Why Do Democracies Exit International Agreements? The Role of Information in International Cooperation on Climate Change*

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Abstract

In December 2011, the Canadian government decided to officially withdraw from the Kyoto Protocol on climate change. While this decision has been expected by some negotiators and policy-makers, it poses an interesting question for political-economic theories of international cooperation: Why do governments exit international agreements that they previously committed to on a voluntary basis? Without a supranational enforcement power at the international level, no country can be forced to participate in an international treaty, and agreements must be self-enforcing. However, international cooperation becomes vulnerable to withdrawal as soon as governments and, even more so, domestic electorates learn about the true benefits from cooperation. While cooperation may be a reasonable choice *ex ante*, this may change after an informational shock occurs. When payoff uncertainty disappears, *ex post* cooperation benefits may be much lower than they were initially believed to be. With highly skewed benefit distributions, countries at the lower end of the distribution are suddenly better off as free-riders. If voters know about this benefit distribution, they back their national governments in exiting international agreements. This theory rationalizes the Canadian government's behavior with the Kyoto Protocol.

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1 Introduction

Right after last year's climate negotiations in Durban have ended on December 9, 2011, Peter Kent, the Canadian Minister of the Environment, announced that Canada is "invoking [its] legal right to formally withdraw from [the] Kyoto [Protocol]".[1] While each member to the Protocol has the legal right to exit the agreement in accordance with Article 27(1), the Canadian decision is remarkable in two respects.

First, even though the Kyoto Protocol, as the flagship agreement on climate change, has been highly contested, it is surprising that a developed economy and advanced democracy is the first state to renege on its commitments. This challenges the notion that material wealth (Dasgupta et al., 2002; Inglehart, 1997; Diekmann and Franzen, 1999) and democratic institutions (Congleton, 1992; Mansfield, Milner, and Rosendorff, 2002) are conducive to international cooperation. Second, one may ponder why the Canadian government initially ratified the Kyoto Protocol at all when they ultimately decided to withdraw. This is the more puzzling as the Canadian government could have put Kyoto to an early end after the US administration under President Bush in 2002 decided not to ratify the treaty. Without Canada's explicit consent, the Protocol could not have entered into force because the minimum participation clause would not have been met. Against the backdrop of this *de facto* veto power, this paper examines how a democratic government's incentives for international cooperation are shaped by their domestic electorate's information about cooperation benefits.

Following the rational design literature (Koremenos, Lipson, and Snidal, 2001), the standard view on international cooperation through formal agreements is that countries sign international treaties only if they benefit from doing so. In contrast to national law, no authoritative institution at the international level exists that can enforce negotiated commitments (Keohane, 1984; Abbott and Snidal, 1998). Due to national sovereignty, international cooperation is voluntary, and remaining an outsider to an international treaty is always an option. Hence, to effectively deter non-participatory free-riding, international agreements need to be *self-enforcing* (Barrett, 1994).

No matter if the lack of deep international cooperation is explained by the countries' unwillingness to ratify commitments far off the unilateral equilibrium point(Downs, Rocke, and Barsoom, 1996), by insufficient managerial capacities (Chayes and Chayes, 1993), or by tough bargaining because of expectedly

[1] "Canada First Nation to Withdraw from Kyoto Protocol", *The Star*, 12 December 2011. See `http://www.thestar.com/news/canada/politics/article/1100802`. Accessed, 12 April 2012.

rigid enforcement (Fearon, 1998), most theories of international cooperation assume that benefits from cooperation are constant over time or are known to the cooperating actors. In the context of the introductory example of climate change, for instance, this assumption of certain cooperation benefits seems far-fetched. The world's climate is a fragile system whose physical dynamics are still insufficiently understood (IPCC, 2007), and benefits from climate cooperation are known to accrue in a highly asymmetric manner around the globe (Nordhaus, 2010).

By relaxing this informational assumption, this article explores how uncertainty of and learning about payoff distributions affect international cooperation over a global public good. Intuitively, one may expect that better information about cooperation benefits makes international agreement easier. This is, however, not the case when governmental cooperation decisions are strategically interdependent. As soon as country benefits are intertwined through positive externalities, non-cooperation becomes an attractive choice when the optimal provision of global public goods becomes prohibitively costly. Therefore, with a highly skewed benefit distribution, international cooperation is more likely to break down when governments are *better* informed about their cooperation benefits than when they lack knowledge about the distributional consequences from cooperation (Kolstad, 2005; Kolstad and Ulph, 2011).

This negative information effect is even more prevalent for democratic than for autocratic governments. In democratic countries, the *ex ante* level of cooperation is higher because uninformed domestic electorates constrain their national leaders' leeway (Milner, 1997; Dai, 2005, 2006). However, as voters learn that cooperation is more costly than they initially thought, they will back their government in withdrawing from international cooperation. Thus, the logic of higher domestic accountability in democracies can cut both ways if a dynamic notion of learning about the payoffs from cooperation is considered. This distinctively informational story, which is the major contribution of this paper, may also shed light on the often found discrepancy between highly cooperative behavior among democracies at the ratification stage, but a much dimmer implementation record (Baettig and Bernauer, 2009; Neumayer, 2002; Barrett and Graddy, 2000). This mismatch, I would argue, results from gradually learning about the true distribution of cooperation benefits over time.

2 International Cooperation and Domestic Politics

When governments negotiate at the international bargaining table, they certainly care about cooperation benefits as such, but they also consider the implications of these agreements for their domestic arena (Putnam, 1988). In the above example of climate change, for instance, ratifying and implementing the Kyoto Protocol confers benefits from reduced global greenhouse gas emissions and may ultimately slow global warming. It, however, also entails additional regulatory costs for firms and consumers. The emissions trading scheme in Europe, as a consequence of the Kyoto Protocol, is but one example for such regulatory costs.

Consuming cooperation benefits is attractive as, once provided, they generously spread around the world. This non-rivalry condition, however, also makes it difficult to provide global public goods in the first place (Barrett, 2007; Sandler, 2004). Having access to these benefits that were provided by others without contributing oneself is the even more appealing choice. Notwithstanding that international cooperation may be easier to strike when treaty targets vary across countries (Gilligan, 2004), when country asymmetries are leveraged (McGinty, 2007), or side-payments are introduced (Barrett, 2001), collective action problems, be it due to non-compliance or free-riding, impede international cooperation even if institutionalized solutions such as international treaties exist.

While cooperation benefits certainly shape incentives for international cooperation, domestic politics have increasingly been shown to matter a great deal, even beyond the distribution of cooperation payoffs. Since international treaties call for domestic implementation, national electorates are empowered to constrain their leaders at the international level (Iida, 1996; Mo, 1995; Tarar, 2005). Dai (2005), for instance, shows that in democracies well-informed domestic interest groups with high electoral leverage can induce domestic governments to comply with costly international regulation. Similarly, Svolik (2006), Chapman (2007), or Fang (2008) argue that democracies cooperate more than autocratic regimes as international commitments allow office-seeking governments to convey information about governmental performance to their constituencies. On a slightly different note, democratic governments that renege on their international agreements may suffer costs at the ballot box (Fearon, 1994; McGillivray and Smith, 2000) and can, therefore, more credibly signal to cooperate internationally. Hence, democratic institutions, it is often argued, are conducive in garnering international cooperation.

By examining the informational assumptions in greater depth, this paper provides a more nuanced per-

spective on the relationship between international cooperation and domestic politics. Extending a classic model of international agreement making (Barrett, 1994) to account for (i) benefit asymmetries, (ii) payoff uncertainty, and (iii) electoral competition, democratic countries are indeed found to cooperate more than autocratic countries – this finding is, however, conditional on the national voters to be badly informed about the true payoff distribution from cooperation. As soon as voters learn about the benefits from cooperation, international cooperation breaks down if the benefit distribution is not sufficiently homogenous. Conditional on the benefit distribution being highly skewed, the likelihood of democracies to cooperate *decreases* as voter information *increases*. This theoretical model rationalizes the Canadian government's withdrawal from the Kyoto Protocol.

3 An Informational Model of International Cooperation

Building on the economic literature on international environmental agreements (Carraro and Siniscalco, 1993; Barrett, 2003), I model international cooperation as a participation game for the provision of a global public good. For this, I assume there to be two countries A and B, each of which consists of a national government and a domestic electorate.

The game proceeds in three stages, where national governments, in the first round, need to decide if they want to cooperate in the provision of the global public good. In the case of international (environmental) agreements, for instance, cooperation is often conceptualized as domestic ratification of the treaty text (Fredriksson, Neumayer, and Ujhelyi, 2007; von Stein, 2008; McLean and Stone, 2012). In the second stage of the game, governments decide on how much of the public good they provide, conditional on participation behavior in the previous round. In the context of the Kyoto Protocol, governments take their abatement decisions in committing to reduce greenhouse gas emissions. Finally, voters take their reelection decision in the third stage of the game. This last stage is crucial as "[t]he electoral process is an instrument which, through the threat of non-reelection, can be used to induce the officeholder to select a value of public output which is closer to [the voters' ideal point]" (Barro, 1973, 26-27). By accounting for this domestic politics dynamic, my model goes beyond what is standard in existing economic models of international environmental agreement-making (Barrett, 1999). Throughout the paper, I refer to the first stage as *participation stage*, the second stage as *abatement stage*, and the third one as *voting stage*.

For each of the governments in the two countries A and B, I assume the governmental utility function, G_i, to be given as

$$G_i(q_i, q_{-i}, \theta_i, T_i) = b\theta_i Q - \frac{1}{2}cq_i^2 + \tau_i r_i p(q_i, T_i) \quad \text{with } i \in \{A, B\}, \tag{1}$$

where $b, c > 0$ are strictly positive benefit and cost parameters, and q_i and q_{-i} are abatement levels in countries i and $-i$, with aggregate abatement, $Q = q_i + q_{-i}$. To induce uncertainty about how beneficial abatement is going to be, θ_i, is a state-specific realization of a random draw from a uniform distribution. This parameter integrates the notion into the model that insufficient information about the true state of the world makes it difficult to assess how strong the benefits from international cooperation are (Kolstad, 2005). Consider the example of climate change. No matter if this uncertainty about abatement benefits is believed to come from its conceptualization as counterfactual outcomes (Kolstad and Toman, 2005), physical uncertainties in the climate system (King, 2005; IPCC, 2007), or non-marginal discounting of long-term benefits (Weitzman, 2007; Dietz and Stern, 2008), it seems appropriate to assume that countries A and B cannot pinpoint the exact benefits from cooperation on climate mitigation.

Apart from these cost and benefit components, the governmental utility function also captures political dynamics. For this, the regime type parameter, $\tau_i \in [0, 1]$, categorizes countries, at the extreme ends, into autocracies, $\tau = 0$, and democracies, $\tau_i = 1$, while r_i represents office spoils. Finally, $p(q_i, T_i)$ denotes the probability of reelection, which is a function of the abatement policy, q_i, a government sets and the national electorate's reference point, T_i.

Drawing on the spatial model of politics (Downs, 1957; Hinich and Munger, 1997; Schofield, 2010), I model the national electorate's utility function as a negative quadratic utility function with a stochastic component. For each country i, this function V_i can formally be described as

$$V_i(q_i, T_i) = -(q_i - T_i)^2 + \epsilon_i \quad \text{with } i \in \{0, 1\}, \tag{2}$$

where q_i corresponds to the abatement policy set by the national government and T_i denotes the voter's reference point against which they hold the national government accountable. The stochastic error terms ϵ_i are independent across countries i and a drawn from an identically distributed univariate normal density with

a zero mean and variance σ^2. Modelling a random error into the voters' utility function captures incomplete information about how policy choices translate into voter utility. With the above distributional assumption, $\epsilon_i \sim_{iid} \mathcal{N}(0, \sigma^2)$, the random utility framework allows me to derive reelection probabilities, p, which are characterized as

$$p(q_i, T_i) = Pr[(q_i - T_i)^2 \leq \epsilon_i] = 1 - \Phi\left(\frac{(q_i - T_i)^2}{\sigma}\right), \tag{3}$$

where $\Phi\left(\frac{(q_i - T_i)^2}{\sigma}\right)$ denotes the cumulative distribution function of a univariate normal with zero mean and variance σ^2, evaluated at the point $(q_i - T_i)^2$.

Substantively, the national electorate's utility function captures the notion that voter utility is decreasing in the distance between the implemented policy q_i and the voters' reference point T_i. The further away the reduction policy is from what voters want to see implemented by their governments, the less vote support the national leaders can hope for.[2] This implies that choosing a policy that is identical to the voters' reference point, maximizes expected reelection probabilities for the government. In fact, with $q_i = T_i$, expected reelection probability is 50%, which, at least in expectation, is sufficient for the government to get reelected. Note, however, that reelection is based on voter utility V_i and not policy choice q_i because the particular policy is inherently unobservable for the domestic electorate. Hence, even with $q_i = T_i$ reelection is never deterministic.

3.1 Equilibrium Characterization

To derive the equilibrium characterization for the two-player abatement game with domestic politics I apply backward induction to find subgame perfect Nash equilibria for the complete stage game. With payoff functions from equations (1) and 2, reelection probabilities from equation (3) can be directly substituted into the governmental utility function, G_i. Governments know, at least in expectation, what their reelection chances are with performance-based voting in their utility-maximizing domestic electorate.[3]

[2] No matter if abatement levels lie above or below T_i, as long as the relative distance between any q_i and T_i is identical, the model generates identical expected reelection probabilities. Since the voters' reference point, T_i, is derived endogenously from a maximization condition, there is no reason why, from a welfare perspective, too little or too much abatement relative to T_i should be preferable.

[3] Voters are non-strategic in that they do not consider strategic repercussions of their vote choice on international governmental cooperation. Instead, they maximize their domestic utility which features no utility component from international cooperation. No matter how simplifying this assumption may be, it is standard in the literature (e.g., Morrow, 1991; Milner and Rosendorff, 1997; Mansfield, Milner, and Rosendorff, 2002) and allows domestic preferences to be treated as constraints. See Pahre (1997) and Bechtel and Urpelainen (2011) for two remarkable exceptions who consider fully strategic behavior at the subnational level. Their

This simplifies the game-theoretic analysis as an equilibrium is characterized by each government's cooperation decision at the participation stage and their abatement decision at the abatement stage. Since participation is conditional on emission reductions in the second stage of the game, I consider the abatement stage first. Let us assume that governments A and B did decide to *not cooperate* in the first round. Then, each government i knows that the other government $-i$ plays a non-cooperative strategy that maximizes individual benefits and is denoted by q_{-i}^{*N}. Under such conditions, the positive externalities from climate abatement are not sufficiently internalized and the global public good is underprovided. With continuous and non-negative abatement levels for both countries i, the optimal individual abatement q_i^{*N} in the unilateral Nash equilibrium is the solution to the following simultaneous maximization problem

$$\max_{q_i \in \mathbb{R}_{\geq 0}} G_i(q_i, q_{-i}^{*N}, \theta_i, T_i) = \max_{q_i \in \mathbb{R}_{\geq 0}} b\theta_i(q_i + q_{-i}^{*N}) - \frac{1}{2}cq_i^2 + \tau_i r_i \left(1 - \Phi\left(\frac{(q_i - T_i)^2}{\sigma}\right)\right) \text{ with } i \in \{A, B\}. \tag{4}$$

This solution consists of a set of orthogonal best-response functions[4], which are implicitly characterized by the first-order conditions, given as

$$b\theta_i - cq_i - \frac{2\tau_i r_i}{\sigma}(q_i - T_i)\phi\left(\frac{(q_i - T_i)^2}{\sigma}\right) = 0 \quad \forall\, i \in \{A, B\}, \tag{5}$$

where $\phi\left(\frac{(q_i - T_i)^2}{\sigma}\right)$ denotes the probability density function of a normal distribution with zero mean and variance σ^2, evaluated at the point $(q_i - T_i)^2$. Due to the orthogonality of best responses, q_i^{*N} and q_{-i}^{*N} form a non-cooperative Nash equilibrium at the abatement stage.[5] In equilibrium governments A and B balance *environmental marginal benefits*, $b\theta_i$, and *political marginal benefits*, $\frac{2\tau_i r_i}{\sigma}(q_i - T_i)\phi\left(\frac{(q_i - T_i)^2}{\sigma}\right)$, with marginal costs, cq_i.

To further examine institutional consequences in the non-cooperative equilibrium, consider Figure 1 below. For $q_i^{*N} < T_i$, the figure schematically illustrates the difference between the unilaterally optimal

focus is, however, on domestic parties and subnational governments, respectively, which are more likely to act strategically with respect to the international outcomes than the national average voter.

[4] Orthogonality follows immediately from the linearity of benefits in the governmental utility function.

[5] Since marginal costs cq_i with $c > 0$ are strictly increasing in q_i towards $+\infty$, the intermediate value theorem ensures the existence of a solution. With $q_i \leq T_i$, marginal benefits asymptotically approach $b\theta_i$ from above, no matter if $q_i \to 0^+$ or $q_i \to T_i^-$. For $q_i > T_i$ and $q_i \to T_i$ marginal benefits tend towards $b\theta_i$, while they tend towards zero for $q_i \to +\infty$. Since marginal benefits do not grow towards $+\infty$, while marginal costs do, there must be an intersection between the marginal costs and the marginal benefits curve. This concludes the existence proof.

abatement levels for an autocratic government, $q_i^{*N}(\tau_i = 0)$, and a democratic government, $q_i^{*N}(\tau_i = 1)$.[6] While autocratic governments do not derive utility from implementing policies that are close to the voters reference point T_i, an autocratic leader sets an optimal policy such that it balances environmental marginal benefits and marginal costs from reducing emissions. With democratic institutions, however, governmental leaders have incentives to not only consider environmental realities, but also target policies to their domestic electorate's preferences. This is why abatement levels for democracies with positive benefits from holding office, $r_i > 0$, are always closer to the national voters' reference point, T_i, than autocratic policies.

[Figure 1 about here.]

As illustrated in Figure 1, it is rational for a democratic government to increase abatement levels beyond that point at which marginal environmental benefits and marginal costs balance. By setting higher abatement policies, the democratic government can increase its chances of getting reelected. In fact, the government raises abatement up to that point at which the *sum* of marginal environmental and marginal political benefits are equal to marginal costs.[7] Qualitatively, this equilibrium condition shows that domestic voters can constrain their national governments if these are sufficiently accountable (Fearon, 1999; Dai, 2005, 2006).

If instead of non-cooperation at the participation stage, governments are able to play cooperatively, a collectively rational Nash equilibrium prevails. For this, both governments A and B maximize group welfare G, which is defined as the sum of the utilities from abatement in both countries. Mathematically, we have

$$G(q_i, q_{-i}, \theta_i, \theta_{-i}, T_i, T_{-i}) = \sum_i G_i(q_i, q_{-i}, \theta_i, T_i). \tag{6}$$

As in the previous case of non-cooperative utility maximization, a Nash equilibrium consists of a set of collectively rational abatement levels, q_i^{*C} and q_{-i}^{*C}, which are solutions to the following simultaneous maximization problem for both countries $i \in \{A, B\}$

$$\max_{q_i \in \mathbb{R}_{\geq 0}} G(q_i, q_{-i}^{*C}, \theta_i, \theta_{-i}, T_i, T_{-i}) = \max_{q_i \in \mathbb{R}_{\geq 0}} \sum_i G_i(q_i, q_{-i}^{*C}, \theta_i, T_i) \qquad \text{with } i \in \{A, B\}. \tag{7}$$

[6] With $q_i^{*N} > T_i$, marginal political benefits would be negative, so that democratic governments have incentives to reduce their abatement levels in equilibrium compared to autocratic equilibrium policies. As in the opposite case with $q_i^{*N} < T_i$, optimal abatement levels in democracies are closer to the domestic voters' reference point, T_i, than in autocratic regimes.

[7] Algebraically, we get $\frac{\partial^2 G_i(q_i = q_i^{*N}(\tau_i = 1))}{\partial q_i^2} < 0$, which is a sufficient condition for a local maximum (de la Fuente, 2000).

Taking first-order partial derivatives, this gives rise to an almost identical set of first-order conditions compared to the non-cooperative case above. In equilibrium, the implicit characterization of the cooperative and non-cooperative abatement levels only differs with regard to marginal environmental benefits. Mathematically, cooperative first-order conditions are given as

$$b(\theta_i + \theta_{-i}) - cq_i - \frac{2\tau_i r_i}{\sigma}(q_i - T_i)\phi\left(\frac{(q_i - T_i)^2}{\sigma}\right) = 0 \quad \forall\, i \in \{A, B\}, \tag{8}$$

where environmental marginal benefits, $b(\theta_i + \theta_{-i})$, are strictly larger than under non-cooperation. This result is unsurprising as with collective utility maximization, the positive externalities from abatement action are fully internalized. In determining optimal abatement levels, government A not only considers its own benefits, $b\theta_A$, from reducing emissions, but also recognizes the benefits, $b\theta_B$, that accrue in country B. This ensures the optimal provision of a global public good (Samuelson, 1954), which is always higher than under unilateral utility maximization.[8] As before, strategic best responses are still orthogonal, so that q_i^{*C} and q_{-i}^{*C} form a collectively rational Nash equilibrium. Moreover, the above described institutional variation across autocratic and democratic regime types still holds true in the collective Nash equilibrium. The only difference is that marginal environmental benefits are shifted from $b\theta_i$ to $b(\theta_i + \theta_{-i})$, but the logic remains entirely intact.

Now that equilibrium behavior at the abatement stage has been determined as cooperative play with (q_i^{*C}, q_{-i}^{*C}) if countries participate and as non-cooperative play with (q_i^{*N}, q_{-i}^{*N}) if countries do not participate, the participation decision in the first stage of the game can be derived. Since international cooperation cannot be enforced due to the sovereignty of the cooperating countries, I draw on an equilibrium concept that reflects this feature of international agreement-making. Carraro and Siniscalco (1993) and (Barrett, 1994) argue that cooperation in international environmental agreements is only stable if both countries A and B have an *individual* incentive to join the agreement.[9] For this, the participation condition requires that

[8] From comparing first-order conditions, it is easy to see that $q_i^{*N} < q_i^{*C}$ for both $i \in \{A, B\}$ as long as the other country's benefits are strictly positive, $\theta_{-i} > 0$.

[9] This internal-external stability concept originates from work in the industrial organization literature (D'Aspremont and Gabszewicz, 1986) and requires two conditions to be true. First, no member from inside the set of cooperators must have an incentive to exit this coalition (internal stability). And second, no player from outside the set of cooperators must have an incentive to join the coalition (external stability). In my two-country case, however, the external stability condition is necessarily void as the minimal coalition consists of both countries.

for each country $i \in \{A, B\}$

$$G_i(q_i^{*N}, q_{-i}^{*N}, \theta_i, T_i) \leq G_i(q_i^{*C}, q_{-i}^{*C}, \theta_i, T_i) \tag{9}$$

holds. If this condition is met for both countries, their individual payoffs from collectively providing the global public good is weakly higher than their payoffs from non-cooperation. Under such conditions, an international agreement is self-enforcing and no authority is needed to enforce abatement levels that are consistent with collective welfare maximization. This participation condition together with optimal abatement levels for cooperation and non-cooperation fully characterize the subgame perfect Nash equilibrium in the complete stage game.

3.2 The Role of Information

As is evident from the first-order conditions above, optimal abatement levels q_i^{*N} and q_i^{*C} depend on the information parameter θ. This parameter comes from a uniform distribution on the unit interval, is independent and identically distributed across countries A and B. Substantively, it captures uncertainty about how beneficial climate abatement turns out to be. In order to examine the impact of payoff uncertainty for international cooperation, actors can either take decisions *before* they learn about the true value of θ or *after* they know this realization. In the first informational scenario, which I refer to as *ex ante uncertainty*, actors are fully ignorant about the true state of the world and therefore can only maximize utility in expectation. In the second case, which I call *ex post uncertainty*, players know their abatement benefits for sure; no uncertainty prevails in this informational scenario.

Since my model comprises national governments and domestic voters as two distinct player types, I speak of *ex ante* uncertainty when none of the players knows the realization of the random variable θ_i; I speak of *ex post* uncertainty when all four players are certain what abatement benefits look like; and finally I refer to a situation in which governments know the true state of the world, but voters do not know it as *partial ex ante uncertainty*. Moreover, I assume that any actor, who knows its own realization of the true state of the world, also knows the realization of the true state in the other country – even though realizations are different across countries. I denote realizations of the random variable θ_i with a superscript, θ_i^0, to indicate the difference between the random variable and a particular instantiation of it.

Since the main difference in cooperative and non-cooperative abatement levels comes from the difference in marginal environmental benefits, the *distribution* of θ_i^0 and θ_{-i}^0 crucially shapes each actor's abatement decision. For the cooperative equilibrium to be sustainable the cooperative and the non-cooperative strategies must be too different in equilibrium. If the cooperative strategy q_i^{*C} requires a low benefitting country to substantially increase abatement beyond the unilaterally optimal level, cooperation becomes too costly relative to the small benefits from cooperation. This induces international cooperation to break down. For this result to come about the benefit distribution has to be skewed, but at the same time all actors need to know about this asymmetry in payoffs. The core insight that will be derived below is that for democracies better information may impede international cooperation if the distribution of abatement benefits is not sufficiently homogenous. I now discuss the influence of the above described informational scenarios on international cooperation in turn.

3.2.1 Ex ante Uncertainty

With *ex ante* uncertainty, all actors take decisions before the true state of the world is revealed. In this incomplete information setup, I assume domestic voters to set their reference point $T_i = \gamma$ for both countries $i \in \{A, B\}$, where $\gamma \equiv \frac{b}{c}$. The appendix shows that this result can be easily derived when domestic voters play a standard international environmental agreements game *without* accounting for domestic politics.[10] This assumption endogenizes the choice of T_i. It can be rationalized as voters are only concerned with the environmental cooperation problem at hand and set their reference point such that, given their own information level, the environmental resource is optimally managed.

When voters set $T_i = \gamma$, governments A and B chose cooperative abatement levels $q_i^{*C} = \gamma = q_{-i}^{*C}$ because this equilibrium strategy maximizes reelection chances and balances environmental benefits and costs at the same time. Therefore, governments in both countries i can perfectly satisfy the environmental and the political constraint in their utility functions G_i. This implies that under *ex ante* uncertainty voter preferences and governmental preferences are perfectly aligned and there is no trade-off for the government in setting optimal policy. This allows me to formulate the following first proposition.

[10] Technically, national voters are assumed to play a baseline game that is mathematically identical to the one played by autocratic regimes.

Proposition 1. *In my two-country abatement model with domestic voters and ex ante uncertainty, the two governments A and B always form a coalition if it holds that the voters' reference point is identical to $T_i = \gamma$. In equilibrium, they choose the same optimal cooperative abatement strategies $q_A^{*C} = \gamma = q_B^{*C}$ to maximize expected utility for governments and voters. Aggregate abatement is identical to $Q^{*C} = 2\gamma$. This result is independent of political differences across countries; it holds, in particular, for any $\tau_i \in [0, 1]$.*

Proof. *See Appendix.*

This proposition reveals two important insights. First, international cooperation can always be sustained in the *ex ante* uncertainty scenario. This results from the fact that with incomplete information about the realization of the true state of the world, the governmental preferences in countries A and B are identical *ex ante*. Even though governments know that their marginal benefits will differ *ex post*, *ex ante* uncertainty homogenizes governmental preferences and induces international cooperation.[11]

Second, the cooperative Nash equilibrium (q_i^{*C}, q_{-i}^{*C}) is played independent of regime type. This finding is reasonable as under *ex ante* uncertainty, preferences of national voters and governments are perfectly aligned. The environmental problem is identical for all actors, and therefore equilibrium behavior is invariant with respect to regime type.

3.2.2 Ex post Uncertainty

When the true realizations of θ_i^0 and θ_{-i}^0 are common knowledge to the governments and domestic voters alike, international cooperation can break down when the benefit distribution is heavily skewed. This argument is not only reflected in governmental equilibrium behavior, but also in the domestic voters' choice about their reference level T_i. The appendix again derives that voters set T_i such that

$$T_i = \begin{cases} \theta_i^0 \gamma & \text{if } \sqrt{2}\theta_i^0 < \theta_{-i}^0 \\ (\theta_i^0 + \theta_{-i}^0)\gamma & \text{if } \theta_i^0 < \theta_{-i}^0 \leq \sqrt{2}\theta_i^0 \end{cases} \tag{10}$$

[11] Barrett (2003), for instance, showed that international cooperation with two symmetric countries will always be sustainable. The major difference between his and my work is, however, that in Barrett's model the symmetry of countries comes from an assumption, while in my case it results from the informational specification.

holds. With complete information voters do understand that the cooperative strategy $q_i^{*C} = b(\theta_i^0 + \theta_{-i}^0)$ can get prohibitively costly. IF cooperative behavior and the required higher abatement levels drive up abatement costs beyond a critical point, non-cooperation is the utility-maximizing choice for the country with the lower benefits. In essence, fully informed voters do not hold their governments accountable to a cooperative standard if they know that cooperation is excessively expensive. This rationale is taken up in how voters set T_i under *ex post* uncertainty. Cooperation is the preferred choice as long as the benefit distribution is sufficiently homogeneous and θ_{-i}^0 falls inside the interval $(\theta_i^0, \sqrt{2}\theta_i^0]$. Without loss of generality, I assume $\theta_A^0 < \theta_B^0$ and derive the second proposition as follows.

Proposition 2. *In my two country abatement model with domestic voters and ex post uncertainty, the two governments A and B with $\theta_A^0 < \theta_B^0$ only form a coalition if $\theta_B^0 \leq \sqrt{2}\theta_A^0$. In such a cooperative Nash equilibrium with voter reference points $T_A = (\theta_A^0 + \theta_B^0)\gamma = T_B$, optimal abatement strategies $q_A^{*C} = (\theta_A^0 + \theta_B^0)\gamma = q_B^{*C}$ are identical and total abatement is equal to $Q^{*C} = 2\gamma(\theta_A^0 + \theta_B^0)$. If $\sqrt{2}\theta_A^0 < \theta_B^0$ holds and if the voter reference points are $T_A = \theta_A^0\gamma$ and $T_B = \theta_B^0\gamma$, cooperation fails and optimal abatement strategies are $q_A^{*N} = \theta_A^0\gamma$ and $q_B^{*N} = \theta_B^0\gamma$. Total abatement in such a non-cooperative Nash equilibrium is $Q^{*N} = \gamma(\theta_A^0 + \theta_B^0)$. These results are independent of political differences across countries; they hold, in particular, for any $\tau_i \in [0, 1]$.*

Proof. *See Appendix.*

The quintessential reading of this proposition is that with complete information international cooperation can only be sustained when the two countries A and B are sufficiently similar in their abatement benefits. Since there is no informational heterogeneity between governments and domestic voters, preferences are again perfectly aligned. The action which is optimal given environmental benefits and costs is also backed by domestic voters. If the government in country A with lower benefits finds it rational to exit international cooperation and plays $q_A^{*N} = \theta_A^0\gamma$ because $\sqrt{2}\theta_A^0 < \theta_B^0$, then national voters support this policy according to equation (10). In this *ex post* uncertainty equilibrium voters do not favor international cooperation if it is not in the government's interest. As a punchline, better information about the distribution of abatement benefits undermines global public good provision when this benefit distribution is heavily skewed. This result is again invariant to regime type as governmental and voter preferences match perfectly.

3.2.3 Partial ex ante Uncertainty

Finally, I consider an information scenario in which national governments are informed about the true state of the world and know θ_A^0 and θ_B^0, while voters are uninformed. In this partial *ex ante* uncertainty world, domestic electorates set $T_i = \gamma$, which reflects their lack of knowledge about the realizations of the random variables θ_i and θ_{-i}. This scenario seems highly relevant for two reasons. First, governments have access to specialized departments and are therefore more likely to be better informed about the expected benefits from cooperation than domestic voters. Second, in contrast to the previous two cases, informational heterogeneity between governments and voters induces these actors' preferences to diverge. With these informational assumptions, I can derive the following third proposition.

Proposition 3. *In my two country abatement model with domestic voters and partial ex ante uncertainty, the two governments A and B with $\theta_A^0 < \theta_B^0$ cooperate even for θ_B^0 outside the interval $(\theta_A^0, \sqrt{2}\theta_A^0]$ if political cooperation benefits are large enough, such that $G_i(q_i^{*C}, q_{-i}^{*C}; \theta_i^0, T_i) - G_i(q_i^{*N}, q_{-i}^{*N}; \theta_i^0, T_i) \geq 0$ holds for both countries i. The likelihood for cooperation is ceteris paribus increasing in the countries' political characteristics $\tau_i \in [0, 1]$ and reelection benefits $r_i > 0$.*

Proof. *See Appendix.*

This proposition proves that as soon as the levels of information between governments and voters differ, democratic governments are willing to cooperate for parameter sets that are strictly larger than those for autocratic regimes. So even if a democracy would find cooperation not to be the utility maximizing choice given environmental benefits and environmental costs alone, cooperation can be sustained as long as political benefits from cooperation are high enough. Hence, if democratic governments value being in office sufficiently much, they are willing to target policies towards their domestic voters' preferences. Political accountability towards a domestic audience makes international cooperation easier to achieve under partial *ex ante* uncertainty.

Comparing Propositions 2 and 3 demonstrates that the likelihood for democracies to cooperate decreases with increasing levels of information. When voters are uninformed about the true state of the world, the partial *ex ante* uncertainty equilibrium shows that cooperation is possible for parameter values for which cooperation is not sustained were the voters fully informed. If the benefit distribution is highly skewed, but

voters do not know this, they hold their domestic governments accountable to an ambitious cooperative standard; democratic governments respond to this claim, and cooperation prevails. As soon as national voters acquire information about the benefits from cooperation, two outcomes are possible. Cooperation continues if cooperation benefits are homogeneously distributed, while cooperation breaks down if countries benefit in a highly asymmetric fashion. Hence, cooperation behavior is shown to be conditional on the benefit distribution, domestic institutions, and an electorate's information level about payoffs from cooperation.

4 Evidence from the Canadian Withdrawal

The Canadian government's recent withdrawal from the Kyoto Protocol illustrates my theoretical argument. With the Canadian ratification of the Kyoto Protocol in 2002 under the Liberal government of Prime Minister Chrétien, Canada committed itself to bring down greenhouse gas emissions by six percent against a 1990 baseline. The just recently published National Inventory Report on greenhouse gas emissions shows, however, that emissions of 692 megatons in 2010 lie 16 percent above 1990 levels, and almost 24 percent above Canada's Kyoto target of reducing emissions to about 558 megatons per year by 2012.[12]

This flagrant form of ongoing non-compliance and free-riding reflects the Conservative Harper government's declaration in 2007 that Canada does not intend to meet its Kyoto target.[13] Thus, the formal withdrawal from the Kyoto Protocol only seems to be the realization of a *fait accompli* that has already been agreed on many years ago. Ever since the Conservative Party has taken office in 2006, "Canada has sought to align its stance with its most important trading partner, the US, [and is, particularly, fearful] that its economy would suffer if it took on stronger curbs than its southern neighbor".[14]

Consistent with my argument's emphasis on the importance of benefit distributions for international cooperation, the Harper government's actions signal strong concern about the Kyoto treaty's compliance cost. While the Protocol itself does not impose any financial penalties for non-compliance, the Protocol's

[12]Canada's National Inventory Report on greenhouse gas emissions was published on 11 April 2012. The full report can be found at the UNFCCC website `http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/6598.php`, and the executive summary is available from `http://ec.gc.ca/ges-ghg/default.asp?lang=En&n=83A34A7A-1`. Accessed, 12 April 2012.

[13]"Canada Wins Few Friends on Climate", *BBC News*, 7 December 2011. See `http://www.bbc.co.uk/news/science-environment-16075719`. Accessed, 12 April 2012.

[14]"Climate Summit Sees Canadian Strike on Kyoto Treaty", *BBC News*, 28 November 2011. See `http://www.bbc.co.uk/news/science-environment-15930562`. Accessed, 12 April 2012.

enforcement branch requires non-compliant countries to make up for the difference between their real and targeted emission levels in the subsequent commitment period, plus an additional deduction of 30 percent.[15] With the tentative agreement in Durban to extend the Kyoto Protocol beyond 2012 to either 2017 or 2020, the Canadian government may have felt a real threat that it will be held accountable for its 24 percent increase in greenhouse gas emissions. Since Canada will arguably suffer only modest adverse effects from climate change – mostly from habitat loss –, these low cooperation benefits do not warrant high abatement costs. To avoid these compliance costs, but also to prevent the Canadian economy to decouple from the economic growth in the United States, the Canadian exit strategy, my theory would argue, is not so much a surprising choice, but rather a pursuit for utility maximization.

Since my theoretical argument not only focuses on distributional concerns, but also stresses institutional and informational dynamics, it is essential to track such components in the Canadian case. Evidence that the availability of new information and domestic political competition can be linked to the Canadian government's decision to withdraw is needed to make my theoretical account convincing. On the informational aspect, I will show that rising world oil prices and the then profitable extraction of non-conventional oil from Canadian oil sands changed information on the compliance cost with the Kyoto Protocol considerably. On the political competition aspect, I can identify declining public support for a stringent continuation of strong climate mitigation action.

When the Canadian government ratified the Kyoto Protocol in December 2002, world oil prices for West Texas Intermediate (WTI) and Brent have been as low as US$ 31.20 and US$ 28.66 per barrel, respectively.[16] At the end of March 2012, the oil prices soared to US$ 103.02 and US$ 122.88 per barrel, which translates into increases of 330 and 429 percent, respectively. This unprecedented rise in world oil prices is extremely important for the Canadian economic development as Canada possesses the third largest oil reserves worldwide – third only to Saudi Arabia and Venezuela.[17] Interestingly, more than 95 percent of these reserves, totalling 175 billion barrels, are available as so-called bituminous sands, colloquially referred

[15] See the UNFCCC website `http://unfccc.int/kyoto_protocol/compliance/items/3024.php` for detailed information on the Kyoto Protocol Compliance Mechanism. Accessed, 12 April 2012.

[16] All oil price data is based on monthly spot prices from Bloomberg as of 11 April 2012. WTI data comes from the New York Mercantile Exchange (NYMEX), and Brent data is taken from the Intercontinental Exchange (ICE).

[17] See the CIA's World Factbook for a complete ranking, which can be found at `https://www.cia.gov/library/publications/the-world-factbook/rankorder/2178rank.html`. Accessed, 8 April 2012.

to as oil or tar sands.[18]

With crude oil prices at such low levels as in 2002, Canadian oil sands could not profitably be extracted. Oil extraction from these non-conventional sources only becomes a lucrative investment opportunity if prices above US$ 40 per barrel can be sustained over long time periods. The *Financial Post* reports that break-even prices in 2007 were about US$ 65 per barrel[19], but those prices have considerably decreased in recent years. Shell, for instance, mentions that "new developments are economical at US$ 50"[20], and BP states that "the average break-even price for Canadian oil sands ranges somewhere between [US]$ 45-70 a barrel".[21] This implies that nowadays, the extraction and refining of oil sands ensures very large profit margins. In fact, "the commodity price [needs to] fall[.] below $ 32, [for] existing facilities [to] make an operating loss."[22]

As Figure 2 illustrates, this has not always been the case. In particular, it has not been the case when the Liberal Canadian government ratified the Kyoto Protocol in 2002. The figure shows average annual oil prices for WTI crude oil in US$ per barrel. The dashed horizontal lines indicate a price range of break-even prices above which oil extraction from oil sands generates positive profits. The exact well-to-wheel prices primarily depend on the technology to separate bitumen from the non-oil particles and on whether mining or *in situ* drilling techniques are used.

[Figure 2 about here.]

However, this unanticipated rise in oil prices, visualized in Figure 2, makes the Canadian economy's compliance with the Kyoto obligations much more expensive than initially thought. This is why, my theoretical argument would claim, the development of the oil prices almost perfectly tracks the discrepancy in governmental behavior with respect to Canada's commitments to Kyoto. Chrétien's Liberal government must have assumed that a six percent decrease in greenhouse gas emissions against a 1990 baseline is doable.

[18] According to the Canadian Association of Petroleum Producers 20 percent of oil reserves are available in oil sands that can be mined, 77 percent are available as *in situ* bituminous sands, and the remaining three percent are conventional oil. See `http://www.capp.ca/library/statistics/basic/Pages/default.aspx`. Accessed, 8 April 2012.

[19] "High Costs Squeeze Oil Sands", *Financial Post*, 5 September 2008. See `http://www.financialpost.com/reports/oil-watch/story.html?id=772092`. Accessed, 20 April 2012.

[20] "Canada's Tar Sands: Muck and Brass", *The Economist*, 20 January 2011. See `http://www.economist.com/node/17959688`. Accessed, 20 April 2012.

[21] "BP and Oil Sands: Frequently Asked Questions", *BP Website*. See `http://www.bp.com/liveassets/bp_internet/globalbp/STAGING/global_assets/downloads/B/BP_and_Oil_Sands_FAQs.pdf`. Accessed, 20 April 2012.

[22] "Tar Sands Boom Hits a Sticky Patch", *Guardian*, 6 February 2009. See `http://www.guardian.co.uk/business/2009/feb/07/oil-and-gas-companies-energy-canada?INTCMP=ILCNETTXT3487`. Accessed, 20 April 2012.

A statement by the Liberal government's Minister of the Environment, Stephen Dion, that "Canada was able to show a plan to cut emissions to a point where we could meet the Kyoto target"[23] speaks strongly in favor of this belief. When the Conservative government entered office, the informational determinants were entirely different. Oil prices kept on rising, the extraction of oil sands loomed as an extremely attractive investment opportunity, and the costs of compliance with the Kyoto Protocol multiplied. Given this new information, it is easy to rationalize why the Liberal government's ambition for a global climate regime was counteracted by the incoming Conservative government.

This predominantly informational story is complemented by significantly decreased concern for the environment in the Canadian electorate. A survey released by the Environics Research Group finds that "[s]upport for action on climate change has slipped from five years ago, but it remains high on the list of Canadians' concerns". While this reflects a general concern for the environment, "[w]hen asked what is the most pressing issue facing Canadians, respondents named the economy and health care far more frequently than environmental issues, and climate change trails toxic chemicals and water quality on the list of domestic concerns".[24] In fact, prior to the 2011 Canadian Federal election only eleven percent of all interviewed respondents named the environment among their top priorities, while health care, job creation, and economic growth topped the ranking.[25]

These poll-based environmental preferences[26] are congruent with Keith Neuman's statement that "for all the noisy opposition from parliamentary critics and environmentalists, the Harper government's climate policies generally align with the views of a majority of Canadians".[27] Neuman, a pollster for Environics, further explains that "while critics say the Harper government is retrograde in its climate change policy, the Conservatives have balanced their opposition to Kyoto and backing for emissions-intensive oil sands with

[23] "Will Kyoto Die at Canadian Hands?", *BBC News*, 27 January 2006. See `http://news.bbc.co.uk/2/hi/science/nature/4650878.stm`. Accessed 10 April 2012.

[24] "Support for Climate Action Still Strong in Canada, Poll Finds", *The Globe and Mail*, 30 November 2011. See `http://www.theglobeandmail.com/news/politics/support-for-climate-action-still-strong-in-canada-poll-finds/article2255707/`. Accessed, 22 April 2012.

[25] Press Release, *Ipsos*, 15 April 2011. See `http://www.ipsos-na.com/news-polls/pressrelease.aspx?id=5207`. Accessed, 12 April 2012.

[26] See `http://www.environicsinstitute.org/PDF-FocusCanada-2011-Final.pdf` for the full survey, "Focus Canada 2011". Accessed, 22 April 2012.

[27] "Support for Climate Action Still Strong in Canada, Poll Finds", *The Globe and Mail*, 30 November 2011. See `http://www.theglobeandmail.com/news/politics/support-for-climate-action-still-strong-in-canada-poll-finds/article2255707/`. Accessed, 22 April 2012.

support for a new global deal and regulatory action at home. It's an approach that appears to resonate with Canadians".[28]

This case study evidence suggests that distributional, institutional, and informational forces matter for explaining the Canadian government's cooperation behavior. As soon as the Conservative Harper government learned about the economic potential of oil sand extraction that became profitable with increased oil prices, compliance costs with Kyoto commitments became prohibitively expensive, amounting to the infamously discussed CAN$ 13.6 billion in Kyoto penalties.

In theoretical terms, the shift from partial *ex ante* to *ex post* uncertainty, resulted in the insight that cooperation is no longer sustainable for Canada, given its low benefits from climate abatement. Peter Kent's strong language that "Kyoto for Canada is in the past"[29], that the compliance cost with the Kyoto Protocol totals CAN$ 1,600 for "every Canadian family [..., and that...] a new agreement that will allow us to generate jobs and economic growth represents the ways forward"[30] sends clear signals to domestic Canadian voters. In line with my theory, governments have strong incentives to provide information about distributional consequences to their national constituencies, so that they can update their reference point against which they hold their government accountable.

The Canadian government's decision to exit the Kyoto Protocol nicely illustrates that a better understanding of governmental behavior in international cooperation problems requires three dynamics to be tied together: distributional concerns about the benefits and costs of global public good provision, domestic dynamics from electoral competition, and the informational basis for policy-making about distributional consequences.

[28] "Support for Climate Action Still Strong in Canada, Poll Finds", *The Globe and Mail*, 30 November 2011. See `http://www.theglobeandmail.com/news/politics/support-for-climate-action-still-strong-in-canada-poll-finds/article2255707/`. Accessed, 22 April 2012.

[29] "Canada Pulls Out of Kyoto Protocol", *CBC News*, 12 December 2011. See `http://www.cbc.ca/news/politics/story/2011/12/12/pol-kent-kyoto-pullout.html`. Accessed, 22 April 2012.

[30] "Canada to Withdraw from Kyoto Protocol", *BBC News*, 13 December 2011. See `http://www.bbc.co.uk/news/world-us-canada-16151310`. Accessed, 25 February 2012.

5 Conclusion

International cooperation on global public goods lies at the heart of international politics research. While previous research has shown how difficult international cooperation can be to achieve (Barrett, 2003), an intriguing link between governmental behavior at the international level and domestic politics has also been identified (Milner and Rosendorff, 1997; Martin, 2000). Building on this two-level games logic, this paper examines how better information about the distribution of cooperation benefits affects the likelihood of a cooperative equilibrium. For this, my model considers the interaction of distributional, institutional, and information dynamics. Consistent with the existing literature, my informational model of international cooperation predicts democracies to cooperate more than their autocratic counterparts. The novelty, however, is that this finding is conditional on voter information to be low. As soon as voter information increases, international cooperation breaks down if cooperation benefits are asymmetrically distributed. Hence, payoff uncertainty and the possibility of actors to learn about the true state of the world qualify the finding that democracies act more cooperatively than autocracies. The theory presented here, albeit motivated by the example of climate change, travels to any cooperation problem that studies global public good provision. As an avenue for future research, this informational theory of international cooperation offers several conditional hypotheses that call for more systematic empirical testing.

Mathematical Appendix

This section presents the mathematical proofs for the three propositions from the main text.

Proof of Proposition 1

Under *ex ante* uncertainty, none of the players knows the realization of the true state of the world. Hence, utility-maximization is in expectations only. To determine the voters' reference point T_i, it is argued in the main text that voters play a standard international environmental agreements game. Conditional on non-participation in the first stage of the game, they face the following simultaneous maximization problem

$$\max_{q_i \in \mathbb{R}_{\geq 0}} \Pi_i(q_i, q_{-i}^{*N}, \theta_i) = \max_{q_i \in \mathbb{R}_{\geq 0}} b\theta_i(q_i + q_{-i}^{*N}) - \frac{1}{2}cq_i^2 \qquad \text{with } i \in \{A, B\}, \tag{11}$$

which yields $q_i^{*N} = \theta_i\gamma$ with $\gamma \equiv \frac{b}{c}$ as a Nash equilibrium. Conditional on cooperation in the first stage of the game, and with collective utility to be defined as the sum of individual utility as

$$\Pi(q_i, q_{-i}, \theta_i, \theta_{-i}) = \sum_i \Pi_i(q_i, q_{-i}, \theta_i), \tag{12}$$

the maximization problem becomes

$$\max_{q_i \in \mathbb{R}_{\geq 0}} \Pi(q_i, q_{-i}^{*C}, \theta_i, \theta_{-i}) = \\ \max_{q_i \in \mathbb{R}_{\geq 0}} b(\theta_i + \theta_{-i})(q_i + q_{-i}^{*C}) - \frac{1}{2}c(q_i^2 + q_{-i}^{*2}) \qquad \text{with } i \in \{A, B\}. \tag{13}$$

This results in a cooperative equilibrium strategy $q_i^{*C} = \gamma(\theta_i + \theta_{-i})$. In expectation, these equilibrium strategies turn into $E[q_i^{*N}] = \frac{1}{2}\gamma$ and $E[q_i^{*C}] = \gamma$ under *ex ante* uncertainty, and it can be shown that

$$E[\Pi_i(q_i^{*N}, q_{-i}^{*N}, \theta_i)] \leq E[\Pi_i(q_i^{*C}, q_{-i}^{*C}, \theta_i)] \tag{14}$$

is always true. Hence, with incomplete information, the cooperative strategy always maximizes utility. This is why domestic voters are assumed to set $T_i = \gamma = E[q_i^{*C}]$.

From this result it follows that, absent any political motives, each government wants to set abatement

levels of γ because this is environmentally efficient. If at the same time, however, domestic voters set their reference point $T_i = \gamma$, governments have no incentives to change their optimal behavior. Choosing abatement policies $q_A^{*C} = \gamma = q_B^{*C}$ is politically efficient as it maximizes reelection probability and is environmentally efficient at the same time. Hence, this solution is invariant to the political system because even without any political benefits, $r_i = 0$, $q_i^{*C} = \gamma$ is the optimal choice.

To verify that $q_A^{*C} = \gamma = q_B^{*C}$ is a solution to the cooperative first-order condition, it is sufficient to show that equation (8) holds for both countries. Clearly, $E[\theta_i + \theta_{-i}] = 1$ because $\theta_i, \theta_{-i} \sim_{iid} \mathrm{U}[0,1]$. Therefore, $b - cq_i = 0$ for $q_i = \gamma$ and $\frac{2\tau_i r_i}{\sigma}(q_i - T_i)\phi\left(\frac{(q_i - T_i)^2}{\sigma}\right) = 0$ if $q_i = \gamma$ and $T_i = \gamma$. □

Proof of Proposition 2

Without loss of generality, assume $\theta_A < \theta_B$. Further let θ_A^0 and θ_B^0 denote realizations of the random variables θ_A and θ_B. If voters are assumed to play a standard international environmental agreements game as before, cooperative and non-cooperative abatement levels are given as $q_A^{*C} = (\theta_A^0 + \theta_B^0)\gamma = q_B^{*C}$ and $q_A^{*N} = \theta_A^0\gamma$ and $q_B^{*N} = \theta_B^0\gamma$. With this, it is easy to derive from the participation condition

$$\Pi_A(q_A^{*N}, q_B^{*N}; \theta_A^0) \leq \Pi_A(q_A^{*C}, q_B^{*C}; \theta_A^0) \tag{15}$$

for the low benefitting country A that cooperation can only be sustained if $\theta_A^0 < \theta_B^0 \leq \sqrt{2}\theta_A^0$ holds. This then rationalizes how voters set T_i under *ex post* uncertainty.

To prove Proposition 2, let us first assume that $\theta_A^0 < \theta_B^0 \leq \sqrt{2}\theta_A^0$ holds. Then, voters choose $T_i = (\theta_A^0 + \theta_B^0)\gamma$. Absent any political constraints, however, $q_A^{*C} = (\theta_A^0 + \theta_B^0)\gamma = q_B^{*C}$ is the environmentally efficient abatement level and cooperation prevails. Hence, adding a political constraint, embedded in voter preferences $T_i = (\theta_A^0 + \theta_B^0)\gamma$, that calls for an identical policy, leaves both governments best off in setting cooperative abatement levels.

Second, assume that $\sqrt{2}\theta_A^0 < \theta_B^0$, and let the voters' reference points be given by $T_A = \theta_A^0\gamma$ and $T_B = \theta_B^0\gamma$. Absent any political constraints, non-cooperative play with $q_A^{*N} = \theta_A^0\gamma$ and $q_B^{*N} = \theta_B^0\gamma$ maximizes governmental utility. Since these abatement levels are identical with the voters' reference points T_A and T_B, political constraints do not affect equilibrium behavior.

Both equilibrium solutions are invariant to the political system because even without political benefits,

$r_i = 0$, $q_A^{*C} = (\theta_A^0 + \theta_B^0)\gamma = q_B^{*C}$ as well as $q_A^{*N} = \theta_A^0\gamma$ and $q_B^{*N} = \theta_B^0\gamma$ are the optimal choices.

Verifying that both solutions satisfy the first-order conditions is trivial and follows immediately from equations (5) and (8). Aggregate abatement levels in the cooperative and non-cooperative equilibrium are $Q^{*C} = 2\gamma(\theta_A^0 + \theta_B^0)$ and $Q^{*N} = \gamma(\theta_A^0 + \theta_B^0)$, respectively. □

Proof of Proposition 3

To prove Proposition 3 it is required to show that the following participation condition

$$G_i(q_i^{*C}, q_{-i}^{*C}; \theta_i^0, T_i) - G_i(q_i^{*N}, q_{-i}^{*N}; \theta_i^0, T_i) \geq 0 \qquad \forall\, i \in \{A, B\}, \tag{16}$$

which can conveniently be rewritten as

$$\begin{aligned} &\Delta env - \Delta cost + \Delta pol \geq 0, \text{ where} \qquad (17)\\ &\Delta env \equiv \theta_i^0 b\left((q_i^{*C} + q_{-i}^{*C}) - (q_i^{*N} + q_{-i}^{*N})\right),\\ &\Delta cost \equiv \frac{1}{2}c\left((q_i^{*C})^2 - (q_i^{*N})^2\right),\\ &\Delta pol \equiv \tau_i r_i\left[\left(1 - \Phi\left(\frac{(q_i^{*C} - T_i)^2}{\sigma}\right)\right) - \left(1 - \Phi\left(\frac{(q_i^{*N} - T_i)^2}{\sigma}\right)\right)\right] \end{aligned}$$

does also hold for $\sqrt{2}\theta_A^0 < \theta_B^0$. In explicit notation, the participation condition is characterized by

$$\theta_i^0 b\left((q_i^{*C} + q_{-i}^{*C}) - (q_i^{*N} + q_{-i}^{*N})\right) - \frac{1}{2}c\left((q_i^{*C})^2 - (q_i^{*N})^2\right) \tag{18}$$

$$+ \tau_i r_i\left[\left(1 - \Phi\left(\frac{(q_i^{*C} - T_i)^2}{\sigma}\right)\right) - \left(1 - \Phi\left(\frac{(q_i^{*N} - T_i)^2}{\sigma}\right)\right)\right] \geq 0. \tag{19}$$

With θ_B^0 outside the interval $(\theta_A^0, \sqrt{2}\theta_A^0]$ cooperation cannot be sustained in autocratic regimes with $\tau_i = 0$. Therefore, it must be the case that the first line in equation (19), which captures $\Delta env - \Delta cost$, is negative. Under partial *ex ante* uncertainty, cooperation can still be sustained, however, if political benefits, labeled Δpol above, and given in the second line in equation (19), are large enough. The formal condition

for a cooperative Nash equilibrium under partial *ex ante* uncertainty with $\sqrt{2}\theta_A^0 < \theta_B^0$ is

$$-\theta_i^0 b\left((q_i^{*C} + q_{-i}^{*C}) - (q_i^{*N} + q_{-i}^{*N})\right) + \frac{1}{2}c\left((q_i^{*C})^2 - (q_i^{*N})^2\right) \tag{20}$$

$$< \tag{21}$$

$$\tau_i r_i \left[\left(1 - \Phi\left(\frac{(q_i^{*C} - T_i)^2}{\sigma}\right)\right) - \left(1 - \Phi\left(\frac{(q_i^{*N} - T_i)^2}{\sigma}\right)\right)\right]. \tag{22}$$

A necessary condition for this to hold is that $\mid q_i^{*C} - T_i \mid < \mid q_i^{*N} - T_i \mid$ to make sure that

$$\left(1 - \Phi\left(\frac{(q_i^{*C} - T_i)^2}{\sigma}\right)\right) - \left(1 - \Phi\left(\frac{(q_i^{*N} - T_i)^2}{\sigma}\right)\right) > 0. \tag{23}$$

Only if this holds, Δpol can be positive and can compensate the negative difference of $\Delta env - \Delta cost$. The formal condition derived in equation (22) is sufficient to sustain cooperation even for θ_B^0 larger than $\sqrt{2}\theta_A^0$ if it holds for both countries i. Clearly, model specifications can be found such that this condition is satisfied; a cooperative outcome prevails under partial *ex ante* uncertainty.

The likelihood for cooperation under partial *ex ante* uncertainty is increasing in both $\tau_i \in [0, 1]$ and $r_i > 0$ because first-order derivatives of the above participation condition, denoted by PC, with respect to these parameters of the political system are strictly positive. Again, the necessary condition $\mid q_i^{*C} - T_i \mid < \mid q_i^{*N} - T_i \mid$ has to hold. The participation condition is more likely to be satisfied for higher values of τ_i and r_i. This is why *ceteris paribus* democracies are found to cooperate more than autocracies under partial *ex ante* uncertainty. The first-order derivatives are given as

$$\frac{\partial PC}{\partial \tau_i} = r_i \left[\left(1 - \Phi\left(\frac{(q_i^{*C} - T_i)^2}{\sigma}\right)\right) - \left(1 - \Phi\left(\frac{(q_i^{*N} - T_i)^2}{\sigma}\right)\right)\right] > 0 \tag{24}$$

and

$$\frac{\partial PC}{\partial r_i} = \tau_i \left[\left(1 - \Phi\left(\frac{(q_i^{*C} - T_i)^2}{\sigma}\right)\right) - \left(1 - \Phi\left(\frac{(q_i^{*N} - T_i)^2}{\sigma}\right)\right)\right] > 0. \tag{25}$$

□

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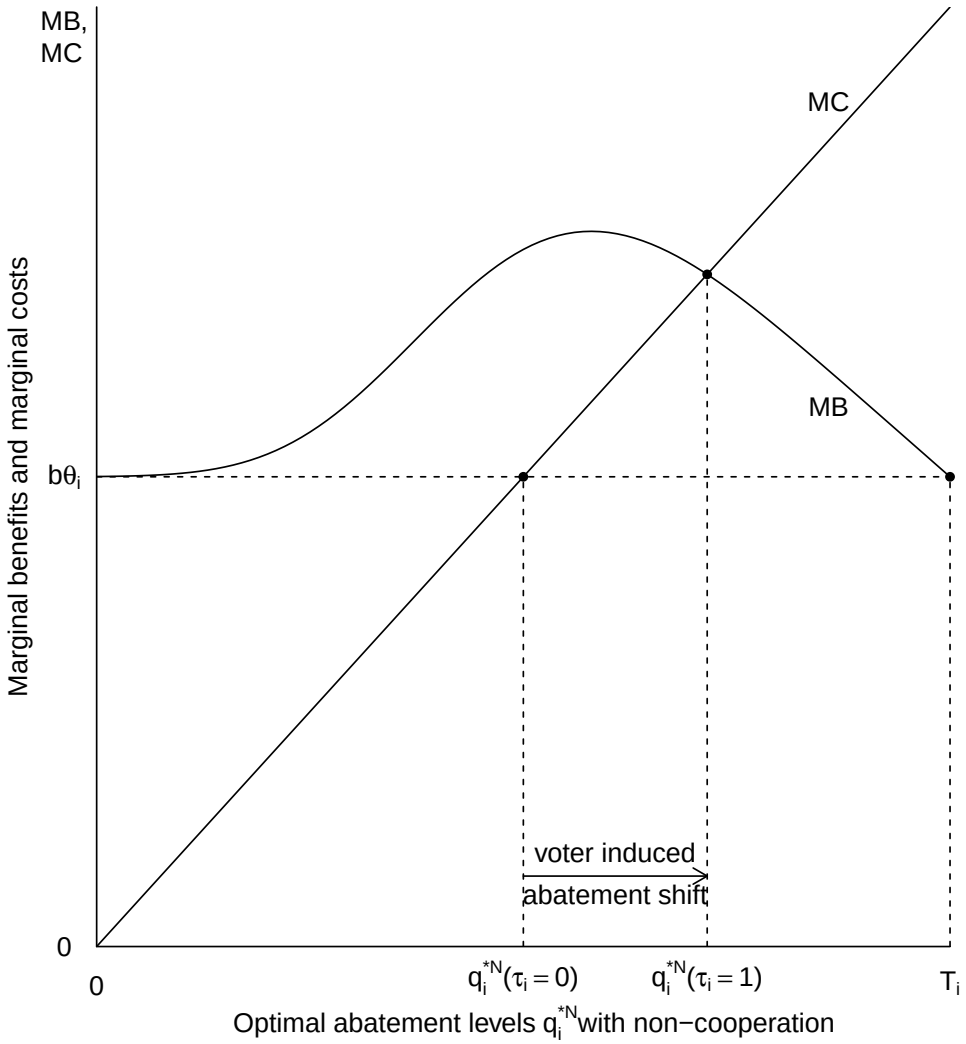

Figure 1: Illustration of first-order conditions. This plot schematically illustrates how institutional variation in optimal abatement levels is induced by the first-order conditions. For autocratic governments with $\tau_i = 0$ that are not accountable to their domestic electorate, the equilibrium abatement levels $q_i^{*N}(\tau = 0)$ balance marginal environmental benefits and marginal costs. Democratic governments with $\tau_i = 1$, on the contrary, increase abatement levels up to the point where the sum of marginal environmental and political benefits equals marginal costs. Hence, $q_i^{*N}(\tau_i = 1)$ will always be closer to the national voters' reference point, T_i, than $q_i^{*N}(\tau_i = 1)$. Democratic governments can be constrained by their domestic voters because of their need to get reelected.

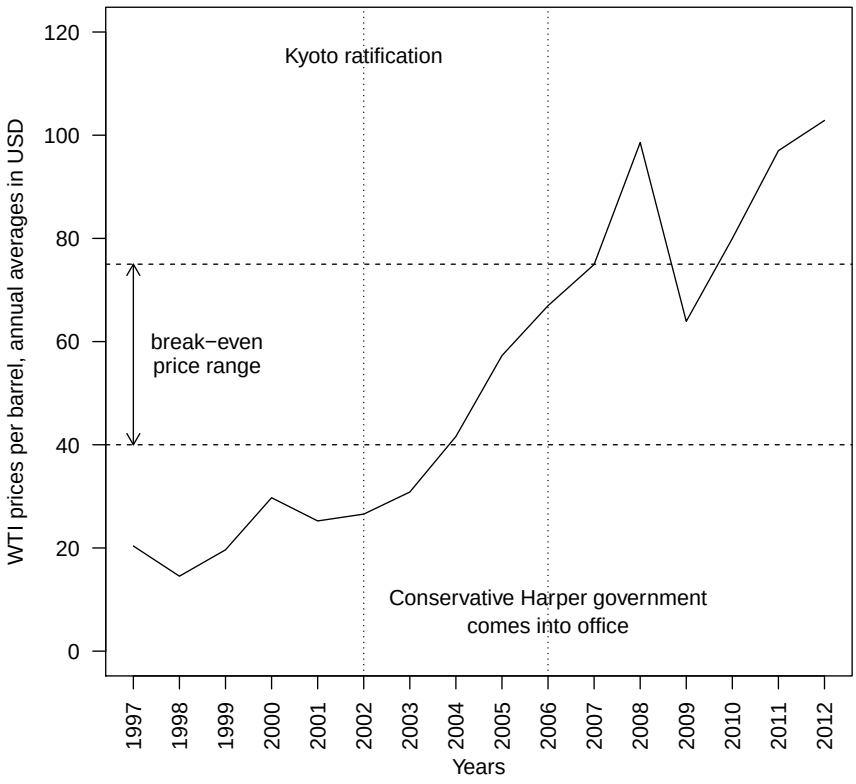

Figure 2: Annual averages of WTI oil prices, 1997-2012. The plot charts the development of annually averaged oil prices for Western Texas Intermediate in US$ per barrel for the years 1997 to 2012. The dashed horizontal lines show the region of break-even prices for well-to-wheel production. Oil prices above these lines make oil production profitable for firms. The dotted vertical lines mark the Canadian ratification of the Kyoto Protocol in 2002 and the government change in 2006.