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Environmental regulations and managerial myopia

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Abstract

It has recently been claimed that, contrary to traditional neoclassical theory, suitably chosen environmental regulation is often beneficial for the regulated firms because it induces cost-reducing innovations. I analyze the extent to which this position is compatible with microeconomic analysis. It turns out that even in a framework in which organizational inefficiencies might lead to underinvestment, environmental policy can only increase firm profits if several very specific conditions are met. These conditions concern the type of policy, the extent of inefficiencies, the costs of potential innovation projects and their effect on productivity and abatement costs.

Keywords: Environmental Regulation, Internal Inefficiencies, Innovation Offsets, Managerial Myopia

1. Introduction

Economists usually view environmental policy as a double-edged sword: the benefits of pollution reduction must be weighed against the costs, including those arising at the firm level. In several recent contributions, Michael Porter and others took issue with this view, using case-study evidence.¹ In many cases, the argument goes, environmental regulation induces firms to carry out innovations that are not only beneficial for the environment, but have additional positive effects, deemed innovation offsets, on productivity. For instance, the 1991 Japanese recycling law requires that electric appliances be easy to disassemble. Hitachi reacted to this requirement with a complete redesign of its washing machines and vacuum cleaners; as a result the number of parts fell by 15-30%, and assembly costs were also reduced. Similarly, in 1990, the Montreal Protocol and the U.S. clean air act forced the electronics company Raytheon to develop CFC-free cleaning processes for electronic circuit boards, basically using water and soap. These substitutes turned out to result in higher product quality and lower production costs (Porter and van der Linde 1995a).

Environmental economists usually regard such examples as exceptional. For instance, in their survey on the relation between environmental regulation and productivity in the United States, Jaffe et al. (1995) conclude that this relation is generally negative, though relatively weak. Further, in a response to Porter and van der Linde (1995a), Palmer et al. (1995, p. 120) concede that regulation has occasionally improved firm productivity, but they hasten to add that “with literally hundreds of thousands of firms subject to environmental regulation in the United States alone, it would be hard *not* to find instances where regulation has seemingly worked to a polluting firm’s advantage.” This attitude is closely related to the theoretical point that, if firms are optimizing agents, then, at least under competitive conditions, they will not benefit from environmental regulation. Such an argument is clearly very relevant, but it assumes away the organizational inefficiencies emphasized by Porter, so that it is too simple to dismiss his point on these grounds. To address his claim, it seems more appropriate to use a framework where organizational inefficiencies are possible in principle and to show why, despite such inefficiencies, environmental policy is unlikely to lead to profit increases for the affected firms.

¹For example, Porter (1991), Porter and van der Linde (1995a,1995b).

For such an approach, it is helpful to distinguish between short-term and long-term innovation offsets. In some of the examples discussed by Porter, the innovations were *short-term*, small changes in processes not requiring big investments, and they had very short pay-back periods. The CFC example is only one of them; other interesting stories include material savings from recycling scraps, and, in particular, many examples where it took environmental regulation to induce massive energy savings; see also Cebon 1992 and De Canio 1993. These authors also attempt to explain why firms (and other organizations) often do not make use of opportunities for energy-saving in the absence of regulation. In two recent papers, Gabel and Sinclair-Desgagné (1998,2000) move towards a more general explanation of why organizations are sometimes slow to pick „low-hanging fruits“, i.e., reap the benefits of certain short-term, low cost innovations. Essentially, the argument, which builds from organizational theories relying on bounded rationality (e.g. Cyert and March 1992) is as follows. Firms take time to develop organizational structures and routines, and these routines are adapted to the organizational environment. These routines cannot be changed rapidly. In particular, a firm may be lacking the routines to look for some kinds of profitable improvements in the absence of external pressure. In some cases, the necessity to comply with regulation may provide the necessary pressure.

Contrary to the papers just quoted, this paper mainly deals with *long-term* innovation offsets. My arguments are more readily applicable to those cases where a product needs to be totally redesigned, involving non-trivial fixed costs, as in the Hitachi example. Of course, there is a straightforward argument why firms might refrain from such innovations: even if the innovation eventually leads to a greater cash flow, the fixed costs may be too high to justify these benefits. Hence, it may be perfectly rational for a firm not to implement such changes, and environmental regulation inducing such changes cannot be regarded as beneficial from the firm's point of view. Another trivial argument why firms might often *appear* to be foregoing the gains of long-term innovations in the absence of regulation is the following: when there is uncertainty about the cash flows generated by any project, a firm might decide not to pursue it. If, in such a situation regulation leads to the implementation of changes that are beneficial *ex post* and have initially been discarded by the firm, this may just be because a state of the world has materialized that was judged as unlikely initially. Hence, with the benefit of hindsight it may seem as though firms

have decided incorrectly, even though their decision was correct *ex ante*. In the following, I shall analyze a slightly more subtle point to explain why firms might refrain from cost-reducing innovations. I shall show that, in principle, such innovations may not even take place when they would increase a firm's long-run profits, properly discounted, and I shall explore the limitations of this idea.

The argument is based on incentive considerations. Decisions about such innovations with a long-run impact are usually not taken by firm owners, but by managers and other employees. Unlike the owners, these agents will usually be less concerned about the effects of their decisions on long-run firm profits. Instead, they will probably consider the effect on their career chances, on their remuneration, and on their job quality (effort, etc.). Owners can, in principle, try to align the employees' objectives with the goal of profit maximization. However, this is usually not simple. In particular, models of Bresnahan et al. (1991), Stein (1988,1989), and Zeckhauser and Pound (1990) have shown that, with asymmetric information, owners will find it difficult to give sufficient long-run incentives for managers. The arguments are variants of the following. Suppose managers can devote time to different activities that increase short-term profits and long-run profits respectively, and the relation between effort and short-term performance is easier to observe than the relation between effort and long-term performance. Then, an excessive allocation of efforts to short-term activities might result. This problem is compounded when managers have a limited time horizon. If a manager expects to retire or change employers soon, his incentives to engage in long-run investments will be particularly low (Milgrom and Roberts 1992, 432-433).²

Because of these incentive problems, firms are not likely to invest enough from the owners' point of view. In particular, they might refrain from innovative activities that can potentially improve productivity and at the same time reduce pollution, even when they are likely to increase expected profits.³ *In principle*, therefore, if managers are indeed myopic, environmental

²Additional incentive problems might arise in multi-divisional firms if cost-reducing innovations in one division yield positive externalities for other divisions.

³There are of course possible countervailing forces. For instance, managers may engage in excessive investments to have a "visible impact" on the firm.

regulation might induce activities that increase long-term profits, and are therefore in the long-term interests of owners.

In this paper, I shall investigate whether these incentive issues can indeed support the idea that firms benefit from environmental regulation. In section 2, I shall present a simple model of environmental regulation in the presence of internal inefficiencies. The assumptions are chosen so that, on the one hand, regulation will subject firms to costs, but on the other hand, it may help to alleviate incentive problems between owners and managers. Using this model, I shall ask: under which circumstances do the positive effects of environmental regulation on expected profits outweigh the negative effects? Section 3 applies the general results of section 2 to two special cases. Section 4 interprets the findings of the model and sketches directions for future research.

2 The Model

Consider a polluting firm that operates on a product market in period 2 in a fashion that is left unspecified for the moment. The firm could be a monopolist, an oligopolist or a perfectly competitive firm. The assumptions will clarify that the innovation can be interpreted as the introduction of a low-pollution technology with innovation offsets. In period 1, the firm can carry out an investment, at costs K . I shall write $I=1$ if the firm invests, $I=0$ if it does not. Suppose first that the firm does not invest in period 1. Then, its technology in period 2 is described as follows. If the firm produces output x and makes no attempts to reduce its emissions, its production costs are given by $C(x)$ where $C_x, C_{xx} \geq 0$, and its emissions level is $E(x)$, where $E_x > 0$. If the firm reduces the emissions level to some $e < E(x)$, it has to incur abatement costs $R(x, e)$ such that

$$R_x > 0, R_e < 0; R_{ee} > 0; R_{xx} \geq 0. \quad (1)$$

A firm that has invested in period 1 affects its production and abatement costs in period 2. If a firm invests, production costs are $\alpha_x C(x)$, $\alpha_x > 0$; abatement costs are $\alpha_e R(x, e)$; $\alpha_e \geq 0$. Most of the time, shall be concerned with the case that both production and abatement costs are lowered, that is, $\alpha_x < 1$ and $\alpha_e < 1$. In principle, however, one could also think of investments where $\alpha_x > 1$

and $\alpha_e < 1$. For instance, an end-of-the-pipe technology might reduce compliance costs but increase variable production costs.⁴

The firm's activity may or may not be subject to environmental regulation. For the moment, consider regulation as a dichotomous choice with $U=1$ if regulation takes place and $U=0$ if it does not. Just as market structure, the precise nature of environmental regulation is left unspecified for now. However, assume that for each combination of environmental policy U and investment I , the firm's product market profits are uniquely determined as $\Pi(U, I)$. In addition, we require the following assumption.

Assumption 1: $\Pi(0, I) > \Pi(1, I)$ for $I=0, 1$.

Hence, for *given* levels of investment, environmental policy affects profits negatively.

Apart from assumption 1, two further conditions will play an important role.

Condition A (Innovation Offsets): $\Pi(0, 1) - \Pi(0, 0) > 0$.

Hence, if this condition holds, then, ignoring fixed costs, the effect of the innovation on firm profits is positive even when there is no environmental regulation. For most frameworks, this will hold because of the cost-reducing nature of the innovation.

Condition B (Environmental Benefits): $\Pi(1, 1) - \Pi(1, 0) > \Pi(0, 1) - \Pi(0, 0)$.

This says that the innovation has additional positive effects on profits that are relevant only when there is environmental policy. This is related to our earlier assumption that innovation reduces abatement costs and hence the costs of complying with environmental regulation, but it is not identical, as the examples below will show.

now turn to the crucial assumption of the model. Investment decisions are taken by managers. Motivated by the models quoted in the introduction, assume that managers and owners both maximize expected profits, but that managers do not operate with the discount factor that the owners would want to be applied. Suppose the discount factors for the owner and manager are $\delta_o \in [0, 1]$ and $\delta_m \in [0, 1]$, respectively⁵; usually we expect that the manager's discount factor is

⁴ Similarly, an innovation that reduces production costs at the expense of higher compliance costs would satisfy $\alpha_x < 1$, $\alpha_e > 1$.

⁵ As usual, the discount factor is $1/(1+r)$, where r is the discount rate.

smaller than the owner's. This is not saying that managers are less patient than owners; it merely reflects the difficulties of giving them long-run incentives, arising for instance, because the relation between managerial activities and long-term success is harder to prove than the relation between these activities and short-term success, or because managers might be unsure about how much longer they will stay in the firm.

Dropping indices, the expected two-period profit is $\delta\Pi(U,1) - K$ if the firm innovates; $\delta\Pi(U,0)$ otherwise. The following result holds.

Proposition 1: *Environmental regulation increases the expected two-period profit from the owner's point of view by inducing an innovation, if and only if the following conditions hold.*

$$(2a) \quad \delta_o [\Pi(0,1) - \Pi(0,0)] > K > \delta_m [\Pi(0,1) - \Pi(0,0)].$$

$$(2b) \quad \delta_m [\Pi(1,1) - \Pi(1,0)] > K.$$

$$(2c) \quad \delta_o [\Pi(1,1) - \Pi(0,0)] > K.$$

In particular, conditions A and B, and $\delta_o > \delta_m$ are necessary for environmental regulation to increase owners' profits.

The result is straightforward to prove. The intuition for the conditions is as follows.

(2a) Without environmental policy there must be a genuine conflict of interest between owners and managers. Specifically, the owner would like the innovation to be carried out, because the resulting increase in profits weighed with the owner's discount factor exceeds the fixed costs, while the manager would prefer to abstain from innovation, because the resulting increase in profits weighed with the manager's discount factor is lower than the fixed cost. Even if condition A holds, that is, innovation offsets exist, this can obviously only happen if $\delta^o > \delta^m$: then, the profit increase $\Pi(0,1) - \Pi(0,0)$ resulting from the innovation may be high enough to justify the initial fixed costs from the owner's point of view, while the managers do not put enough weight on the future to carry out the decision.

(2b) Environmental regulation must solve the conflict of interest by inducing the manager to invest. This might happen if condition B holds. Then, environmental regulation makes the innovation more attractive because, apart from the productivity effects, abatement costs become relevant as well. Even the manager who weighs the future less than the owner may be induced to

carry out this innovation because under condition B, the benefits from innovation are higher than without regulation.

(2c) For the owner, the beneficial effect $\delta_e [\Pi(1,1) - \Pi(1,0)]$ of environmental policy (the manager is induced to innovate) must not only outweigh the fixed costs K , but also the negative effect of compliance $\delta_e [\Pi(0,0) - \Pi(1,0)]$. This is equivalent with (2c). Note that this condition implies the first inequality in (2a). For suppose an owner prefers innovation and regulation to no innovation and no regulation. Then he must at least prefer innovation without regulation to no innovation without regulation by assumption 1.

To sum up, beyond the requirement that innovation offsets exist and managers do not face adequate incentives, three further (non-trivial) conditions must be fulfilled for environmental regulation to increase profits. In the next section, I shall give specific examples to show that these three conditions can, in principle, be satisfied simultaneously, and to clarify comparative statics.

Before doing so, some additional remarks on the source of the problem are in order. So far, the difference between the discount rates of managers and principals was simply taken as given. Is there anything the owners could do to solve the problems resulting from short-termism? There are certainly some possibilities here. For instance, suppose frequent job change is the reason why managers do not give much weight to the long term. Suitable long-term contracts, where employees pay an up-front bond and face an increasing wage profile afterwards, could act as a remedy. However, such contracts may be costly for the firms — employees are likely to demand compensation for the implied loss in mobility. Alternatively, the principal might want to induce long-term effort by rewarding them particularly generously when actions turn out to have favorable long-term effects. Again, there is a clear limitation for such an approach: the more time has passed between managerial decision and the outcome of the decision, the less clear is the causal relation between the two. Hence, to some extent trying to reward the long-term would have to rely on measuring the unmeasurable.

3 Examples

In this section, I shall consider two examples with a specified type of regulation and behavior of the firm, so as to understand more precisely what conditions (2a)-(2c) mean.

Example 1

Consider a monopolist who produces a homogeneous good in period 2 with emissions as a by-product. If the firm does not innovate, it produces with constant unit costs c and a maximal emissions level of 1 per unit output. Hence, using the terminology of the last section, if the firm innovates, its unit production costs are $\alpha_x c$ for the maximal emissions level, and reduction costs are $\alpha_e R(x, e)$. Finally, assume that the firm faces unit demand: up to a reservation value of p , consumers are willing to buy one unit of the good produced by the monopolist. For higher values, demand is zero.

When there is no environmental regulation, the firm's profit in period 2 is therefore given as $\Pi(0, 1) = p - \alpha_x c$ if it innovates, $\Pi(0, 0) = p - c$ if it does not.

Now suppose there is environmental regulation. First, as a benchmark case consider a very rigid form of regulation demanding that the firm achieves the emissions target e^* , using the existing end-of-the-pipe abatement technology. Suppose the reduction costs necessary to fulfill this requirement are $r = R(1, e^*) > 0$. Hence, with rigid environmental regulation and without innovation, the firm's profits are $\Pi(1, 0) = p - c - r$, with innovation they are $\Pi(1, 1) = p - \alpha_x c - r$. Then, condition B is not satisfied. Intuitively, as environmental regulation demands the introduction of the end-of the-pipe technology, the costs of compliance are the costs of introducing this technology, no matter whether the innovation takes place or not. Hence, the following result is obvious.

Corollary 1: *In this example, end-of-the pipe-regulation never increases profits.*

Now suppose that firms still have to reduce emissions by the same amount, but regulation is more flexible in the sense that it does not specify the use of the end-of-the-pipe technology, but also allows the firm to introduce an innovation. Hence, expected net profit in period 2 is

$\Pi(1,1) = p - \alpha_x c - \alpha_e r$ if the innovation is carried out. If, in spite of this “flexible” regulation, a firm does not innovate, and applies the existing end-of-the-pipe technology, $\Pi(1,0) = p - c - r$.

Total expected profit for a firm facing flexible regulation is $\delta\Pi(1,1) - K = \delta[p - \alpha_x c - \alpha_e r] - K$ if it innovates; $\delta\Pi(1,0) = \delta[p - c - r]$ otherwise. When there is no regulation, total expected profit for the firm is $\delta\Pi(0,1) - K = \delta[p - \alpha_x c] - K$ if it innovates; $\delta\Pi(0,0) = \delta[p - c]$ otherwise.

In this setting, application of proposition 1 yields the following result.

Corollary 2: *Environmental regulation increases the expected two-period profit from the owner’s point of view by inducing an innovation if and only if the following conditions hold.*

$$(3a) \quad \delta_o(1 - \alpha_x)c > K > \delta_m(1 - \alpha_x)c.$$

$$(3b) \quad \delta_m[(1 - \alpha_x)c + (1 - \alpha_e)r] > K.$$

$$(3c) \quad \delta_o[(1 - \alpha_x)c - \delta_o\alpha_e r] > K.$$

For the proof, note that conditions (3a)-(3c) correspond to (2a)-(2c) of proposition 1 for the special case under consideration.

Corollary 2 has some straightforward comparative statics implications, which are summarized as follows.

Corollary 3 *For the owner to benefit from environmental regulation, it is necessary that:*

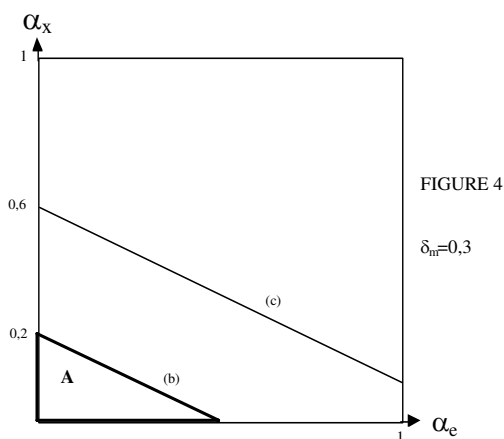
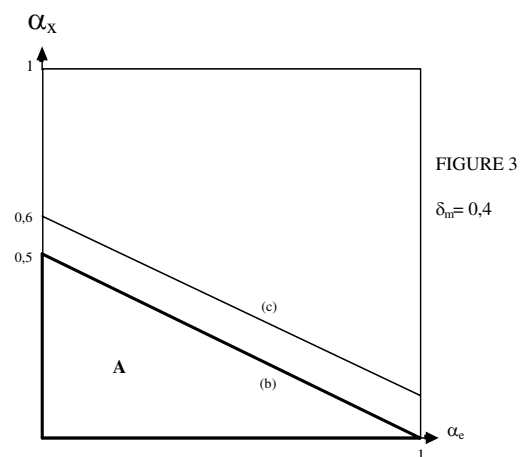
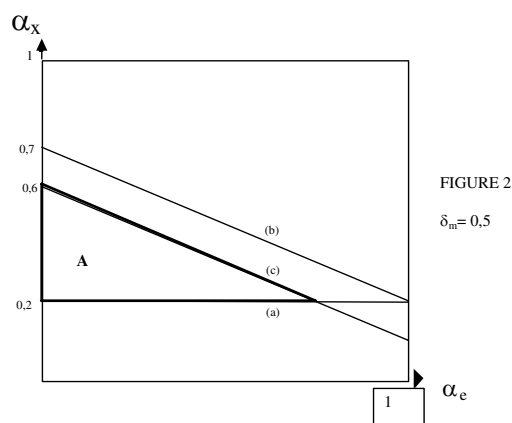
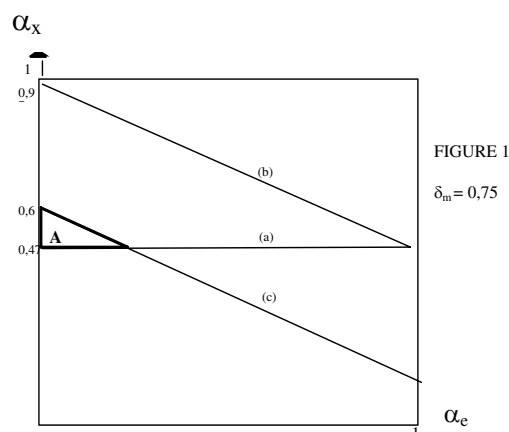
- δ_m is smaller than δ_o , but not too small.
- α_e is sufficiently small;
- α_x is neither too high nor too small relative to K .

The intuition for the result goes as follows. δ_m must be smaller than δ_o , for otherwise there is no incentive problem that can be solved by environmental regulation ((3a) does not hold).⁶ However, if δ_m becomes too small, then even with environmental regulation the manager will not innovate ((3b) does not hold). The greater the effect of the new technology on abatement costs, i.e., the smaller α_e , the more likely it is that the manager will be induced to innovate by environmental policy ((3b)), and the more likely it is that the benefits of environmental policy

⁶Of course, if managers have higher discount factors than owners rather than lower ones, there still is an incentive problem, but from the owners point of view managers will invest too much rather than too little. Hence, if environmental regulation makes innovation more attractive, it tends to exacerbate the incentive problems.

exceed the costs from the owner's point of view ((3c)). The size of α_x relative to K indicates the positive effect of innovation when there is no regulation: the smaller α_x , the greater this effect. On the one hand, this effect must be large enough that, without regulation, the owner wants the innovation (left hand side of (3a)). On the other hand, it must not be too large; otherwise the manager innovates even without regulation (right hand side of (3a)).

FIGURES 1-4: Example 1 for parameter values $\delta_o = 1$; $c = 0,5$; $k = 0,2$; $r = 0,25$



Figures 1-4 show the implications of changes in the managerial discount factor, the abatement cost effect and the productivity effect of innovation. In all of these figures, parameters are fixed at $\delta_o = 1$; $c = 0.5$; $K = 0.2$; $r = 0.25$. The managerial discount factor is $\delta_m = 0.75$ in Figure 1, $\delta_m = 0.5$ in Figure 2; $\delta_m = 0.4$ in Figure 3; $\delta_m = 0.3$ in Figure 4. Lines (a), (b) and (c)

correspond to conditions (3a)-(3c) of corollary 2.⁷ The set A consists of all vectors (α_e, α_x) for which innovation offsets dominate over the costs of regulation.

The figures confirm the result of the corollary. The area marked “A“ contains low values of α_e and intermediate values of α_x ; it increases as δ_m grows from 0.75 to 0.5 to 0.4, and it decreases as δ_m falls to 0.3. However, note that in the last two figures, A contains low rather than intermediate values of α_x ; if managers are sufficiently impatient, it is impossible that the beneficial effects of innovation on productivity are so high that managers would have innovated even without regulation. Therefore, the last statement of corollary 3 needs to be interpreted correctly: there are values of the remaining parameters for which the restriction that α_x should not be too low has no bite.

The figure also points to another interesting fact. The line forming the upper boundary of the set A is decreasing. Hence, starting from such a boundary value, suppose the innovation has a weaker positive effect on productivity (α_x increases). For a situation to arise where the firm owners’ benefit from regulation, a simultaneous increase in the environmental effect is necessary (α_e has to increase).

Example 2

I shall now sketch another example for the set-up described in section 2. In this example, the output level is not fixed. Many of the insights carry over. However, it turns out that there is an additional reason why environmental policy might not increase profits in this setting.

Consider a firm that can first carry out a cost-reducing investment, then choose output x and emissions level e , taking prices as given. Its production technology is given by general functions $C(x)$, $E(x)$ and $R(x, e)$, satisfying the assumptions in section 2.

Environmental policy is now given by a linear emissions tax t . Accordingly,

$$\Pi(1, I) = \max_{x, e} px - \alpha_x C(x) - \alpha_e R(x, e) - te,$$

$$\Pi(0, I) = \max_x px - \alpha_x C(x)$$

⁷Recall that the left hand side of (3a) is redundant, as it is implied by (3b).

where, with a slight abuse of notation $\alpha_e = \alpha_x = 1$ for $I=0$.

In this setting, the conditions of proposition 1 may still hold in principle. However, compared to example 1, a complication arises. Not even condition B is always satisfied: even though the investment reduces compliance costs, this does not imply that it is more valuable when there is environmental regulation, i.e., that $\Pi(1,1) - \Pi(1,0) < \Pi(0,1) - \Pi(0,0)$, or equivalently, $\Pi(0,1) - \Pi(1,1) < \Pi(0,0) - \Pi(1,0)$. If the environmental policy corresponds to a marginal emissions tax, this inequality holds if and only if $\left| \frac{d}{dt} \left(\max_{x,e} (px - \alpha_x C(x) - \alpha_e R(x,e) - te) \right) \right|$ is smaller for $I=1$ than for $I=0$. By the envelope theorem, the absolute value of this derivative is $e^*(I)$, the optimal emissions level for the given value of I . Hence, condition B holds if and only if the optimal emissions level is lower after the investment than it was before. This need not always be the case, because the investment could lead to an expansion of output, resulting in higher emissions despite better reduction possibilities. However, if α_x is sufficiently high relative to α_e , condition B will hold, because the expansionary effect of decreasing marginal production costs is relatively small.

Suppose for instance that $C(x,e) = cx^2$, $E(x)=x$ and $R(x,e) = x\left(\frac{x-e}{e}\right)$. Then, it can be shown that for parameter values $\alpha_e=4/9$; $\alpha_x=1/2$; $p=10$; $c=2$; $\delta_o = 1$, there is no choice of taxes and managerial discount factors such that condition B holds. Intuitively, in this case, the profit increase due to investment is lower with environmental policy than without because regulation leads to a major contraction of output, so that the productivity gains become small.

4. Interpretation

The model shows that environmental regulation may be beneficial for firm owners when several conditions concerning the firm's internal organization, the nature of the regulation, and the kind of potential innovation are satisfied.

With respect to internal organization, I emphasized the role of incentive problems. On the one hand, we saw that incentive problems may play a role in generating the inefficiencies causing innovation offsets. On the other hand, greater incentive problems do not necessarily imply that regulation is more likely to have positive effects on firms: for regulation to be beneficial from the

owner's point of view, differences in time preferences of principal and agent should be of medium size.

Further, unsurprisingly, the nature of environmental policy is important. In the example, we saw that innovation offsets can only arise when policy is sufficiently flexible: a policy that targets only end-of-the-pipe technologies cannot be beneficial for the firm.⁸ In addition, and somewhat beyond the modeling framework, the timing of policy is important. Policy that demands the immediate reduction of emissions will favor off-the-shelf solutions: firms will not have much choice but to respond by applying best available technologies. Firms will only be able to engage in innovative activities when some advance warning is given.

Finally, the nature of potential environmental innovation projects plays a crucial role. In the example, we saw that innovation projects with "medium" level productivity effects and high abatement cost effects are particularly likely to lead to innovation offsets that dominate abatement costs. Beyond that, the time structure matters: it is important that benefits of innovation arise mainly in the long run.

The most interesting element is organizational structure. With respect to this issue, there are two further directions for research.

As a first extension, it is important to relate the likelihood of the organizational inefficiencies that are responsible for innovation offsets to the market environment. Intuition suggests that such links exist. The nature of product market competition, for instance, helps to determine how likely internal inefficiencies are. First, with little competitive pressure, firms with organizational slack are more likely to survive. Further, it is generally harder to measure managerial performance and thus to give appropriate incentives when there are few competitors in the market whose performance can serve as a yardstick for the performance of the own firm's managers (Holmström and Tirole 1989). This suggests that innovation offsets are more likely in markets with little competition. The nature of the market for skilled labor also influences whether organizational or strategic inefficiencies are likely to arise. High managerial mobility makes it

⁸However, even a policy that imposes the adoption of best available processes might be beneficial for a firm if internal inefficiencies prevented the adoption in the absence of environmental regulation. Of course, in this setting, we would not want to speak of "innovation offsets".

more likely that managers lack appropriate incentives to engage in long-run investments. Finally, financial markets might play a role. Well-functioning markets are often said to prevent deviations from profit maximization: a firm that does not maximize profits will be a likely target for takeovers. While this takeover mechanism is unlikely to be perfect (see Scherer and Ross 1990), there should at least be a negative relationship between the effectiveness of the market for corporate control and the likelihood of innovation offsets.

A second extension pertains to the case where regulation has short-term innovation offsets. In this case, the organizational failure must be different from the one described in this paper. For instance, in some of the cases discussed by Porter, environmental regulation sparked off internal communication, eventually leading to the discovery of innovation possibilities. Typically, waste management personnel detected pollutants; with the help of other experts the causes of pollution were then traced back to the process design (Porter and van der Linde 1995b, p. 122). The processes could then be adjusted to alleviate the problem. Without environmental regulation, the necessary communication between waste management personnel and process engineers might never have taken place. Related issues have been investigated in great depth by Aoki (1986,1990), who argues convincingly that a firm's ability to discover and implement different types of innovations may depend strongly on its organizational structure. In particular, job design is important: firms that rely heavily on specialization advantages and do not allow their employees to spend some time learning about related jobs within the firm might not be aware of possibilities for cost reduction that presuppose "horizontal" internal communication. Therefore, if typical innovations with positive effects on the environment and on productivity indeed rely heavily on internal communication between organizational members, then environmental regulations may have positive effects by fostering communication that does not take place on a regular basis within the regulated firms. A complementary approach to the one presented here would try to determine the conditions under which environmental regulation would increase expected profits in a setting with imperfect internal communication.

5. Conclusions

This paper analyzed circumstances under which environmental regulation might raise the expected profits of firms, contrary to traditional neoclassical theory. More precisely, I investigated whether regulation might lead to such an increase by inducing myopic managers to carry out cost-reducing investments with positive effects on the environment. The analysis suggests that several additional conditions need to be fulfilled for environmental policy to increase firm profits. Thus, this paper finds little support for the argument that the benefits from innovation offsets *regularly* exceed the costs.⁹

The more important contribution of this paper is to identify several factors pertaining to the likelihood of innovation offsets: the type of regulation, technological factors, market environment and firm structure. Hence, while the analysis does not support the view that environmental policy with zero or negative costs is realistic, it yields a slightly more subtle contribution. Thinking about innovation offsets helps us to understand which circumstances determine the costs of environmental policy, as, other things being equal, they are inversely related to the likelihood of innovation offsets.

Among the factors influencing whether innovation offsets take place, the role of firm structure seems to be of more general relevance. Although many economists are showing increasing willingness to deal with the interior of firms, environmental economists have been reluctant to embrace this tendency.¹⁰ While many important insights for environmental policy have been gained by using abstractions such as the profit-maximizing firm, the time may have come to check what we can learn from treating firms as collections of individuals with different goals and information-processing capacities. Possibly, the main insight from such an approach would be that many of our familiar results carry over unscathed to a modified environment — but even that would be a contribution.

⁹A model that relies more strongly on internal communication problems than on incentive issues might change this, but I am not totally convinced.

¹⁰Exceptions include recent papers by Gabel and Sinclair-Desgagné (1993, 1998, 2000) and Sinclair-Desgagné and Gabel (1997).

References

- Aoki, M. (1986), "Horizontal vs. Vertical Information Structure of the Firm," *American Economic Review* 76, 971-983.
- Aoki, M. (1990), "Towards an Economic Model of the Japanese Firm," *Journal of Economic Literature* 28, 1-27.
- Bresnahan, T., Milgrom, P., and Paul, J. (1991), "The Real Output of the Stock Exchange," in Z. Griliches, ed., *Output Measurement in the Services Sector*, University of Chicago Press, Chicago.
- Cebon, P. "Twixt Lip and Cup: Organizational Behaviour, Technical Prediction and Conservation Practices," *Energy Policy*, 20, 802-814.
- Cyert, R. and March, J. (1992), *A Behavioral Theory of the Firm*, 2nd. ed., Blackwell, Cambridge.
- De Canio, S. "Barriers within Firms to Energy-Efficient Investments," *Energy Policy*, 21, 906-914.
- Gabel, L., and Sinclair-Desgagné, B. (1993), "Managerial Incentives and Environmental Compliance," *Journal of Environmental Economics and Management* 24, 229-240.
- Gabel, L., and Sinclair-Desgagné, B. (1998), "The Firm, its Routines, and the Environment," in T.H. Tietenberg and H. Folmer (eds.), *The International Yearbook of Environmental and Resource Economics 1998/99: A Survey of Current Issues*, Edward Elgar, Cheltenham.
- Gabel, L., and Sinclair-Desgagné, B. (1998), "The Firm, its Procedures, and Win-Win Environmental Regulations," forthcoming in H. Folmer et al. (eds.), *Frontiers of Environmental Economics*, Edward Elgar, Cheltenham.
- Holmström, B., and Tirole, J. (1989), "The Theory of the Firm," in R. Schmalensee and R.D. Willig (eds.), *Handbook of Industrial Organization*, North-Holland, Amsterdam.
- Jaffe, A.B., Peterson, S.R., Portney, P.R., and Stavins, R. (1995), "Environmental Regulation and the Competitiveness of U.S. Manufacturing," *Journal of Economic Literature* 33, 132-163.
- Milgrom, P., and Roberts, J. (1992), *Economics, Organization & Management*, Prentice-Hall, Englewood Cliffs, NJ.

Palmer, K., Oates, W.E., and Portney, P.R. (1995), "Tightening Environmental Standards: The Benefit-Cost or the No-Cost Paradigm?" *Journal of Economic Perspectives* 9, 119-132.

Porter, M.E. (1991), "America's Green Strategy," *Scientific American* 264, 168.

Porter, M.E. and van der Linde, C. (1995a), "Towards a New Conception of the Environment-Competitiveness Relationship," *Journal of Economic Perspectives* 9, 97-118.

Porter, M.E. and van der Linde, C. (1995b), "Green and Competitive: Breaking the Stalemate," *Harvard Business Review*, September-October 1995, 120-134.

Scherer, F. and Ross, D. (1990), *Industrial Market Structure and Economic Performance*, 3rd ed., Rand-Mc Nally, Chicago.

Sinclair-Desgagné, B., and Gabel, H.L. (1997), "Environmental Auditing in Management Systems and Public Policy," *Journal of Environmental Economics and Management* 33, 331-346.

Stein, J. (1988), "Takeover Threats and Managerial Myopia," *Journal of Political Economy* 96, 61-80.

Stein, J. (1989), "Efficient Capital Markets, Inefficient Firms: A Model of Myopic Corporate Behavior," *Quarterly Journal of Economics* 104, 655-670.

Zeckhauser, R., and Pound, J. (1990), "Are Large Shareholders Effective Monitors? An Investigation of Share Ownership and Corporate Performance," in R. G. Hubbard, ed., *Asymmetric Information, Corporate Finance, and Investment*, Chicago University Press, Chicago.

