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Abstract: Environmental authorities are regularly challenged to defend their regulations and policies in terms of how they impose additional costs on business and affect economic competitiveness. This paper discusses the links between environmental protection (and government policies and regulations more generally) and competitiveness. It provides a brief discussion on the nature of competitiveness, presents a Prisoners' Dilemma model of firm and government strategies that incorporates competition, and briefly relates the results of these investigations to key empirical results from the literature.

Keywords: environmental protection; competitiveness; competition; Prisoners' Dilemma; sustainable development; globalisation.

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Biographical notes:

Geoffrey Oliver has been an economist for the Canadian Federal government for over a decade and has been with the Environment Canada's Regulatory and Economic Analysis Branch since 1999. During his tenure with the federal government he has worked on diverse policy issues ranging from biotechnology patenting, to the economics of information and computer technology. He is currently looking at the interplay of economic and environmental policies, focusing on the issue of competitiveness and the setting of appropriate market signals. He is also analysing the links between environmental policies and innovation.

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1 Introduction

Competitiveness has become a central preoccupation of public policy. While always a primary focus of the private sector, in recent decades and with increasing globalisation, governments and the broader society have also been engaged. Indeed, some governments have stated that competitiveness is their highest priority.

Environmental authorities, such as Environment Canada (Canada's Federal Environment Ministry) are regularly challenged to defend their policies and regulations in terms of how they impose additional costs on business and affect economic competitiveness. These challenges typically arise from segments of the business community, other government departments, other levels of government and researchers and commentators on these issues.

Fundamentally, the authors have been convinced of the need for a more critical look at competitiveness. Currently, competitiveness often receives greater priority than it deserves: many seem to believe that if a policy might reduce the competitiveness of a sector of the economy, then this is serious grounds for revising or even dropping the policy. Such conclusions are often premature. We argue that competitiveness is a multifaceted and complex issue and a more subtle analysis is needed.

This paper illustrates how competitive forces can work to our advantage or disadvantage, depending on the circumstances. Firstly we provide an overview of the nature of competitiveness and some of its key dimensions. This is then followed by a more formal section presenting some modified Prisoners' Dilemma (PD) models of firms' and governments' strategies (domestic and international), with respect to competitiveness and environmental protection. By varying assumptions about the distribution of industries internationally and whether pollution impacts are felt locally or globally, the model provides different, but plausible predictions of national behaviour. The next section reviews some of the empirical evidence of the impacts of environmental policies and regulations on competitiveness and attempts to show how the results of the PD model can be reconciled with current empirical results. Finally, the last section provides a brief summary of the paper and some suggested approaches for policy-makers in reconciling competitiveness with sustainable development.

2 Competitiveness

The pursuit of competitiveness is generally unquestioned – rarely are reasons provided as to why competitiveness is a good thing. In a previous paper [1], we have attempted to address the apparent gap in the mainstream thinking vis-à-vis competitiveness, putting the concepts and values behind competitiveness under scrutiny and assessing how, why, whether and when competitiveness should be a guiding goal. Here, we focus on the core economic issues with respect to competitiveness.

In general, economic competitiveness is concerned with performance in a competitive market and can be considered at a number of levels:

> for *firms*, competitiveness is a survival issue: their ability to stay in business depends on generating revenues and reasonable returns on investment which in turn depends on how competitive they are in setting prices, attracting customers etc.

industries must also be competitive, both with other competing industries within the economy and more importantly, with similar industries in other regions and countries

finally, we can assess the competitiveness of *geographic areas* and assess the overall competitiveness of *a region or country* [2].

A useful device for assessing competitiveness at these different levels is to use a sports analogy. In sports, there are a variety of actors, each with different roles and perspectives on competitiveness. In assessing how an economic actor responds to the issue of competitiveness, it is very useful to ask whether they are a *player*, a *team*, a *coach*, a *referee*, or a *rule maker* – or some combination of these.

By and large *firms tend to be the players or teams*; they are competitors in the marketplace, but not the referees, coaches or rule-makers. They are constantly focused on improving their competitiveness – if the market is competitive their very survival may be at stake. *Industries are also players or teams* to the extent that they are competing with other industries [3].

2.1 National governments play a multiplicity of roles with respect to 'national competitiveness'

Governments have always had a keen interest in the performance of industry: it is a critical component of overall and individual well-being and indeed is the source of most of the revenues that allow governments to perform their other key functions. With respect to the *domestic economy*, they play all roles, *except that of competitor*. In Canada, the federal government is a competitiveness *coac*h via a variety of policies and programs, notably those of Industry Canada, which help to improve the competitive performance of Canadian firms and industries. As a *referee*, government agencies and the legal system play a key role in adjudicating disputes amongst competitors and ensuring that business laws are applied and enforced fairly and effectively. Indeed, property rights are at the heart of the market system and it is governments and the courts that shape and enforce these rights.

Finally, perhaps the most important role of government is as the *governing body or rule-maker*. Government laws and policies set the domestic rules for market competition; ranging from the aforementioned foundation of basic property rights, to a sophisticated set of marketplace framework laws i.e. competition law, consumer protection laws, intellectual property rights, bankruptcy law, etc. Even criminal laws such as those pertaining to murder are part of the legal environment that frames our competitive market. Organised crime has proved that extortion, blackmail and even murder are effective tools of competition, even if these are dimensions of competition that the broader society seeks to constrain.

Domestic and international considerations are central when discussing the role of government with respect to competitiveness. In a closed economy, countries and national governments are not generally competing with other countries. Competition may occur within the country amongst different political approaches and there will undoubtedly be competition amongst parties and candidates to form the government. But domestically, the government itself, which endures regardless of who is in power, while generally striving to improve its performance, is not actively competing against any adversaries.

In an open economy, things are quite different. A national government does not simply set the competitiveness rules for the domestic market according to its preferred balance amongst the market, environment, social considerations, etc. It now must meet the test of international markets. With increasing globalisation, domestic laws are not just potentially redistributing rights and resources amongst domestic players; they may also change the relative attractiveness of domestic goods on the international market. Now the national government's policies may enhance or detract from the competitiveness of domestic industries in the *global market*. In essence, the *shift from a domestic to international context puts national governments in the position of player*, actively competing with other jurisdictions for economic benefits such as foreign direct investment, market share for domestic production, skilled knowledge workers etc.

For example, an environmental regulation may be well thought out and achieve a strongly supported and reasonable balance between *domestic* economic, environmental and social priorities (i.e. represent a policy consistent with the principles of sustainable development). However, if an equivalent environmental regulation is not duplicated in other jurisdictions internationally, then there may be competitive pressures on the government to adjust its policies to compete with those of other nations.

Finally we note that the government's role as a rule-maker, which it clearly exercises domestically, is severely constrained internationally. A national government can no longer set the rules governing an increasing share of economic activity, which occurs in world markets. So we see that with the shift from a domestic context to an international setting, national governments must:

1 adopt a new role, as active players in competition with other countries

2 cope with a reduced role as governing bodies and rule-makers.

In the next section, we develop a series of models to analyse the competitiveness impacts of environmental protection that illustrate many of these issues.

3 The polluters dilemma: a game theory approach to competitiveness and environmental protection

To illustrate the various competitiveness and environmental protection dynamics involved at various levels in the economy, we present various PD payoff matrices. Firstly, we note some limiting assumptions. These payoff matrices illustrate single-round PD games: in this context there is little or no trust, nor opportunity for co-operation between the players. Given the opportunity, time and resources, players might find ways to ensure a co-operative result, which would resolve the dilemma (e.g. trusted third-party intervention can resolve the issue). Also, extending the game beyond a single round changes the dynamics; once the players know they will have repeated interaction with each other, reputation, retaliation and enforcement enter the picture. There is an involved literature on repeated PD games, which show that co-operation can be promoted, particularly in an evolutionary context (see [4]). We also need to assume that no consideration of social welfare influences the player's decision; no player cares about how the other player or the collectivity fares. These are contestable assumptions empirically.

One of the main themes we wish to emphasise is that competitive dynamics can

generate both positive and negative results. The rest of this section is divided into two main parts. The first is a short discussion of green dynamics where competitive forces within an economy can foster socially optimal behaviour. In particular, we use the case of increasing demand by consumers to illustrate how standard competitive forces in a market can be modelled using PD analysis. This lays the groundwork, notation and basic concepts for a longer discussion of dissipative or harmful competition. The second part examines international competition with respect to environmental standards and policies, using the PD models to examine different scenarios.

3.1 Domestic analysis – green dynamics and firm-level competitiveness

If a market is governed by well-structured framework laws that fully internalise key costs and benefits, then economic theory suggests that competition at the firm-level will generate optimal outcomes. Output levels will be efficient, in that the costs of production are properly balanced with the desires of consumers and this will tend to maximise the benefits for society. Now much of environmental economics is dedicated to illustrating that this is not the case and that interventions are needed to remove externalities and distortions that prevent this optimum from being achieved. We will not discuss this extensive area of knowledge and research – instead, we will look at the other side of the issue, where market factors help competition push firms to improve environmental performance. Our intent is not a fulsome discussion, but rather to use this area to illustrate the potential for a PD analysis to account for positive competitive outcomes.

Green dynamics, where market factors and developments induce better firm performance can be classified into three main areas:

eco-efficiency

innovation and the Porter hypothesis

green demand

There has been a great deal written about all three areas, but we will look more closely at green demand, to introduce the PD model and make some preliminary observations.

3.1.1 Green demand

We begin by explaining notation and outlining some basic assumptions that are embodied in Table 1. The arbitrary but illustrative numbers introduced here will be used throughout the document. We have two identical profit-maximising firms (A and B), in a closed market economy. If a firm chooses to produce without any pollution controls, it will generate a net benefit for itself of five units, but the pollution will impose a cost on society of -3. If it chooses to use more costly pollution reducing technology, it will gain only four units of benefit, but impose no pollution costs on society.

Table 1

	Firm B	
	D (dirty)	*C (clean)*

Firm A	D (dirty)	(5,5) TPB = 10 SC = -6 *NSB = 4*	(5,4) ⇩ (0, 8) TPB = 9 ⇨ 8 SC = -3 ⇨ 0 *NSB = 6 ⇨ 8*
	C (clean)	(4,5) ⇩ (8,0) TPB = 9 ⇨ 8 SC = -3 ⇨ 0 *NSB = 6 ⇨ 8*	(4,4) TPB = 8 SC = 0 *NSB = 8*

In the Table, if player A chooses D (to defect, or choose the dirty technology), this designates a payoff along the top row of the Table; conversely, choosing C (to co-operate, or use the clean technology) selects the bottom row. Similarly, B's choice designates the left (D) or right (C) column.

The ordered pair (r,c) in each box of the Table identifies the payoffs to the players, following the 'Roman-Catholic' convention, where the first number is the Row payoff to player A and the second number is the Column payoff to player B. A particular payoff can be designated as A_{CD}, which designates the payoff to player A in the bottom right, or CD box. In each box is the ordered pair with individual firm payoffs and underneath is TPB, which sums the total private benefits to the firms.

So far, this is fairly standard notation for PD matrices. We have added some additional features:

There is also SC = Social Cost and NSB = Net Social Benefit (TPB –SC)

We have used arrows to show shifts in payoffs, costs and benefits which reflect the outcome of competitive forces. Thus, some quadrants will have two sets of payoffs and figures, representing outcomes before and after competitive forces have played out.

In Table 1, firms can choose to produce their goods and impose a pollution externality, or to use more costly, cleaner technologies that eliminate the pollution. Without market pressure from green consumers, the strategy for each player in this case is straightforward. D, using dirty technology (D) is the obvious choice, given that there are never higher benefits to the firm from the clean choice (C). [5] (This represents the first ordered pair in the table quadrants, on the tail end of the arrow).

Without assuming green demand, from the perspective of the players, this is not a PD. The firm payoff of using the dirty technology is higher for both players than it is to use clean technology. It is only the social cost, the externality that both firms produce, that makes it preferable for both firms to co-operate (or be forced) to use clean technology. Remember that in this model, the firms are assumed not to care about social costs and benefits unless they directly impinge on their own welfare. This failure of firms to internalise the pollution impacts of their activity provides a classic rationale for government intervention, via regulations and other policies to require firms to use clean technology and maximise social welfare. However, it is possible that market factors such

as green demand could achieve the same result.

Green demand or consumption represents a demand side shift, a shift in consumer preference for products that are better for the environment. Products will be assessed on the environmental impact of the product itself, as well as the impact of the processes surrounding its production, use and disposal. Green consumption flips the competitiveness dynamic. Clean production, which was previously only seen as an additional production cost is now a feature of the product that provides value to consumers [6]. In Table 1, the competitive outcomes and associated payoffs (at the pointed end of the arrows) reflect the complete domination of green demand and consumers do not buy from firms using dirty production. This table is now a PD for the firms, in that if they could collude to avoid implementing costly pollution control devices and deny consumers green goods, they would. However, the PD dynamic forces the shift to the lower quadrant payoff (CC = 4.4 versus DD = (5.5)), *which works to the greater social good*. Under extreme assumptions, where all consumers are ultra-green, the clean firm drives the dirty firms out of business and captures all the demand. Facing such competitive pressures, the dirty firm would be forced to go clean as well. In short, market competition will force producers to meet consumer demands. If green demand is sufficiently strong, then government intervention may be less warranted. Green demand will engage market forces and force firms to improve their environmental performance.

Of course, this result is not really surprising. In essence, competitive markets force all firms into a PD, one that lowers firm returns but maximises social good. Standard economic analysis clearly shows that if firms collude and form a cartel, they will be able to exact higher prices, be less responsive to demand pressures and reap higher returns than they would under competitive conditions. Competition forces firms to be responsive – if there is a demand for green goods, competitive markets will deliver them. See [7] or other industrial organisation texts for an overview of this argument. In general, properly functioning markets create PD and competition with a positive overall outcome for society.

However this result is not assured with respect to producer environmental behaviour. Being a green consumer is not easy. Unless eco-efficiency gains allow the green product to be priced lower than alternatives, the consumer will have to pay more for the green product; this is a classic quality-price trade-off. Information costs for green consumers can also be significant. The research and science on environmental impacts is evolving, complex and not always accessible. It can be extremely difficult and time-consuming to gather and assess environmental information on products. While price information is usually readily accessible, determining the quality of a product is often more difficult. If the quality in question does not relate to the physical properties of the product, but its environmental impact in production, use and disposal/recycling, the information is often not directly available by examination. Finally, consumers may face difficulties and high transactions costs in acting together. Individuals may not wish to pay more for environmentally better products, if they are not convinced others will join them. If they act alone, they will pay more and yet see little gain for the environment.

Given these considerations, it is by no means clear that green demand would be an adequate mechanism for internalising the costs of the environmental damages imposed by dirty firms. It remains to be seen whether efforts such as eco-labelling, environmental performance indicators, etc. can bring green demand to significant levels.

3.2 International – country level analysis

We now consider an international model, where we assume four identical countries, W, X, Y and Z. Each country has two firms. We assume no trans-boundary pollution, i.e. that pollution damages occur only within the country of production. Green dynamics are assumed to be inadequate to address pollution externalities.

Under the basic assumptions discussed previously, we saw that it is in each country's domestic interest to develop policies that force firms to use clean technology. However, the international context adds a new dynamic. In Table 2 we model a payoff matrix focusing on country W and for the moment assume that countries X, Y and Z act together to take uniform decisions. We will also assume full capital mobility, in that firms can choose to relocate to countries when it is in their interest to do so [8].

Table 2 All countries are identical

		Countries X, Y and Z collectively	
		D (dirty)	*C (clean)*
County W	D (dirty)	(4,12) *NSB=16*	(4,24) ⇩ (16, 0) *NSB = 28 ⇨ 16*
	C (clean)	(8,12) ⇩ (0,16) *NSB = 20 ⇨ 16*	(8,24) *NSB=32*

Note: Pollution effects are local

Now the payoff to a country for each clean firm is four representing the lower return (four instead of five) to the firm, but no pollution costs are imposed on society. Each country has two firms and so under clean technology, each country has a total benefit of eight. In the table, box CC, where all countries have enforced policies against pollution, the payoffs are $W_{CC} = 8$ and $[X,Y,Z]_{CC} = 24$; 8 for each of the three countries X, Y and Z.

Each dirty firm provides a net benefit to a country of two, representing a higher return of five to each firm, but also an imposed pollution cost of -3. Box DD has payoffs where each country gets a return of 4; 2 from each of the two domestic firms.

Let us examine the dynamics of Table 2 more closely. Beginning in CC, we see that this box has the highest net social benefit. Looking at country W's choice, we see that if they change their rules and allow their firms to be dirty (shift to DC), then, initially at least, this will not be to their advantage. They will incur the costs of greater pollution within their country and reduce their benefits from eight to four.

However, a new dynamic occurs. Country W now allows firms to use dirty technology, which gives firms a higher return of five, as opposed to four with clean technology. Country W has set itself up as a *pollution haven*. Based on this higher return and assuming no other costs as well as frictionless capital mobility, firms will shift their operations from countries X, Y and Z and move to Country W. A new dynamic is being

introduced, that of inter-country competition for capital and investment, based on environmental standards and relative returns to firms. Under the extreme case, Country W attracts all the firms and gains a return of 16, which is much better than the original eight it received under W_{CC}. Other countries are left bereft and lose all their industries and the associated benefits. However, net social benefits have been reduced considerably, dropping from 32 to 16.

Of course, countries X, Y and Z do not sit by idly, watching their domestic industries fly to offshore pollution havens. They will match the lower standards of W and retain their industries. This is represented by the shift from DC to DD, where eventually all countries are allowing their firms to pollute. This dynamic is commonly referred to as the *race to the bottom*. Box CD illustrates that if country W tries to clean up its act alone, it will be initially better off, but the international competition from other jurisdictions will cause its domestic industries to leave and leave it with a lower return. Thus, under these dynamics, countries will be penalised for having higher environmental standards than the international norm, even if both a domestic and a global benefit-cost analysis shows the higher standards are fully warranted [9]. Again, we note that as the dynamic plays itself out in boxes DD and CD, the net social benefit is reduced to 16, as compared to 32 when everyone insists on clean production by firms.

An obvious resolution to this dilemma is to invoke an external authority, such as an enforced international agreement, that will bind countries to implement effective policies for clean production.

3.2.1 Dissipative vs positive competition

In this example, countries are trapped in a race to the bottom, an example of dissipative competition. Countries are competing for capital and investment and while it is always better to win than lose in a competition, ultimately the competition itself reduces net social benefit. In general, dissipative competition occurs when the gains from the competition are less than the losses [10]. Gains and losses can be usefully categorised as: general social gains and losses, reflecting a positive or negative externality imposed by the decisions of the players in the competition; or, actual gains and losses to the players in question. It is the interplay between individual gains and losses to players and the broader externalities to society, the social gains and losses, which will determine whether any given competition generates higher or lower net social welfare. *Whether competition will be positive for the players and society in general cannot be determined a priori – each case needs to be examined individually*. The policy should be tailored to ensure that the rules and competitive environment are structured so as to maximise net social welfare.

In this case (Table 2), the countries themselves are made worse off in the equilibrium competitive result, DD, than they would be if they were forced to co-operate. However, we saw in the previous discussion on green dynamics, that competition can be dissipative for the players, but generate a greater positive social externality. Firms incurred greater costs to produce green products, but consumers and society benefited by the competition to meet green demand.

In the current example, it has been suggested that an international agreement could be used to avoid countries gaining competitive advantage by lowering environmental standards to attract a disproportionate share of investment. Other solutions may also be

possible. For example, trade measures that would allow for discriminating against production and process methods have been a long-standing area of discussion in the trade and environment literature [11]. The green dynamics discussed above can also apply here. If eco-efficiency, green demand or longer term strategies shift incentives for firms sufficiently, then this can also change the dynamic [12]. Pollution havens may not be attractive if they represent a less competitive option for firms catering to a changing, greener international market. Of course, green dynamics, while providing positive signals, have yet to be proven adequate in shifting firm and country behaviour to the degree required by many of the current environmental challenges we face.

3.2.2 Timing and market share

The dynamic in Table 2 will shift if the distribution of firms is skewed. Consider what happens if one country dominates the industry in question (Table 3). We now let country W have ten firms, while the rest of the Countries still have two firms. Now country W has no incentive to shift from a clean world CC, to try dirty production; because of their greater share of industry, they would receive a proportionate (larger) share of the pollution. As before, they have no immediate incentive to reduce environmental standards, because this would reduce their payoffs from 40 to 20. Unlike before, they are still not better off if they attract foreign investment to their country. The payoff from more dirty firms (12 more added to 20) still does not bring them back to where they were (final payoff after attracting foreign investment is still only 32, compared with 40). So the dominant country will initially have no incentive to reduce its standards, even if it attracts foreign investment.

However, the pressures for a race to the bottom are not completely eliminated. Countries X, Y and Z can gain by lowering standards and attracting investment from W to their pollution havens. In box CD, we see that while these countries initially incur greater pollution and reduced welfare (shift from 24 to 12 in total) eventually competitive forces attract more firms from W. As investment drains from W, the race to the bottom will reassert itself and country W will feel competitive pressures to reduce their standards. Thus, in this example, the dynamic is slower and lopsided, but eventually country W is driven to reduce its environmental standards. The obvious interpretation of these results is to equate county W with the developed world and countries X, Y and Z with the developing world. As will be discussed later, there are many reasons to resist quick assessments with respect to pollution havens and the race to the bottom. Nevertheless, this model does suggest that these dynamics are not occurring largely because of the lopsided distribution of industry and economic activity between regions.

Table 3 One country dominates economically

		Countries X, Y and Z collectively (each country still has 2 firms)	
		D (dirty)	*C (clean)*
County W (has ten firms)	D (dirty)	(20,12)	(20,24) ⇩ (32, 0)
		NSB=32	*NSB = 44 ⇨ 32*

	C (clean)	(40,12) ⇩ (0,32) *NSB = 52 ⇨ 32*	(40,24) *NSB=64*

Note: Pollution effects are local

3.2.3 Sensitivity to social costs: size and distribution

Our example of four identical countries being trapped in a PD combining a pollution haven and a race to the bottom (Table 2) is sensitive to several assumptions. The overall benefit of a polluting firm must be positive, or else there is no gain from attracting such firms to your country. We assumed that dirty firms produced a net direct benefit of five and a social cost of -3, yielding a net social benefit per dirty firm of two. If the social costs were worse than -5, these would negate all the benefits each firm generated and there would be no incentive to creating a pollution haven. Each additional firm not only provides no benefit but will 'overall' be harmful to the country it operates in. If the costs of clean technology remains one, then all countries will force firms to use clean technology and there will be no PD, no pollution havens and no race to the bottom [13].

Our final Tables examine the case where the costs of pollution are not borne locally, but instead are shared globally. This would correspond to the climate change case, where CO_2 emissions have no significant local effects, but are a major global greenhouse gas.

In Tables 4 and 5, we assume that the countries are identical in terms of their susceptibility to global pollution and will always bear one quarter of the total social cost, regardless of their individual responsibility. Social costs are still -3 per firm. We will now contrast Table 2 with Table 4 and Table 3 with Table 5, respectively, to highlight the dynamic changes when negative effects of pollution are no longer only felt locally, but can be shared with other countries.

Firstly, we note some general features. Tables 4 and 5 have an explicit reference to social costs and more importantly social costs imposed per country, because this figure may now be independent of the decisions of the individual countries affected (i.e. a country that has no polluting industries can now be affected by offshore pollution). We also see that the net social benefit in each box has not changed, but the distribution of these benefits has shifted radically. Finally we see a new feature, negative returns to countries. Previously, the worse case scenario was to lose all your industry to the pollution havens (benefits = 0): now, you can lose all your industry for 0 benefits, but incur pollution costs from those very firms operating in other countries!

Table 4 All countries are identical

	Countries X, Y and Z collectively	
	D (dirty)	*C (clean)*

County W	D (dirty)	(4,12) SC = -16 SC/country = -4 *NSB=16*	(8.5, 19.5) ⇩ (34, -18) SC = -6 ⇨ -24 SC/country = -1.5 ⇨ - 6 *NSB = 28 ⇨ 16*
	C (clean)	(3.5,16.5) ⇩ (-6, 22) SC = -18 ⇨ -24 SC/country = -4.5 ⇨ -6 *NSB = 20 ⇨ 16*	(8,24) SC = 0 SC/country = 0 *NSB=32*

Note: Local pollution shared globally

Table 5 One country dominates economically

		Countries X, Y and Z collectively (each country still has 2 firms)	
		D (dirty)	*C (clean)*
County W (has ten firms)	D (dirty)	(38,-6) SC = -48 SC/country = -12 NSB = 32	(42.5, 1.5) ⇩ (68, -36) SC = -30 ⇨ -48 SC/country = -7.5 ⇨ -12 *NSB = 44 ⇨ 32*
	C (clean)	(35.5,16.5) ⇩ (-12, 44) SC = -18 ⇨ -48 SC/country = -4.5 ⇨ -12 *NSB = 52 ⇨ 32*	(40,24) SC = 0 SC/country = 0 *NSB = 64*

Note: Local pollution shared globally

Let us now look closely at the difference between Tables 2 and 4. Recall that we are talking about four identical countries. The main difference is that the incentive to defect (allow dirty firms to operate) is significantly increased. In Table 2, countries took an immediate reduction in benefits if they reduced their standard from the international norm and it was only as they attracted a disproportionate share of international

investment to their pollution haven that this strategy proved attractive. In Table 4, there is no delay. Dirty firms generate higher returns and they export a share of their pollution abroad. In the table, country W immediately improves its situation as benefits shift from 8 to 8.5. Competitive forces exacerbate this. When W attracts all the firms from other countries, their benefits increase to 44 and the rest of the world is forced to endure part of the impacts of their pollution, imposing a net negative cost of -18 (-6 for each of countries X, Y and Z). The temptation payoffs are increased, the sucker costs are worse and the force of the PD increased accordingly. However, the final payoffs and social benefits in box DD are not any different between the two matrices – eventually all countries race to the bottom and all firms are polluting and, because all countries are identical, each shares the same overall reduction in welfare.

Contrasting Table 3 with Table 5 shows some very dramatic results. In analysing Table 3, we noted that the dominant country W, with its ten industries, did not have any immediate incentive to reduce its standards, as it would feel the effects of a large amount of pollution right away. Even attracting the last share of foreign investment did not make them better off than with a smaller, but clean industry. Only as a significant number of their domestic firms moved to pollution havens would they want to lower standards to retain investment. In Table 5, country W can export the pollution and it has an immediate and strong incentive to allow pollution. W only faces one quarter of the pollution costs generated by its domestic industry, but retains all its firms, so W's benefits can increase immediately from 40 to 42.5. This could further increase up to 68, if Country W can attract firms from all the other countries.

In Table 3, dominant country W has an initial incentive to go from box DD to CD and gain the benefits of cleaning up its large number of dirty domestic firms. It is only the threat of competition and the shift of its firms to pollution havens, that keep it from going clean alone. However, in Table 5, Country W has no incentive whatsoever to clean up its industries, because it can export most of its pollution to the other countries. In Table 3, competition is needed to generate a PD and the race to the bottom. In Table 5, *the ability to externalise the costs is sufficient to generate the PD; competition only exacerbates the problem.*

The most telling dynamic in Table 5, however, is that the dilemma for Country W is very weak. The final equilibrium payoff is only slightly less than occurs under the co-operative outcome ($W_{DD} = 38$ versus $W_{CC} = 40$). With a slightly higher concentration of the global industry, or with slightly different cost or damage assumptions, W could export even more pollution and may have no interest in any binding international agreement to impose clean technology. The co-operative outcome is not just unstable, as it is in any PD structure, but is actually a worse outcome for W than when everyone pollutes. The rest of the world would have to buy W off to induce any agreement to change!

Finally, if the pollution is shared globally, but the economic benefits accrue locally, then we might see countries allowing firms to pollute, even though at the broader level, the pollution would completely negate the value of the economic activity. In the discussion of the local case (Table 2) we noted that if social costs per firm were worse than -5, then no country would fail to regulate and no pollution haven or race to the bottom would occur. However, *when the pollution costs are exported, even activities that have negative overall value may be encouraged within a jurisdiction*. Everyone is worse off, but no country will take positive action alone, because unilateral action will make a

country worse off.

3.3 Summary of game theory results

This section has shown that payoff matrices can be very useful for modelling strategic behaviour relating to environmental protection and competitiveness. The examples in the payoff matrices above have highlighted how strategies relating to environmental protection and competitiveness are sensitive to a variety of assumptions. Those examined included different numerical assumptions with respect to costs and benefits for firm and society, the distribution of economic activity, whether pollution is local or global and whether environmental values are internalised by consumers in their purchase decisions. In many cases, competitive market forces were critical in driving the outcome: in some cases, such as green demand, the competition was positive and generated higher welfare; in others, the competition was dissipative, providing incentives to create pollution havens and fuel a race to the bottom. These latter cases suggested a role for rules and international agreements to curtail such competition. The final analyses illustrated how regions with a disproportionate share of economic activity might be leaders in curtailing pollution which has a local impact, but not support environmental measures to address pollution whose impact is mainly global.

While such theoretical examinations can be helpful, they cannot be relied upon exclusively. We need to contrast the insights from such analysis with empirical results. To begin with, we will need baseline information to determine which of the various assumptions examined here to invoke when looking for a more specific framework of analysis. Indeed, as the next section will show, many of the data uncovered to date do not support the conclusions suggested by the models above.

4 Links to literature and empirical results

In this section we highlight key results from some of the literature and where fruitful, explore links to the results from the previous section of this paper.

The great majority of studies we have reviewed, conclude that:

> by and large, the overall scale of environmental costs (absolutely and with respect to other factors) is not large enough to affect the competitiveness of firms [14–19]
>
> environmental protection measures are not generating competitive disadvantages with respect to economic growth [20,21], productivity [22–24,20,25], investment decisions [26–29], employment [30–34], trade flows [31,35,24,28,33,36–38] and profitability [33].

Nations with the most stringent environmental standards show the best economic performance. Michael Porter [39,40] goes even further, arguing that among other things governments can support competitiveness and innovation through ‘strong environmental protection.’

However, we argue that governments must still take seriously all plausible claims that environmental policies and measures are having, or could have, a significant, negative impact on competitiveness. Firstly, even if such claims appear to be without empirical support, they are invoked regularly in discussions regarding environmental policies.

Secondly, it is not clear that these empirical results will hold if the cost of environmental policies imposed on industries continues to increase – notably the long-term, post Kyoto impacts of climate change mitigation policies. If significant impacts are discovered, governments must investigate further – the response must be based on a full understanding of the source of the competitiveness disadvantage.

In those instances where policies may be affecting industry in a very real way, we need to examine whether:

our environmental standards deviated significantly from those of competitors

we can influence the external economic environment to level the playing field

competitiveness impacts have been assessed using a static or dynamic approach – does the result consider how markets, technology and tastes are evolving?

other factors that influence competitiveness are actually driving this result (e.g. relative wages, exchange rates, shifts in the business cycle, etc.)

we have used the optimal mix of policy instruments to achieve the environmental target

the loss of competitiveness is really the market responding to better economic signals and overall represents a positive adjustment

we have clearly understood the strategic dimensions of this issue and determined whether competitive forces are working to generate higher social welfare, or are fuelling dissipative competition and a race to the bottom.

Until we can answer these questions we cannot determine how to respond to a reported loss in competitiveness resulting from an environmental policy. But we also need to keep in mind that competitiveness is only one element in a panoply of considerations when developing environmental policies.

5 Conclusions

We have discussed the various facets of competition and competitiveness and the interface between environmental protection and competitiveness. A PD model with five payoff matrices, each with different competitiveness and environmental scenarios, was developed to analyse the complex issues involved in this area and the strategic behaviour of both firms and nations.

The section on PD models highlighted how strategies are sensitive to a variety of assumptions and how, in many cases, competition was critical in driving the outcome. In some cases, such as green demand, the competition was positive and generated higher welfare, while in others, the competition was dissipative, providing incentives to create pollution havens and fuel a race to the bottom. This reminds us that governments provide the framework for effective functioning of markets and the use of competition as a tool to improve performance and the overall welfare of a nation's citizens. It also reinforces the argument in support of international rules and agreements to curtail the perverse effects of dissipative competition. Framework rules must promote economic activity that improves social welfare and must establish rules that promote positive behaviour vis-à-

vis the environment and other core values of citizens.

We have also tried to link our analysis and models to some of the key results in the empirical literature. While we do not contradict the general consensus that environmental measures rarely reduce competitiveness, we do show that these results may be less robust than assumed and that there remains some unanswered questions. The logic of the models presented is intuitive and often compelling. As we take on more complex environmental problems that incur more significant costs, we suggest that many of the strategic behaviours described in this section could emerge.

Economic competitiveness and competition are, from the perspective of a sovereign government, tools for achieving a goal, not goals in themselves. For a sovereign government, competition and competitiveness are tools to help improve economic performance and provide a better quality of life for its citizens. The same logic applies globally. If globalisation erodes national sovereignty and domestic ability to set critical marketplace rules, then we would want international agreements and institutions to adopt a similar, instrumental view, on the role of competitiveness and competition.

Sustainable development provides underlying principles for the development of public policies. It suggests a broad inclusive approach to considering issues, rather than a narrow technology assessment confined to a particular discipline. We believe that this is the most fruitful way to examine the interplay of economic competitiveness and environmental protection.

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References and Notes

1 Oliver, G. and Basak, R. (2001) 'Competitiveness and environmental protection: sustainable development rules', *Presented at the Canadian Society for Ecological Economics Conference*, Montreal, August.

2 Competitiveness is also an issue at the individual level, where people compete for jobs based on training and aptitudes. This is an important issue for individuals, governments, educational institutions, and the broader society, but not one that will be addressed further in the paper, particularly since striving for competitiveness at this level rarely has significant environmental impacts.

3 For instance, telephone and cable companies are competing with respect to providing Internet access. They are also in broader competition with the television industry and other entertainment industries for the dollars and attention of consumers.

4 Axelrod, R. (1984) *The Evolution of Cooperation*, New York: Basic Books.

5 Indeed, there are huge risks in choosing C. Under *extreme competitiveness assumptions*, if A chooses to be dirty and B chooses to use clean technology, A is able to lower its costs, decrease its product price and corner the whole market, putting B out of business. This is *not* the competitiveness dynamic illustrated in Table 1.

6 We have seen, over the last decade, a proliferation of firms adopting environmental management systems (EMS), third-party EMS certification such as the ISO 14,000 standards series, firm-level environmental performance indicators and reporting, eco-labelling initiatives, green/social investments and funds, etc.

7 Scherer, F.M. (1980) Industrial Market Structure and Economic Performance, Boston: Houghton Mifflin.

8 This assumption does not correspond to most empirical evidence. We discuss this more fully in a later section.

9 It is only with an internationally flavoured domestic benefit-cost analysis, (but devoid of a global perspective or global accounting stance) that we might find strategic gains that will distort distribution and show temporary and illusory net domestic benefits to lower environmental standards.

10 Conversely, when firms are competing in ways that generate a positive externality, then the competition is positive rather than dissipative. For instance, when competition centres around factors such as: more efficient production and resource use, higher product quality, better service, etc., then the competition is positive. However, if the competition centres on factors such as lowering costs by using dirty technology, making false claims about products, using physical intimidation of competitors, etc. then firms are competing in dimensions that are dissipative.

11 Esty, D.C. (1994) *Greening the GATT: Trade, Environment and the Future*, Washington: Institute for International Economics.

12 There is anecdotal evidence of supply chain management that limits supply sources to ISO 14,000 certified partners. There has also been many cases of restrictions vis-à-vis specific products, such as Home Depot's (a large American chain of home renovation stores) ban on the purchase of old-growth forest products.

13 We assume all actors have identical preferences. One could conceive a matrix whereby country W has higher disutility of pollution due to wealth effects and X, Y, Z are developing countries with a higher tolerance for environmental degradation. This exacerbates the PD and the incentive to create a pollution haven.

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