mitigation costs. If so, given effective economic instruments and for our sample of firms, the goal of at least some reduction in CO₂ emissions by 2008–2012 may be a realistic one.

Differences among firms' ability to reduce emissions present opportunities and challenges for policy makers in designing instruments. It is likely

that companies' stated goals reflect the forms of marginal cost functions of CO₂-emissions reduction as expected by managers. If so, opportunities exist to equalize the marginal costs of CO₂-emissions reduction across firms and sectors. But this may result in unequal burden for some firms and/or sectors, which the politicians expressly wish to avoid. Indeed, the Prime Minister and provincial premiers 'agreed that no region should be asked to bear an unreasonable burden as Canada seeks to reduce its greenhouse gas emissions' (Environment Canada, 1998). Yet, this may not be warranted on economic efficiency grounds.

In our survey, we found several patterns of regional and sectoral differences (Table 2). For example, compared with other regions, Alberta and BC have a higher proportion of survey respondents that feel they are capable of reducing CO₂ emissions by more than 5%. However, firms in these provinces see CO₂-emissions reduction as more damaging to their competitiveness and are more willing to lobby for concessions than firms in other regions (Table 4).

A polling firm, COMPAS (1999), conducted opinion surveys in the spring and fall of 1998, asking CEOs or executives of 400 Canadian companies, including service and construction industries, for their responses concerning climate change. The survey's results agree with ours in several respects. For instance, CEOs or executives of firms in BC are more likely to identify possible actions to reduce firms' emissions (COMPAS, 1999:53). Yet, executives of firms in BC and Alberta are less optimistic about the economic impacts that policies for mitigation could bring about (COMPAS, 1999:60).

This may be a reflection of barriers and disincentives that resource-intensive firms, which are dominant in western Canada, face in taking action to reduce emissions. For example, by not allowing forest companies to sell electricity into the BC provincial grid, opportunities for cogeneration have been limited (Forest Sector Table, 1999). The task of policy makers is to discover such barriers and disincentives and reduce or eliminate them in order to utilize CO₂-reduction potentials.

The VCR program has been also the object of some criticism. Most notably, the Pembina Institute (1995a,b, 1996) argues that the voluntary actions reported in this program do not go beyond business-as-usual and policy-as-usual practices of participating firms. Our findings support the Pembina Institute's contention that, at present, the VCR does not contribute to efforts to meet the Kyoto commitment. Specifically, participation in the VCR did not have an impact on the stated realistic

CO₂-emissions reduction potential of firms.⁹ This suggests that firms participate in the VCR program more for political reasons than from concern about the environment. However, it may be too early to judge, at this moment, the effectiveness of the VCR, since the program is still in the process of development.

Our findings about involvement in the VCR program and the stated potential for emission reductions have several further implications. First, firm size is an important constraint in determining a firm's strategy concerning mitigation efforts. Pressures from several institutions have complex impacts on a firm's mitigation efforts. Although pressures from environmental groups and the media or local communities have positive effects on the potential level of GHG emissions reduction, they have negative or no effect on the level of commitment to the VCR program. In contrast, financial institutions and shareholders or boards of directors play significant roles in making deeper commitments to the VCR (e.g. submission of action plans). This may suggest that business stakeholders, such as financial institutions and shareholders or boards of directors, induce specific actions, while institutions in a civil society play important roles in encouraging a firm to seek higher emissions reduction.

If Canada is to stabilize and, finally, reduce its CO₂ emissions in the coming century, it needs to involve all the sectors of its economy. *Action Plan 2000* highlights the importance of the industrial sector in meeting Canada's Kyoto commitment (Government of Canada, 2000:4). How much, then, can the industrial sector contribute to reducing CO₂ emissions, given current policies in Canada? Our general conclusion is that, given current government policies, the industrial sector will not meet the target set by the Kyoto Protocol. The current approach of education and moral suasion, along with voluntary compliance, is unlikely to achieve its aims. Nor are offsetting emissions through carbon sequestration likely to be sufficient (van Kooten et al., 2000).

Then what should Canada do? If Canada is to meet its international obligations, much stronger policy measures to encourage emissions reduction, such as carbon taxes, tradable emission permits or regulation, are likely needed. Other than introducing a large carbon tax and other tough regulatory

measures, Canada can use domestic and international cooperative mechanisms to minimize the costs of reducing the CO₂ emissions of Canadian industry as a whole. Such mechanisms may include establishing partnerships with other organizations and trading carbon offsets. Those measures have not been fully considered by the majority of companies in our survey, perhaps because a formal framework for such mechanisms has not yet been fully developed. Afforestation of agricultural lands may be a promising way to achieve this goal in the Canadian context, although its effectiveness is limited (van Kooten, 2000).

Another possibility is to encourage firms to make deeper commitments by applying pressure via appropriate stakeholders. For example, financial institutions, shareholders and board of directors may be able to exert significant influence on firms' behaviour by pressuring managers to consider ways to go beyond their current assessment of what can be accomplished realistically. Designing incentives that lead these stakeholders to exert more influence on firms' climate change policy than now may not be easy, however.

While we have interpreted our results with caution, it is important to point out some of the limitations of our study. The response rates of different segments of the population studied varied significantly. Smaller firms were underrepresented. Generally it can be assumed that those responding have higher interest and knowledge of the issue than non-respondents. In analyzing, for example, the assessment by firms of their potential in reducing emissions, the aggregate estimate obtained should be regarded as a very optimistic assessment. While our analysis suggests that the use of 'soft' variables improves the explanatory power of our models, the measurement of these variables is not as reliable as the measurement of the economic variables. Finally, as with any study, there are variables not included in the study which could improve explanation. For example, we found that size of firms is significant in all the models and have interpreted it as due to economies to scale, but it is possible that market structure (reflected in sizes of firms) is the cause of behaviour. Indeed, one would expect different behaviour in oligopolistic than in competitive markets.

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⁹We re-estimated Model 4, adding the dummy variable for VCR participation (letter of intent) first as an exogenous and then endogenous variable, using OLS regression (see Heckman, 1979; Greene, 1981). In both cases (results not shown here), the VCR participation dummy was not significant at a 10% level.

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