THE FIRM, ITS ROUTINES, AND THE ENVIRONMENT

by

H. L. GABEL*
and
B. SINCLAIR-DESGAGNE**

97/05/EPS

This working paper was published in the context of INSEAD's Centre for the Management of Environmental Resources, an R&D partnership sponsored by Ciba-Geigy, Danfoss, Otto Group and Royal Dutch/Shell and Sandoz AG.

* Professor of Economics and Management at INSEAD, Boulevard de Constance, 77305 Fontainebleau Cedex, France.

** Ecole Polytechnique de Montréal and CIRANO, 2020 University, Montréal, Québec.

23 January 1997

The firm, its routines, and the environment

H. Landis Gabel[1]

Bernard Sinclair-Desgagné[2]

Abstract

This paper starts with the critical observation that neoclassical environmental economics is inconsistent in assuming that markets are flawed but that firms are perfect. By assumption, firms flawlessly maximize profits. From this point, the paper goes on to examine in a non-mathematical way how the neoclassical model of the firm might be modified to allow for the inclusion of an organizational constraint deriving from an organization's need to control its agents' behaviour with internal management systems, policies, standard operating procedures, and routines. When a firm is modelled in this way, one can explain some interesting organizational failures. These organizational failures are defined as deviations from the behaviour of the simpler neoclassical firm.

The authors use their model to explain an observation that has generated considerable controversy in the literature on environmental policy. That observation is that strict environmental regulations may prompt companies to find profitable opportunities which they had overlooked previously (sometimes called "low hanging fruit"). The authors conclude the paper with the corporate and public policy implications of their results.

Introduction: The neoclassical paradigm and environmental economics

> The firm in mainstream economic theory has often been described as a 'black box.' And so it is. This is very extraordinary given that most resources in a modern economic system are employed within firms, with how these resources are used dependent on administrative decisions and not directly on the operation of a market.
>
> (Coase, 1992 p.714)

> Most production in modern economies occurs within organizations, and this production is regulated only to a limited extent by prices. . . . These observations make it clear that if economists wish to understand how resources in modern economies are allocated, we must understand what goes on inside organizations.
>
> (Stiglitz, 1991 p. 15)

It has been customary among environmental economists schooled in the neoclassical tradition to assume that the link between environmental regulatory policy and the allocation of environmental resources is very simple. It is a perfectly rational and efficient black box firm which maximizes profits given whatever technological, market, and regulatory policy constraints are imposed on it. Because economists have long assumed that the firm behaves in this way, and have been content to model its behaviour as such, they saw no reason to pierce the corporate veil to understand in microanalytic detail the management processes taking place within the firm.

This tradition has had several predictable results. One was that economists concerned with environmental problems focused their attention almost exclusively on public policy instruments applicable outside the firm. This was natural since their model provided little substance to the firm, *per se*. The model was more concerned with the web of market relationships between the firm and other economic agents, so economists naturally believed that environmental problems originated in the market. The assumed cause of the problems was reality's violation of some assumption critical to sustaining the efficiency of a perfect market. For example, the neoclassical model assumes that producers and consumers, the decision makers in the model, bear all the costs of their decisions. If third parties bear some of these costs (called 'external costs'), as is typical with the environment, then the decision makers' incentives are distorted, and the market will fail to function efficiently. The consequence of market failure is typically that natural resources are over-used (polluted, to use the pejorative term).

Since environmental problems had to originate in market relationships, it was natural to seek to solve them by fixing the market's flaws. Economists have for several generations proselytized for the cause of public policy instruments that do so. Marketable quotas which establish property rights to environmental resources, effluent taxes which increase inefficiently low prices, and legal liability for compensating victims of third-party damage are favoured instruments.

A second predictable result of the neoclassical paradigm was that although managers of business firms foundered trying to cope with the rising tide of environmental pressures, of which public policy was only one, economists had little advice to offer. Proffered advice came from other academics and business consultants,[3] but it lacked the rigour characteristic of economic science. In particular, there has been little rigorous analysis of how a company's environmental strategy is operationalized in the management control systems, formal and informal, that would normally convert strategy into action.

None of this is said to criticize economic analysis of market failure or to detract from economists' well-founded enthusiasm for market-based policy instruments. Rather, it is to suggest that the logic that looks for failed assumptions to the neoclassical model of the market should be carried into the firm. It is inconsistent, albeit convenient, to assume that markets are flawed but that firms are perfect.

Firms are, of course, exceedingly complex institutions, and profit maximization is far from trivially easy even in a context of relatively simple and stable market relationships. Instead of a sole and rational decision maker who maximizes the firm's value, any reasonably large real firm has a titular principal, its chief executive officer, but it is actually 'run' by vast numbers of agents, to many of whom may be delegated a great deal of autonomy to manage their day-to-day activities. These activities are controlled and co-ordinated, however, by a set of interrelated management systems and a multitude of procedures for operationalizing the principal's objectives.

The point to emphasize is that the principal does not directly make the decisions that determine the firm's performance. Rather, the process is indirect. Profit maximization must be accomplished - or attempted - via this network of necessarily imperfect systems and procedures that link the principal's objectives to the agents' actions.[4] We use the term 'management systems' broadly to include formal systems (budgeting, accounting, compensation, etc.), corporate policies, standard operating procedures, and simpler work routines and habits, many of which may not be explicitly defined.[5] These systems are the grist of consulting firms and the management literature, they hold centre stage in business school curricula, and they preoccupy practising managers. To assume that the firm simply and perfectly maximizes profit is to assume away one of the main challenges facing its managers.[6]

Thus, the link between environmental regulatory policy and the allocation of environmental resources is complex, multistep, and imperfect. Regulatory policy is only a first step. That policy may occasionally intervene in the management systems themselves, but more commonly, it alters the external rules to which the corporate principal is subject. These altered rules must then induce the principal to change the management systems which play a crucial role motivating and controlling the actions of the agents. Finally, the agents must respond to the changes in the management systems, presumably in consort with the objectives of both the corporate principal and the regulatory policy maker. Only at this last step is there an environmental impact.

In these steps, there are invariably slips that break the direct link traditionally assumed between the regulator and the environment. Managers have limited attention spans, information flows imperfectly between managers and employees, and employees work according to their own objectives.

All these imperfections and more cause organizational failures within the firm. As we will argue in this paper, these organizational failures are systematic, they are in many respects similar to the market failures long studied by environmental economists, and there are instruments available to fix them analogous to the instruments available to fix markets.

Because our focus is within the firm, our analysis is not just relevant to the public policy maker. It should be obvious that organizational failures are relevant to the firm's management as well, since their manifestation is frequently unachieved profit potential. To give an example which will reappear below, if a firm is systematically losing money by wasting environmental resources, the firm's management would like to know it as much as, and possibly more than, the environmental policy maker.

The objective of the paper is to show that organizational failure is pervasive and systematic, that it has important implications for environmental management, and thus that it is an interesting phenomenon for academics, business managers, and public policy makers to understand.

This paper is organized as follows. In the next section, we will look at the evidence that justifies our interest in going beyond the market and entering the firm's doors. It is not enough simply to argue that the neoclassical assumption that the firm is a unitary rational decision maker is literally false. It is, after all, just an assumption. The evidence we examine is a claim that has attracted much attention: that strict environmental regulations might be 'win-win', simultaneously reducing the firm's private costs and the external costs it imposes on the environment. We discuss this claim, then present a non-technical model of the phenomenon. That is followed by sections on corporate and public policy implications. The paper ends with some conclusions.

Low hanging fruit and win-win environmental regulations

> Economists . . . tend to regard energy efficiency like the man whose friend draws his attention to a £20 note lying on the pavement. 'It can't be,' he says. 'If it were, somebody would have picked it up.'
>
> Every scheme to encourage investment in energy efficiency finds plenty of what the industry calls 'low hanging fruit' - projects with succulent returns. Robert Ayres, in a paper at a conference on energy and the environment in the 21st century at the Massachusetts Institute of Technology last year, drew attention to the 'energy contest' begun in 1981 by the Louisiana division of Dow Chemical, to find capital projects costing less than $200,000 with payback times of less than a year. In 1982 the contest yielded 27 projects in which Dow invested $1.7m: the return averaged 173% (a payback period of about seven months). The contest continued, with more projects backed each year. In 1988 95 projects were picked, costing a total of $21.9m - and yielding an average return of 190%.
>
> (*The Economist*, 1991 p.15)

Dow's experience is not unique. The 3M company has eliminated 500,000 tons of waste and pollutants and saved $482 million in so doing and another $650 million by energy conservation since it started its 3P ('Pollution Prevention Pays') programme in 1975. An eighteen-month project run by the Centre for the Exploitation of Science and Technology in the UK to test the benefits of waste reduction and clean technologies saved more than £11 million a year for the eleven participating companies, mostly from simple changes in processes which reduced inputs of water, energy, and raw materials. The US Environmental Protection Agency has estimated that if the entire country were to switch to energy-efficient lighting, its electricity bill would fall by 10% and air pollution would be reduced by between 4 and 7%. The Agency's Green Lights Program, initiated in 1991, has helped companies switch to energy-efficient lighting to save money and the environment.

There seems to be anecdotal evidence that low hanging fruit is abundant; so abundant that Michael Porter, in an article published in *Scientific American*, claimed that

> Strict environmental regulations do not inevitably hinder competitive advantage against foreign rivals, indeed, they often enhance it.
>
> (Porter, 1991 p.96)

That is, environmental policies are potentially win-win policies. They may prompt firms to see and pick low hanging fruit - a harvest for both the environment and for those firms.

The significance of what has become known as the 'Porter Hypothesis' is that it apparently contradicts the conventional wisdom that environmental regulations shift formerly external costs back onto firms, burdening them relative to competing firms in countries with less strict regulations. Porter has subsequently elaborated on the hypothesis with many more examples (Porter and van der Linde, 1995), and others have taken up his argument, including senior officials in the US government (Gore, 1993).

The precise claim and meaning of the Porter Hypothesis are unclear because Porter's original examples mix several different ways by which the hypothesis could be true. The box that follows attempts to categorize these ways to show that most are actually not controversial. The only one that is, at least to mainstream economists, is the case where regulations purportedly reduce the absolute costs of the firms subject to them. It is controversial because it requires the existence of abundant low hanging fruit, and this in turn contradicts the neoclassical model of the firm. This is the case we will address in this paper.

[Box: 'The Porter Hypothesis' about here.]

If regulations lower the costs of firms subject to them, several conditions must occur. One is that firms are not productively efficient (they are not minimizing private costs), *ex ante*. They are

operating inside a cost efficiency frontier as diagrammed in Figure 1.[7] On the frontier, a policy such as an effluent tax that shifts formerly external costs onto the firm will reduce social costs as the firm re-optimizes to reduce its effluent emissions. This will raise social welfare. But the investment costs to reduce emissions and the tax will also raise the firm's private costs and reduce its profit. The firm will move down and to the right along the trade-off curve. Only from a starting point inside the frontier (for example, at a point like 'a', above and to the right of the frontier) is it possible to reduce simultaneously both social and private costs (i.e., to move down and to the left).

Note that because social costs equal the sum of private and external costs, this is not just a cost transfer from society to the firm. If external costs were simply shifted to the firm, social costs would not change. Rather, the expectation is that when external costs are shifted to the firm, the firm will then re-optimize and in so doing reduce social costs.

Another way of illustrating this is via a marginal cost of pollution reduction curve of the sort often shown in basic economics texts.[8] Figure 2 illustrates this. The low hanging fruit metaphor assumes that the firm is operating in the region where cleanup *saves* it money; that is, to the right of E^0 at a point like E^1.

All of this presupposes, in terms we have been using, that there is an organizational failure in the firm.

[Figures 1 and 2 about here.]

A second condition is that environmental regulations, while shifting external costs to the firm, stimulate a sufficient improvement in productive efficiency to outweigh the internalized cost. Clearly, the existence of win-win opportunities neither assures that strict environmental regulations will help firms find them, nor that if found, they are valuable enough to offset the internalized costs. In diagrammatic terms, regulations must move the firm down and to the left from point 'a' in Figure 1. In Figure 2, if we were to take an effluent tax as our example, the savings from the cleanup from E^1 to E^0 must pay for both the costly cleanup from E^0 to the optimum level of effluent E^* and the tax liability incurred at E^*.[9] We can see from the figure that win-win is most likely in situations where the firm is far from the efficiency frontier, where the burden of the tax is light, and where the shift to the frontier can be made cheaply.

A final condition that is required for the hypothesis to be interesting to academics and practitioners is that it is *systematically true*. One can always find some anecdotal examples to contradict the simplifying assumptions of abstract deductive models. Porter apparently believes it is systematically and commonly true, even though he qualifies his statements with words like 'may', 'often', and 'in many cases'. Yet when he uses Japan and Germany as examples to argue that strict environmental policies have helped promote their productivity growth, he is clearly making a general statement.[10]

Porter's claim has spawned a number of papers, both pro and con, in business and academic journals. Most are anecdotal, some are theoretical, and a few are empirical. As examples, Meyer (1992) claims to find some statistical evidence in the US of a positive impact of environmental regulations on economic performance. Palmer and Simpson (1993 p. 17), by contrast, find Porter's arguments 'based on unlikely assumptions and inconclusive anecdotal evidence.' Similarly, Oates, *et. al.* (1994 p. 21) conclude that 'Until such time as we acquire more compelling evidence on the Porter Hypothesis, it is our sense that it should not be given much credence.' Walley and Whitehead (1994) believe that win-win opportunities certainly exist but that they are rare. Jaffee, *et al.* (1995 p. 159) conclude their survey paper saying, 'there is . . . little or no evidence supporting the revisionist hypothesis that environmental regulation stimulates innovation and improved international competitiveness.'

Procedures and routines in business

> People are, at best, rational in terms of what they are aware of, and they can be aware of only tiny, disjointed facets of reality.
>
> (Simon, 1985 p. 302)

> The way in which the organization searches for alternatives is substantially a function of the operating rule it has. . . . The organization uses standard operating procedures and rules of thumb to make and implement choices. In the short run these procedures dominate the decisions made.
>
> (Cyert and March, 1992 pp. 133-4)

We have already argued that the firm can be imagined as a principal who is linked to his or her agents by a network of systems and procedures. These systems, procedures, and routines are key features of any organization. Cyert and March (1992) identified several types of procedures: task performing, record keeping, information-handling, and planning. And they serve several functions including providing stability to an organization, co-ordinating and controlling agents' behaviour, and economizing on the limited time and attention which curse all of us but which are assumed away by traditional economic modelling.

Let us imagine a decision maker in a firm facing a flow of questions, problems, or demands for decisions, each of which must be resolved not only in isolation but in relation to other parts of the organization. Perhaps initially, in the process of learning a job, he or she regards each event as unique and fashions a novel resolution for each. After some time, however, patterns emerge which make it possible to categorize incoming events according to standard types and to devise standard operating procedures (SOPs) appropriate for resolving each type. To the extent that this is possible, work is more efficient.

Thus, for example, the image of a firm setting each product's price by some idiosyncratic calculus of marginal costs and revenues is inaccurate. In reality, pricing decisions are standardized; they might be done, for example, by applying a fixed profit margin to standardized cost figures generated by a highly standardized cost accounting system. As Cyert and March (1992 p.124) observed, pricing decisions are 'almost as routinized as production line decisions.'

Inevitably, however, there are mismatches between the actual events and their standardized types, and the firm must cope with this. It can refine further its current SOPs or create new ones. This will reduce the average mismatch between an event and a SOP, but it will raise the firm's administrative cost. Alternatively, the firm can limit the number of its SOPs, but the result will be a higher cost of mismatches.

When one imagines a firm as a collection of systems, procedures, and routines, it becomes clear that one can introduce a concept of productive efficiency which is similar but not identical to that of neoclassical economics. The firm devises its systems in order to minimize operating costs. Those systems are rigid, however, so that once they are installed, they act as a constraint on the firm's objective of profit maximization. If the costs of that constraint are great enough, the firm can invest in changing the systems. Although the system constraint on profit maximization is novel, the logic of cost minimization and thus productive efficiency should be familiar.

When one imagines a firm as we have described it, it also becomes clear that relative to a simpler neoclassical firm, our firm can make 'mistakes'. That is, the organizational constraint that we introduce will prevent the firm from seeing and reacting to opportunities or threats which would be evident to an unconstrained firm.[11] This is what we call 'organizational failure'. The failure may be either an unwitting violation of the environmental laws and regulations or a missed opportunity to make profit (that is, low hanging fruit left unpicked). We will be concerned exclusively with the latter mistake here. It should be clear, however, that the term 'organizational failure' does not connote that the firm is inefficient given the assumed need for systems and procedures to economize on managerial time.

Although we might suppose that the firm's systems, procedures, and routines are ideal when first devised, it should be clear that with the passage of time, they will become less and less so. Relative prices change, regulatory and other environmental conditions change, and the firm's competitive situation changes. If the procedures could be changed frequently, marginally, and at negligible cost, there should be no problem. Unfortunately, they cannot be. The routines which undoubtedly increase an organization's efficiency also reduce its adaptability to changing circumstances.

Networks of SOPs have many characteristics in common with networks of physical assets that must be made compatibility by technical compatibility standards.[12] One, noted above, is that they are a means of assuring compatibility between different elements of a system. Technology standards assure compatibility between software and hardware. Organizational standards assure compatibility between design, production, and marketing or between the accounting system and the compensation system. Each possible outcome of the application of a set of procedures in one part of an organization

(that is, each standard solution to a routine problem) must be matched with procedures in many other parts. A related characteristic is that any change in one SOP requires co-ordination with many other SOPs. Otherwise, behaviour in the organization will not be controlled or predictable. There is no room for unilateral action.

This implies a third characteristic, again related. A change in systems is likely to be revolutionary, disruptive, and costly. It is revolutionary in that the old systems are not pushed to evolve further but are destroyed to be replaced new ones. And conversion must be done simultaneously for a multiple of elements. It is disruptive because agents must abandon traditional patterns of behaviour in which they have specific competencies and thus value to the firm, and they must learn new routines in their place. Clearly, agents may have a personal motive to resist this; the benefits of the change may be external to them. And it is costly. Apparent resistance to change may be more than just selfishness. Experimental evidence indicates that learning new routines is more difficult and costly when old routines must first be unlearned (Shiffrin and Schneider, 1977).

One can take the example of manufacturing systems. We are all familiar with the way modern manufacturing systems with lean inventories, paced production, high quality standards at each production stage, and extremely high co-ordination, differ from their mass-production antecedent. The difference is not one of degree; it is radical. The change from the old to the new could not have been done unilaterally by any single department or work group. It would have lacked both information on what was needed and the authority to co-ordinate the related moves. There was a crucial role for the principal to make the organizational design decisions. And with relevance for what will be discussed, the new systems spread from firm to firm as information on 'best practice' spread.

One may bemoan companies' reluctance to change manufacturing systems, environmental management systems, or many others. But one should note that this rigidity can be the penalty of success. Companies are often successful because they have imbedded their routines so deep into their employees' consciousness and subconsciousness that they become part of the company culture. Indeed, one could argue that some companies amount to little more than their routines and the associated brand identity. MacDonalds is one obvious example; it is essentially the company's routines and the brand identity they connote that are franchised. IBM and Apple differ by much more than their product lines. Both firms succeeded in great part due to their routines, different though they were, and each fell victim to the rigidity of its routines when a changing situation necessitated restructuring. In the environmental domain, the Body Shop is best known not for its products but for a set of practices which support a philosophy embodying environmental virtue.

The rigidity they introduce into a firm is not the only - and possibly not the worst - curse of systems and procedures. They may also blind the firm to the changes that make those same systems and procedures obsolete. As Cyert and March observed regarding procedures for record keeping,

> The records that are kept determine in large part what aspects of the environment will be observed and what alternatives of action will be considered by the firm.
>
> (Cyert and March, 1992 p.126)

Modelling the phenomenon

We can use the analogy of a profit hill, shown in Figure 3, to model the story told above. The firm can choose among a variety of systems and procedures x and y to maximize profit - to reach the top of the profit hill marked 'A'. (The concentric rings in the figure, resembling contour lines around a hill projecting from the page, are lines of iso-value.) Imagine that the firm initially designs its systems and procedures to be perfectly suited to its situation so that it is located at 'A'. Once these choices are made, however, and the systems and procedures designed and implemented, further marginal changes are constrained by the need for compatibility among the system elements. Thus, changes in x and y are still possible, but only in a relationship such as that defined by the line 'aa'. To move off that line, the firm would have to completely scrap and rebuild its systems and procedures.

[Figure 3 about here.]

The private profit peak 'A' does not coincide with the social welfare peak, 'W', because the firm imposes external environmental costs on society. The difference in their heights is the value of the externality. This is the traditional perspective taken in environmental economics.

Initially, the firm's procedures match its situation as shown in Figure 3. Over time, however, the situation changes, but let us assume that the procedures do not. Figure 4 diagrammes the new situation. We see that the firm, still at point 'A', is not at the peak of the new profit hill, 'B'. In fact, the line 'aa' does not pass over that peak. (Imaging that a hill moves stretches our analogy, but we hope that the reader will allow us some liberty here.) Without a radical restructuring, the firm can only partially reoptimize by moving along 'aa' from point 'A' to 'C', now the highest point of 'aa'. In short, the firm's procedures are no longer a perfect match to its situation, and a performance gap develops between the firm's profit and the maximum profit available to the firm if its procedures were reset to the new situation. This gap represents what we have called 'organizational failure'.

[Figure 4 about here.]

The firm could, of course, go through a radical restructuring and reoptimization. Reoptimization of its systems and procedures would entail defining some new line like 'bb' which goes over the top of the new profit hill. Such a reoptimization, which would move the firm from 'C' to 'B', would make economic sense if in present value terms the cost of the performance gap exceeded the cost of restructuring. But this logic assumes that the firm knows where 'B' is, and this need not be so. As

we discussed before, the principal may not know what this map looks like, and if the agents do, they may not tell. They may have an incentive to make the change from 'A' to 'C' since that does not fundamentally threatening them, but the change from 'C' to 'B' definitely does. It destroys the value of their knowledge of the firm's SOPs.

If environmental regulations prompt a fundamental reoptimization of procedures from 'aa' to 'bb', such as is shown in Figure 4, can we call the result a win-win? First, the firm emerges higher on the profit hill than before (at 'B' rather than 'C'). This is because the regulations prompted changes that revealed and picked some low hanging fruit. Second, social welfare increases. (As we will discuss below, this need not be the case, but it is so as the figure is drawn.) Thus, this begins to look like a win-win. But two costs have been neglected which we must now pick up.

One cost we have neglected is that of regulatory compliance. If, for example, the shock that prompts the reoptimization of procedures is a new effluent tax or legal liability, there will be an explicit compliance cost. For example, a tax on carbon emissions will result in expenses for energy saving devices and tax payments for the continuing, albeit diminished, emissions. New legal liability will result in expenditures to reduce risk plus penalties for the occasional, albeit less likely, accident.

We can model this as shown in Figure 5. Start with the firm's profit level at 'C', which is the best it can achieve using the set of procedures optimally suited to past conditions but imperfectly suited to the conditions represented by the mountain with a peak 'B' (as in Figure 4). If from that point, new and costly environmental regulations are imposed on the firm, the mountain drops as shown in Figure 5;[13] the vertically distance is a measure of the regulatory cost, *per se*. With no change, the firm's profit would deteriorate from the level 'C' to 'C*'. We can now see why the firm might make the change in procedures necessary to move from 'C*' to 'B*' even though it did not do so to move from 'C' to 'B'. The differences from 'C*' to 'B*' may exceed that from 'C' to 'B' (as is actually drawn). If the cost of revising procedures lies between the two differences, it is rational that the firm reorganize after the regulations but not before.

[Figure 5 about here.]

What we have just produced with our model fits the common interpretation and the examples of an 'absolute cost reduction' win-win regulation. (See Box: 'The Porter Hypothesis'.) Environmental regulations provoked a radical rethinking in the firm which was good for the environment, and the rethinking paid the cost of regulatory compliance with money to spare.

Unfortunately, there is a second cost that has been and is commonly neglected in accounting for win-win regulations: the cost of the management system restructuring. This is, of course, quite different from the cost of regulatory compliance, *per se*. In the frequent anecdotal references to examples of win-win regulations, the cost of management attention given to environmental issues is never priced and never counted. When we consider this cost in the context of the model, clearly environmental regulations cannot increase the firm's profit. We can see in Figure 5 that in terms of

operating profitability, 'B*' is superior to 'C'. But the firm must pay something more than 'B' minus 'C' for the restructuring. (If the restructuring cost less than that, the firm would have done it earlier.) Even though the firm found low hanging fruit, it would be better off if the environmental regulations had never been imposed.

Of course, environmental regulations may not be win-win even in this restricted sense that the low hanging fruit pays for the specific compliance costs. Many special conditions had to hold true in the model to get the result we demonstrated. One, not mentioned in the text above, is that the profit hill had to drift in the direction of the social welfare maximum. Had the hill drifted in the opposite direction from that shown in Figure 4, the firm would have moved away from the social welfare maximum.

The reader can see that this model differs little from the traditional neoclassical model. Both are models of decision makers optimizing subject to constraints. But the constraints in the neoclassical model are external to the firm. Here, by contrast, there is an internal constraint - the firm's organizational procedures. In the short run, they are given. In the long run, they are endogenous to the firm's investment decision. In this respect, the organizational constraint can be thought of as a technology or capital constraint analogous to the more familiar technology or physical capital constraints seen in neoclassical modelling. They might be modelled as given in one context and as endogenous to the firm's optimization problem in another.

The model and the story of CFCs

To give the model some life, we can rebuild it in the language of a particular case: that of CFCs in the last decades.[14]

Start with a firm in the early 1970s, using CFCs for a variety of applications with no awareness of their environmental impact.[15] Assume that the firm is then at point 'A'. Management practices and routines ('aa') ignore all but obvious legal issues concerning the environment, and this is optimal for the time.

By the late 1980s, CFCs have been convincingly implicated for ozone destruction, and the 1987 Montreal Protocol has introduced a number of restrictions on their use. That and many other changes in the environmental arena and in the firm's markets have moved the profit peak to 'B'. The firm has adapted to the changes to some extent (moving to 'C'). For example, CFCs were removed from aerosols when mandated by the US EPA in 1978. But CFCs are still used in other applications where they are legal and where the firm feels that it can easily pass the cost on to customers. Using CFCs to clean electronic circuitry is a good example.

It is important for the reader to appreciate what we are not saying at this point. We are not saying that there are no cost-effective alternatives for CFCs available to the firm. As history later showed, cheaper alternatives - low hanging fruit - are there. What we are saying is that management does not feel that it is worthwhile to pay the cost (the cost of shifting from 'aa' to 'bb') to make the

changes in systems, procedures, and even culture that are necessary to look for those alternatives. In short, no one is paying any attention to the matter.

To express this in terms we used earlier, there is organizational failure evident here. Low hanging fruit is left on the tree. The neoclassical firm would see this, but our firm does not because it faces a constraint the neoclassical firm does not face: the organizational constraint. Because of that constraint, our firm does not find it worthwhile to go through the organizational trauma of changing systems and procedures. Thus, it is blind to an opportunity.

One might object and argue that no significant systems or procedural changes should be needed to discover that soap and water or lemon extract are as effective as CFCs in cleaning electronic circuitry.[16] So it might seem. But we are all surely aware from personal experience that we often fail to see what we are not looking for, and the same is true for organizations. There is abundant evidence that firms traditionally have not looked for cost efficiency when looking at environmental matters.

When environmental regulatory costs were lower, companies commonly dealt with them with a 'regulatory compliance' mentality (Epstein, 1996c) rather than with an cost-effectiveness mentality. It was sufficient back then for managers to ask company experts what was necessary to ensure regulatory compliance, and then the necessary actions were taken without question. They were not questioned because the logic driving the actions derived from a legalistic as opposed to an economic or a strategic perspective. A natural result was that company staff with environmental, health, and safety responsibility rarely initiated cost saving ideas since it was neither their charge nor were they held accountable for cost.

The situation changes for our firm in 1990 when the Montreal Protocol is revised to ban CFCs completely by the year 2000. Suddenly the firm has to contemplate the absence of CFCs at *any* price. This is the shock that finally provokes a radical change in perspective and its specific manifestation, a serious and thorough campaign of CFC replacement. Once the campaign is launched, the firm discovers that there had long been alternatives available which were cheaper than CFCs.

Because strict environmental regulations prompt the firm to find CFC replacements that are actually cheaper than the CFCs, this looks superficially like a story of win-win regulations. But as we noted in the previous section, to draw this conclusion is to ignore the cost of all the changes the firm has to make that are necessary to provoke the search. From its own perspective, the firm would be better off with CFCs rather than with some cheap CFC replacements and the whole of the ozone depletion issue to contend with.

The story recounted above could be paralleled by stories of campaigns for energy savings, waste reduction, and others. These campaigns may be provoked by environmental regulations, and they often generate production cost savings. But we doubt that these savings repay the full costs of the "greening" of the organization.

Corporate policy implications

What can a company do to retard the slow obsolescence of its procedures and routines? What can it do to provoke a revolution when it becomes necessary, rather than let decay proceed? What can be done to minimize the costs of that revolution? What is the state of the art in companies' policies and procedures to deal with environmental issues?

Answers to the first couple of questions take one into the enormous literature on change management, and it is not our intention to go there in this paper. It will have to suffice to offer a few remarks that come directly from the analysis above.

We have seen that agents may have little incentive or ability to provoke a radical revolution in the SOPs they have learned. Having said that, the environmental field is one where a company may be able to harness agents' own values of respect for the environment in a way that may not be possible in other, less morally laden fields.

Beyond that, if the revolution will not start at the bottom of the organization, it will have to be led by the principal at the top. This necessitates that the principal be as aware as possible of circumstances lower in the organization. This is invariably difficult. Simon notes the problem.

> The insulation of the higher levels of the administrative hierarchy from the world of fact known at first hand by the lower levels is a familiar administrative phenomenon.
>
> (Simon, 1945 p. 238)

Furthermore, the principal must be prepared to provoke the instability that every transition brings. This is undoubtedly an unattractive prospect for even the most proactive manager even though the periodic need to upset outdated habits is well understood by most individuals and is well known in management theory.[17] The alternative may be to await the instability of a crisis.

There are aids available to managers to surmount these obvious problems. One is benchmarking to industry best practice. Referring again to the analogy of the hill, managers can always draw inferences of their position by reference to their immediate surroundings, and in this way they may learn of the marginal changes their organizations need to make to improve performance. But it is harder for a manager to see a completely new peak in the far distance. By the practice of benchmarking, managers make an explicit point of looking in detail at the practices that other firms, in particular effective ones, are using to solve some problem. This gives managers vision they too often lack looking only inward.

Both business process reengineering and total quality management programmes are two other methods by which principals can force a reevaluation of procedures prior to a crisis, and with only a presumption that a reevaluation is cost effective.

What constitute state of the art environmental SOPs? 'Green accounting' is one.[18] When environmental liabilities and regulatory costs were insignificant for most firms, they developed accounting procedures that hid those costs in G&A or other overhead accounts. Environmental costs and threats have increased, but few firms have changed their accounting procedures. This has

effectively hidden low hanging fruit. Epstein, commenting on his survey of more than 100 companies' activities in this area, says that:

> . . . not only do companies not know the total of their environmental costs, they do not know what causes those costs. To improve the management of these costs, managers must understand the cost drivers.
>
> (Epstein, 1996c p. 12)

Modifications of activity-based costing procedures assign current environmental costs to the specific activities that cause them, allowing companies to focus on cost reduction.

Accounting properly for current environmental costs is not difficult once companies make the necessary adjustments. Accounting for future liabilities associated with actions taken today is a much harder challenge, and few companies have begun to wrestle with it. Today's heavy and unplanned burden for cleanup under Superfund legislation resulted from undercosting and underpricing products years ago. Costs that were assumed to be external ended up internal to the firms. Now managers see product take-back legislation on the horizon. But unless current accounting and incentive systems impose expected future liabilities on today's decision makers, the experience of Superfund will be repeated years from now. Not only will today's undercosted and underpriced products fail to provide financing for the liabilities, but design and production decisions that would lessen future liabilities will go unnoticed. Tomorrow's low hanging fruit is being planted.

One can see in green accounting some of the rigidities and barriers to implementation of procedural changes discussed earlier. Accounting explicitly for speculative but potentially huge future liabilities is alien to traditional accounting practice. Data requirements for green accounts must be met by line managers to whom they are an unwanted burden. Once environmental costs are isolated and then allocated to specific products and processes, there will be an impact on profit and loss centres, and change must extend elsewhere: to pricing procedures, to expectations of return on net assets, to budgeting and investment processes, and to compensation and promotion procedures.

We commented in the 'Introduction' that there has been little formal economic modelling of how a company's environmental strategy can be operationalized. There has been some such modelling, however, examples of which we can only briefly cite here. One of the first papers was Gabel and Sinclair-Desgagné (1993). In that paper, we showed the extent to which an incentive-based compensation system could be used to deal with the multi-task principal-agent problem. The setting was one in which an agent allocated limited effort between two activities, earning profit for the firm and reducing its risk of an environmental accident. The principal wanted to control the agent's effort allocation, but that allocation was not directly observable. All the principal could do was to infer the agent's effort from some imperfect measure of performance. The question we posed was whether the principal should link the agent's compensation to the measure of performance on environmental risk reduction.

We found that when the agent did not exert maximum effort, it was optimal for the principal to use an incentive wage to reward performance on risk reduction. Furthermore, the optimal wage should be more sensitive to measured performance on a given task as the relative accuracy of the measurement improved.

If the agent did expend maximum effort, however, we showed that it may not be efficient for the principal to pay an incentive wage. A fixed wage may be preferable. The intuition behind this result was that if the agent's effort were already maximum, interaction between the principal and the agent would amount only to sharing the risk involved in having the firm's income depend on imperfect performance assessments. Assuming that the agent was more averse to risk affecting his income than the principal, which seemed realistic, the latter would have to bear most of that risk (or the agent would leave the firm). This implies that the agent's income level should be the same across all uncertain contingencies, which could only be achieved if the wage were constant.

In a second paper (Sinclair-Desgagné and Gabel, 1996), we examined the topic of environmental audits conducted by the firm. These are actively promoted by public authorities as voluntary steps companies may take to improve their environmental performance. The European Commission's EMAS policy is an example.[19] We showed in the paper that the principal's decision on whether to institute a policy of audits depended on whether or not the agent's precautionary motive dominated his or her aversion to risk. We integrated into the model the agent's wage, allowing it to depend upon the results of the environmental audit. We found that the optimal wage with an audit should have a greater range than if there were no audit. The size of the wage, like the decision to conduct an audit, depended on whether or not the agent's precautionary motive dominated risk aversion.

Regarding the impact that an audit policy might have on agents' behaviour, we showed that it should induce them to pay more care to the environment. This may come at the expense of care dedicated to more traditional profit-making activities, but this trade-off was not necessary. Under some plausible circumstances, a well designed audit scheme could result in more attention paid to both traditional and environmental matters.

Work by Holmstrom and Milgrom (1991), although not directly addressed to environmental matters, is relevant to our topic nonetheless. The issue of their paper is that of assigning different tasks to different agents rather than designing a reward system to induce a single agent to allocate effort as in the Gabel and Sinclair-Desgagné papers. In essence, the amount of effort dedicated to the different tasks is centralized with the principal who decides on the number of agents assigned to each. But there is still the problem of how to define the tasks and how to structure the incentives for them. This is what Holmstrom and Milgrom dealt with.

The two authors explored the problem of task assignment on the basis of a monitoring criterion. They concluded that tasks which are easier to monitor and those which are harder to monitor should be assigned to different agents with strong and weak incentive compensation schemes respectively. The intuition is as follows. As shown in Gabel and Sinclair-Desgagné (1993), greater financial incentives should be associated with activities that are more accurately monitored. If a single agent

were made responsible for two tasks, one carrying strong pay incentives and the other not, he or she would allocate too much attention to the former task at the expense of the latter. It is better to assign each task to a different agent.

Since a reasonable assumption in the present context is that monitoring environmental performance is inherently relatively difficult, it would follow that profit and loss objectives should be the domain of one agent with strong incentives, while caring about environmental risks should be the responsibility of another with a fixed salary. This seems consistent with commonly observed business practice. Firms frequently have line managers with profit and loss responsibility working under strong incentive salary plans based on financial measures, while staff with responsibility for environmental affairs have salaries independent of operating profit.

Another paper relevant to our current topic although not originally addressed to it is Beckenstein and Gabel (1986). The paper is concerned with the centralization vs. decentralization decision. It starts with the situation where agents' decisions are made with uncertainty as to their legality and probability of prosecution. In the analysis, the principal has two alternative ways of influencing the quality of those decisions. One is to provide better information to agents and to monitor their decisions. The other is to centralize decision making, either by making decisions personally or by imposing standard operating procedures that would constrain the agents. Both of these solutions reduce the probability that the firm would unwittingly violate the law, but their costs are quite different. Information and monitoring entail explicit costs while centralization of decision making or standardization of procedures entail no explicit costs but raise the probability that legitimate and profitable actions would not be taken (i.e., that low hanging fruit would be left on the tree). That is, information and monitoring reduce the probability that agents make either error - violating the law and overlook good prospects - while centralized decision making or standardized procedures reduce the probability of making the first kind of mistake while raising the probability of making the second. (The reader may see here the origin of some of the ideas in this paper.)

Beckenstein and Gabel show that the choice between the two alternatives and consequently the probability of violations and the cost of any level of compliance depend, among other things, on the policy approach of the enforcement agency. The enforcement agency's policy variables include the size of fines and the enforcement 'vigour'. More vigorous enforcement results in more convictions but more acquittals as well. The analysis demonstrated that an increase in fines or in the likelihood that a violation would be prosecuted should prompt the principal to reduce monitoring and further centralize decision making. The intuition is that higher fines and more frequent prosecution increase the relative cost of violating the law, and centralization is more effective than monitoring to prevent this from happening. This result is related to that of Sinclair-Desgagné (1994) where it is shown that if the regulator ignores the incentive system of the firm, then the resulting set of penalties forces the firm to be centralized.

Public policy implications

Porter (1991) had little to say regarding the kind of public policy tools he espoused, but his criticism of command and control standards and end-of-pipe technologies and his praise of flexibility and policies that stimulate investment and innovation all suggest that market-based instruments win his favour. In this, of course, he keeps company with the fraternity of economists whose model he rejects. But this is not the only seeming irony. It seems ironic as well that Porter would favour market-based incentives for firms that do not appear to respond efficiently to market incentives in the first place.[20]

We see less conventional policy messages in our analysis. One is that policy that seeks to push companies through the revolution in procedures we have spoken of must entail an attention-getting shock. Irrespective of the particular instrument - whether command and control or market incentive - it is better to hit the firm with a stunning blow rather than slowly to ratchet up the regulatory burden.[21] The case of CFCs discussed previously illustrates this.

Another message is that public policy can play an important role by setting performance standards, encouraging voluntary codes of practice (whether originating in the public or private sector), and disseminating information on best practice. Management practices and standards are public goods for which exclusion of non-payers is difficult. If a firm invests to develop industry best practice, other firms may observe and adopt those practices without the cost of developing them. This can undermine a principal's incentive to develop wholly new systems and procedures. Public investment gets around the problem.

Examples of such initiatives include the International Organization for Standardization's ISO 14000 and the British Standards Institute's BS 7750, environmental accounting and auditing standards like the European Commission's EMAS, consulting help like the US EPA's 'Green Lights', and many countries' eco-labeling schemes for products. Encouraging private industry codes of conduct like the Valdez Principles and Responsible Care fits here as well.

Although none of these voluntary policies is easily explicable by traditional economic analysis, all make sense in our framework. All of these provide information to companies about best practices which they might otherwise be ignorant of, and each provides them with means to operationalize integrated sets of procedures by reference to the experiences of others. The fact that none of the examples is obligatory does not lessen policy effectiveness; it simply means that firms will not bear the administrative cost unless they see a return in it.

Notwithstanding what was just said, there is an element of compulsion to these 'voluntary' agreements. Courts in the US and Canada are coming to regard failure to meet best practice as a signal of negligence. So practice like Responsible Care and ISO 14000 may *de facto* entail a legal obligation not only for those firms agreeing to them but for others as well (Webb and Morrison, 1996). In parallel fashion, adoption of best practice is a defence against negligence. So there is a quasi-regulatory incentive for firms to adopt these standards.

Finally, we see a new argument in favour of market-based environmental policies: they are economical in terms of their consequences for a firm's organizational systems. This is because in the limit, they entail no special burden on those systems. Imagine that all external environmental costs were internalized into market prices. In this idealized situation, environmental issues would disappear completely as explicit concerns for the firm, and they would reappear imbedded inseparably in new prices of inputs and outputs. As far as the environment is concerned, the firm becomes the neoclassical firm of tradition in the sense that the environment does not contribute to the organizational constraint. There is no more risk of 'regulatory mentality' since it was the result of a legalistic regulatory approach. Market-based policies allow the firm to think with only a commercial mentality. Thus, in a ironic sense, strict and pervasive market-based policies allow a firm to be less, not more, conscious of the environment.

Conclusions

We have argued that anecdotes of low hanging fruit may be more than isolated examples of inconsistencies that can always be found with simple economic models. In fact, they may be ubiquitous for reasons we have described. They may be caused by inertia or static friction in SOPs which both blind firms to changing conditions and thus emerging opportunities, and also make adjustment to new conditions slow and difficult even when the need becomes apparent.

If low hanging fruit is commonplace, then it is possible that some environmental regulations could be win-win in the limited sense that they reveal opportunities to save money even if that saving does not pay for the requisite changes in systems and procedures. Nevertheless, even win-win outcomes defined in this way may be far from commonplace. The existence of low hanging fruit is a necessary but not a sufficient condition for them to occur. We have shown how both win-win and win-lose regulations can occur. Furthermore, the changes in routines we have discussed here are one-shot changes. If they uncover low-hanging fruit, they will do so just once. After company procedures have been adapted to a new environmental consciousness, further regulatory stringency is much less likely to reveal opportunities to save money.

We close this paper with a reminder that the justification for environmental regulations does not and never did rest on increasing private profit. It rests on increasing social welfare. Our presumption throughout this paper is that environmental regulations are in the public interest. If they are not simultaneously in the interest of companies subject to them, so be it. Admittedly, from a political viewpoint, it might be advantageous if there were no potential losers and thus no opponents to a policy. But in our view, it is not credible for environmental policy makers to argue that businessmen should welcome their work. Rather, policy makers should focus on the public interest and consider any low hanging fruit that firms might pick an unintended but welcome bonus.

Bibliography and references

Beckenstein, A. and L. Gabel (1986), 'The Economics of Antitrust Compliance', *Southern Economic Journal*, 52(3), 673-92.

Coase, R., (1992), 'The Institutional Structure of Production', *American Economic Review*, 82(4), 713-9.

Cyert, R. and J. March (1992), *A Behavioral Theory of the Firm*, 2nd Ed., Cambridge: Blackwell.

The Economist (1991), 31 August, 15.

Commission of the European Communities (1993), 'EC Council: Regulation Setting up an EC Eco-Management and Audit Scheme', European Union, Brussels.

Epstein, M. (1996a), *Measuring Corporate Environmental Performance*, Burr Ridge, Il: Irwin.

Epstein, M. (1996b), 'You've Got a Great Environmental Strategy - Now What?', *Business Horizons*, September-October, 53-9.

Epstein, M. (1996c), 'Improving Environmental Management with Full Environmental Cost Accounting', *Environmental Quality Management*, Autumn, 11-22.

Gabel, H. L. (1995), 'Environmental Management as a Competitive Strategy: The Case of CFCs', in Folmer, Gabel, Opschoor (eds), *Principles of Environmental and Resource Economics: A Guide for Students and Decision-Makers*, Aldershot: Edward Elgar, 328-46.

Gabel, H. L. and B. Sinclair-Desgagné (1993), 'Managerial Incentives and Environmental Compliance', *Journal of Environmental Economics and Management*, 24, 229-40.

Gabel, H. L. and B. Sinclair-Desgagné (1995), 'Corporate Responses to Environmental Concerns', in Folmer, Gabel, Opschoor (eds), *Principles of Environmental and Resource Economics: A Guide for Students and Decision-Makers*, Aldershot: Edward Elgar, 347-61.

Gore, A. (1993), *Earth in the Balance: Ecology and the Human Spirit*, Harmondsworth: Penguin.

Holmström, B. and P. Milgrom (1991), 'Multi-Task Principal-Agent Analysis: Incentive Contract, Asset Ownership, and Job Design', *Journal of Law, Economics, and Organization*, 7 (Special Issue), 24-52.

Jaffee, A., S. Peterson, P. Portney, and R. Stavens (1995), 'Environmental Regulations and the Competitiveness of U.S. Manufacturing', *Journal of Economic Literature*, XXXIII(1), 132-63.

Mansfield, E. (1974), *Economics: Principles, Problems, Decisions*, New York: Norton.

Meyer, S. (1992), 'Environmentalism and Economic Prosperity: Testing the Environmental Impact Hypothesis', unpublished manuscript, MIT.

Molina, M. and S. Roland (1974), 'Stratospheric Sink for Chlorofluoromethanes: Chlorine Atom Catalyzed Destruction on Ozone', *Nature*, 249(5460), 10-12.

Milgrom, P. and J. Roberts (1992), *Economics, Organization and Management*, Englewood Cliffs: Prentice-Hall.

Nelson, R. and S. Winter (1982), *An Evolutionary Theory of Economic Change*, Cambridge: Harvard University Press.

Oates, W., K. Palmer, and P. Portney (1994), 'Environmental Regulation and International Competitiveness: Thinking about the Porter Hypothesis', unpublished manuscript, University of Maryland and Resources for the Future.

Palmer, K. and D. Simpson (1993), 'Environmental Policy as Industrial Policy', *Resources*, Summer, 17-21.

Porter, M. (1991), 'America's Green Strategy', *Scientific American*, April, 96.

Porter, M. and C. van der Linde (1995), 'Green and Competitive: Ending the Stalemate', *Harvard Business Review*, September-October, 120-34.

Postrel, S. and R. Rumelt (1992), 'Incentives, Routines, and Self-Command', *Industrial and Corporate Change*, 1(3), 397-425.

Shiffrin, R. and W. Schneider (1977), 'Controlled and Automatic Human Information Processing: II. Perceptual Learning, Automatic Attending, and a General Theory', *Psychological Review*, 84, 127-90.

Simon, H. A. (1985), 'Human Nature in Politics: The Dialogue of Psychology with Political Science', *The American Political Science Review*, 79(2), 293-304.

Simon, H. A. (1945), *Administrative Behavior*, 3rd ed., New York: Free Press.

Sinclair-Desgagné, B. and H. L. Gabel (1996), 'Environmental Auditing in Management Systems and Public Policy', CIRANO and INSEAD Working Paper.

Sinclair-Desgagné, B. (1994), 'La Mise en Vigueur des Politiques Environnementales et l'Organisation de la Firme', *L'Actualité Economique*, 70(2), 211-24.

Stiglitz, J. (1991), 'Symposium on Organizations and Economics', *Journal of Economic Perspectives*, 5(2), 15-24.

Walley, N. and B. Whitehead (1994), 'It's Not Easy Being Green', *Harvard Business Review*, May-June, 46-52.

Webb, K. and A. Morrison (1996), 'Voluntary Approaches, the Environment and the Law', unpublished manuscript, Office of Consumer Affairs and Carlton University, Canada.

Figure 1
Social and private cost frontier

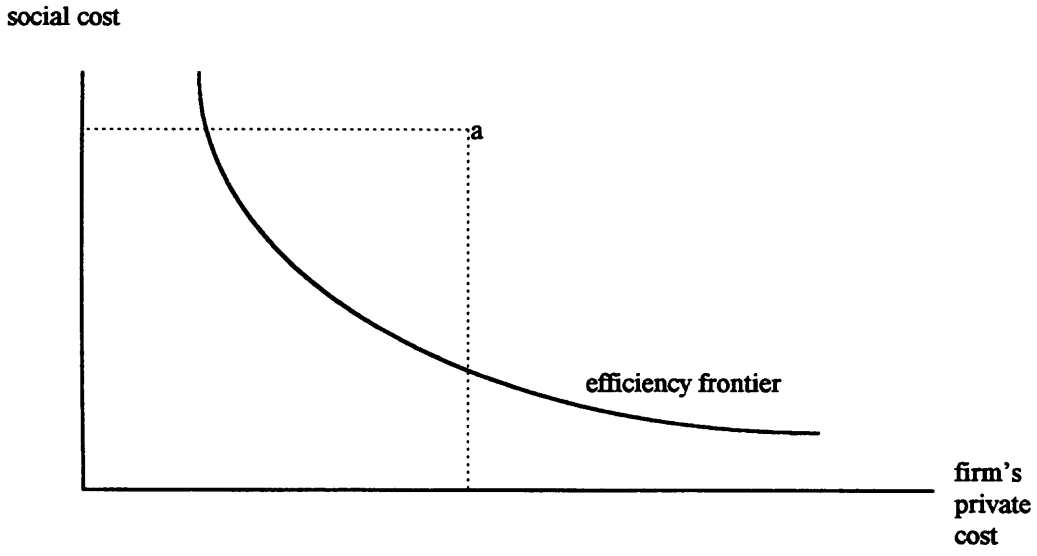


Figure 2
Marginal cost of effluent reduction

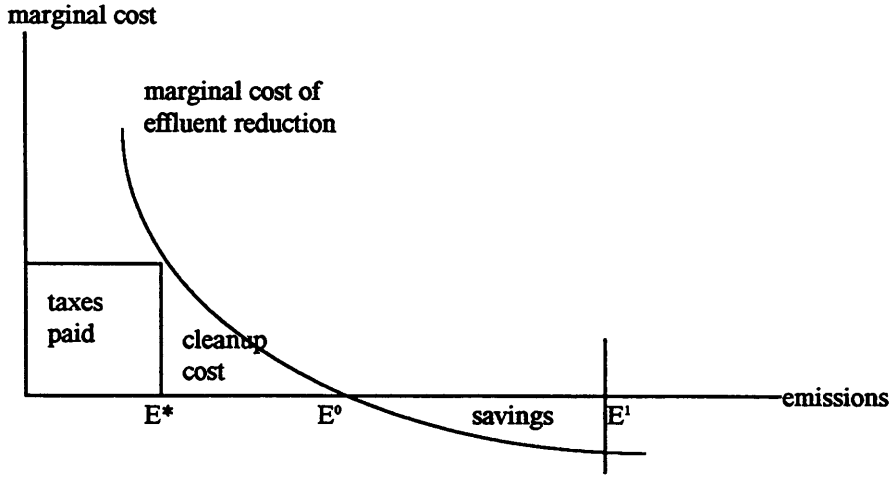


Figure 3
Optimal procedures locus and value

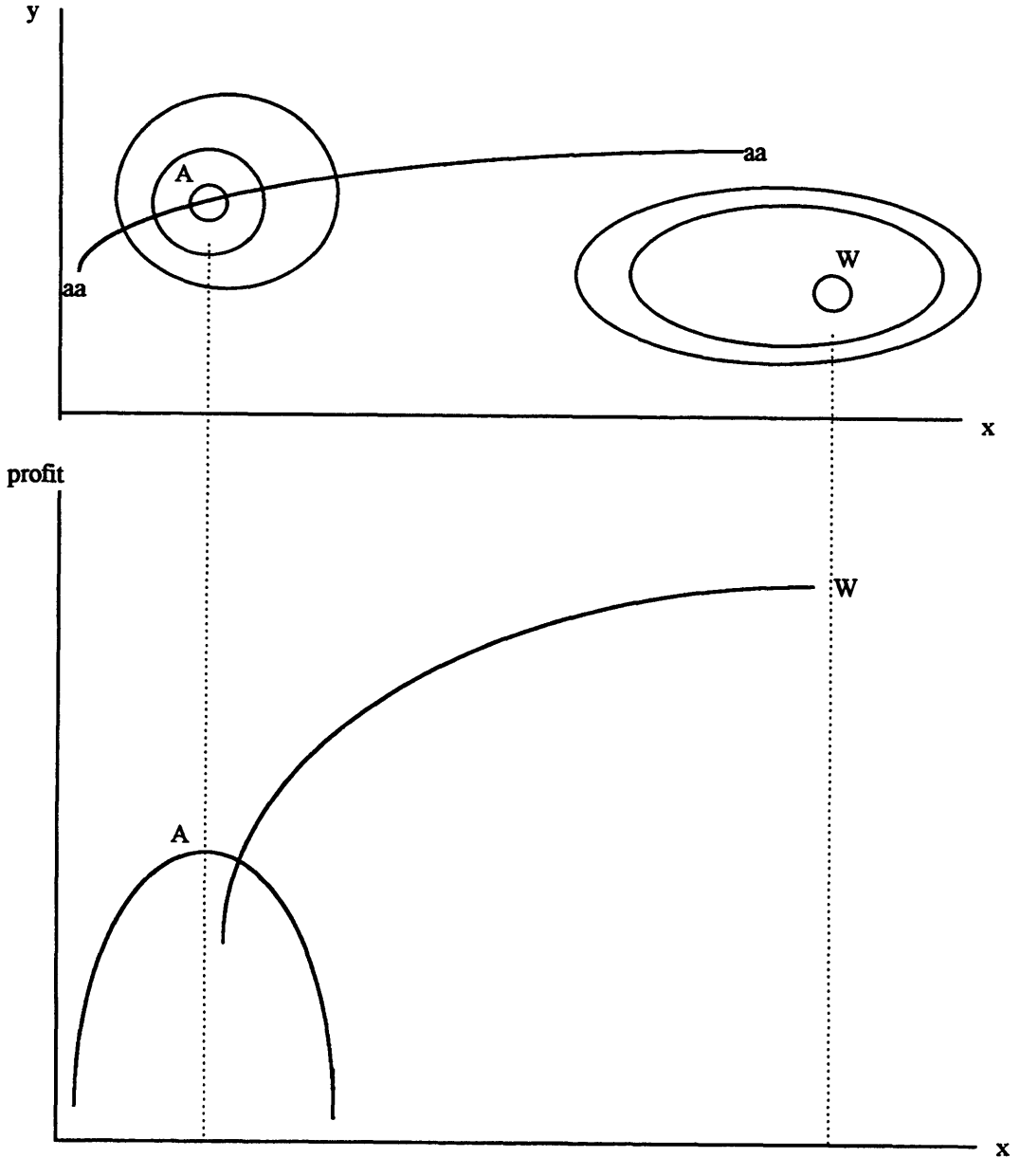


Figure 4
Optimal procedures locus and value

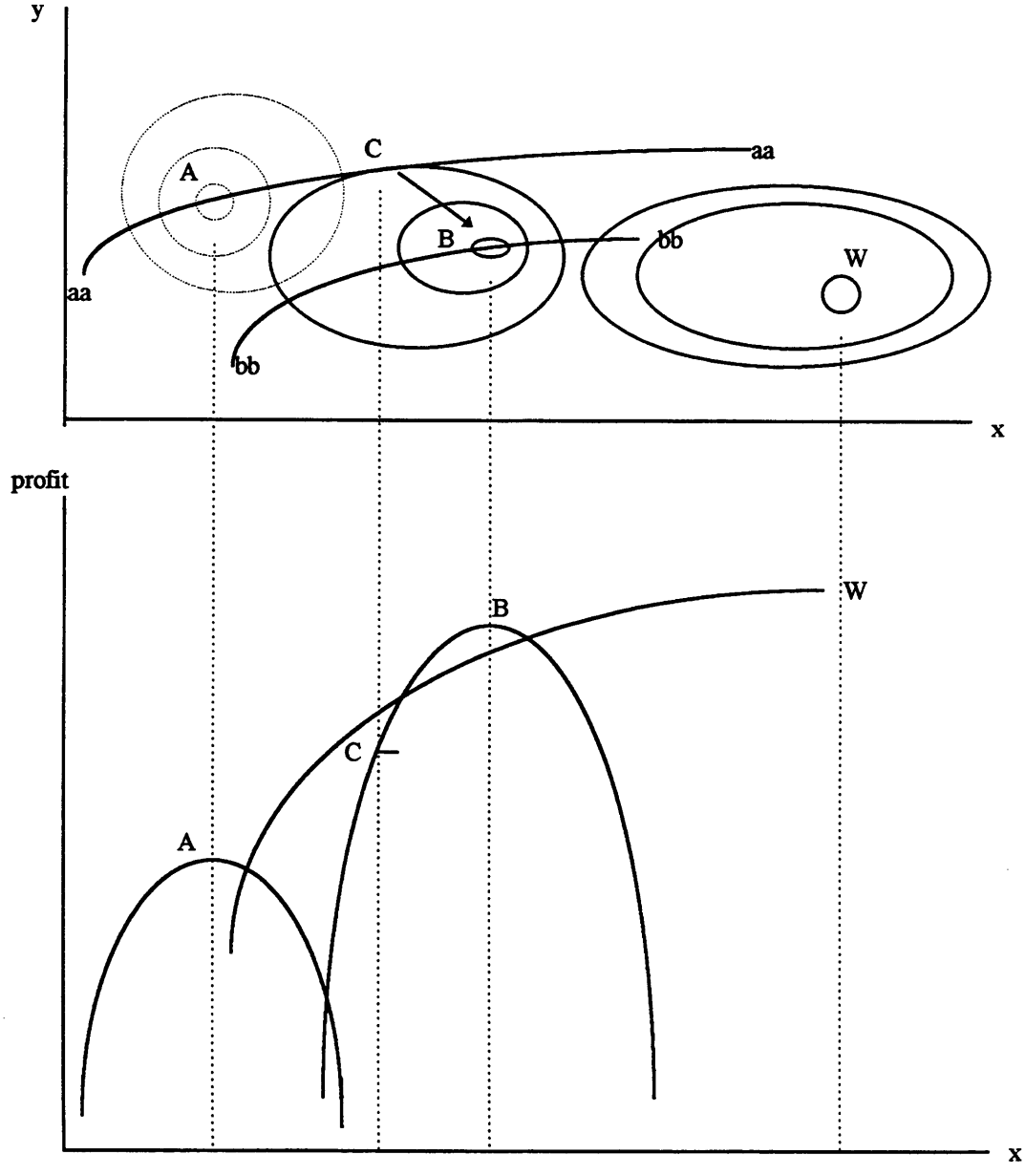
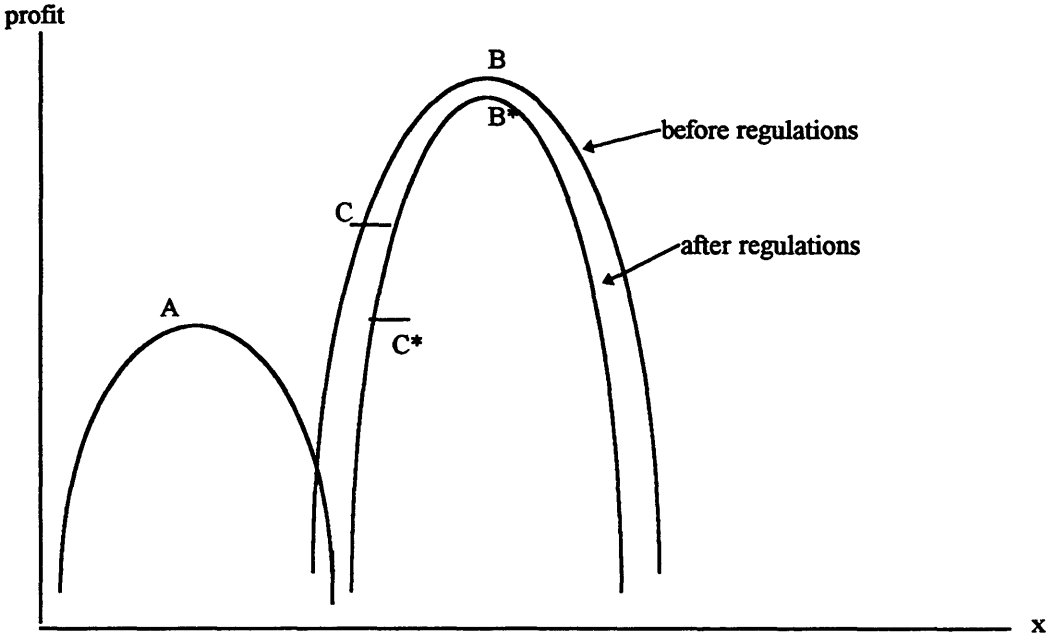


Figure 5
Optimal procedures value



The Porter Hypotheses

> Strict environmental regulations do not inevitably hinder competitive advantage against foreign rivals, indeed, they often enhance it.
>
> (Porter, 1991 p.96)

A purposely provocative claim, but how truly provocative is it? What are the different ways in which the Porter Hypothesis might be true?

enhanced competitiveness of producers of complementary products and services

Environmental regulations can obviously benefit firms that specialize in offering products and services that protect the environment. For example, US and EU auto emission standards help their catalytic converter producers, and the regulations could stimulate their exports and international competitiveness if other countries were to adopt the same technology later.

Porter has this variant in mind when he gives examples like German exports of air emission abatement equipment and technologies to the US (Germany is the more strict) and US exports of relatively benign pesticides (an industry in which it has strong regulations). The factual accuracy of these examples is questionable, however (Oates, *et al.*, 1994), and in any case, they are not really win-win. Private economic costs increase to those ultimately subject to the regulations (that is, US public utilities, and farmers respectively in the examples above). There is no implication in these examples that firms are blind to low hanging fruit.

relatively enhanced competitiveness of the regulated firms

A second and considerably stronger variant of the Porter Hypothesis is that stringent regulations help the firms subject to them - the polluters themselves. What is the logic?

There are actually two different stories that can be told here. One is that strict domestic environmental regulations will *raise* the costs of domestic firms subject to them (and thus raise consumer prices), but they will raise the costs of foreign competitors subject to the regulations by even more.[22] Domestic firms, forced by strict regulations to be first-movers, may get a relative advantage developing the technology, achieving experience efficiencies, or by some other means.

Porter has this story in mind with his example of the Montreal Protocol ban on CFCs. The ban helped DuPont and ICI in the more profitable CFC-replacement business (Gabel, 1995). But the replacement HCFCs and HFCs are privately more costly to produce, and so they sell at a higher price on the market. This is not win-win. The cost burden on the private sector *rises* even though some

firms (and possibly countries) benefit at others' expense. Thus, rational firms would not unilaterally adopt the requirements of the regulation, yet they would benefit if the regulation were forced on all. And, of course, for this to work, it is necessary that analogous environmental regulations be later adopted in other countries. If those other countries were to ignore the environment or pass alternative regulations, then the first mover may be left at a competitive disadvantage.

absolutely cost reduction for the regulated firms

The final story that can be told is that strict regulations will prompt a firm to find so much low hanging fruit that it will *reduce* its private costs at the same time as it will improve its environmental performance. This is the only variant of the Porter Hypothesis that is truly win-win. It is also the only variant that is controversial to economists, because it assumes there is widespread organizational failure in the firm.

Another reason why this is controversial is that it seems to imply the paradox that firms should adopt environmental policies voluntarily and unilaterally since it is in their narrow self-interest to do so. Were it not for the stupidity of firms' managers, environmental policy would be self-enforcing. Porter (1991 p. 96) clearly has this in mind when he concludes that, '. . . the "Chicken Little" mind-set that regulation inevitably leads to costs and an adversarial posture toward regulators must be discarded.'

This is the variant of the Porter Hypothesis that is relevant to the analysis in this paper.

---

[1] INSEAD

[2] École Polytechnique de Montréal and CIRANO

[3] Good examples of work in this genre are Epstein (1996a,b,c).

[4] For an elaboration of some of this, see Milgrom and Roberts (1992 Chapter 4).

[5] The notion of routines is developed in Postrel and Rumelt (1992) and Nelson and Winter (1982).

[6] To keep the paper focused, we will maintain the traditional assumption that the firm's principal desires to maximize profits. Our point of departure with neoclassical economics is only to reject its assumption that the firm can be represented as a single perfectly rational decision maker.

[7] The reader should note that this static curve implies a given state of technological knowledge. The discovery of new technology that simultaneously allows less environmental damage and lower private cost is not evidence in favour of the Porter Hypothesis, nor does it contradict the neoclassical assumption that the firm maximizes profit. Many technological improvements economize on material intensity, and this is generally good for both the firm and the environment. One only needs to compare a steel mill in Britain in the second half of the 1900s with one a century later to realize that the newer is both cleaner and lower cost. But most of the difference has nothing to do with environmental regulations.

Porter implies in part that strict environmental regulations will induce more of this kind of innovation than would otherwise appear. This is difficult to validate, however, since it requires counterfactual evidence; evidence of a path of technology that was not followed.

[8] See, for example, Mansfield (1974, p. 380).

[9] An example will make this point clear. The US EPA's Green Lights program, noted in the text, helped companies save money and the environment by switching to energy-efficient lighting. Had this been a tax on energy rather than a voluntary program, the energy cost saving would have had to offset the taxes paid for continuing energy use.

[10] The obvious alternative hypothesis is that the causality is reversed; that those countries' productivity levels and wealth caused their strict environmental regulations.

[11] In a mathematical maximization model, this simply represents the reduced objective function value that the new constraint causes.

[12] Compatibility standards are the technological or dimensional standards that allow different products to work together. Examples are standards for computer hardware and software, standards for audio or video hardware and software, automobile wheels and tires, etc.

[13] The regulations would certainly shift the position of the hill as well, since it would be coincidental if the same policy combination of x and y were equally suited before and after the regulations. For the sake of clarity in the diagram, however, we assume that the location of the hill is unchanged; only its height changes.

[14] CFCs are chlorofluorocarbons, which deplete the ozone layer in the stratosphere. The ozone layer protects humans, animals, and plants from the damaging effects of ultraviolet radiation from the sun. See Gabel (1995) for a development of this case.

[15] For reference, this impact was first suggested as a theoretical possibility in 1974 (Molina and Roland, 1974).

[16] These were, in fact, perfectly effective.

[17] One can observe it in other domains, too. Mao's Cultural Revolution in the late 1960s is an example, albeit a failure.

[18] 'Green accounting' is an imprecise term which typically implies identifying and assigning all environment costs to specific products and processes. Whereas truly 'external costs' may be neglected for decision making, they are commonly identified and often regarded as relevant to decisions on the grounds that they will likely be internalized by future regulations. Life cycle assessment and costing, legacy costing, and full environmental cost accounting are related tools or synonyms for green accounting.

[19] cf., Commission of the European Communities (1993).

[20] The authors actually heard members of CEFIC (The European Chemical Industry Council) argue against a carbon tax in Europe on the grounds that there was already so much unexploited opportunity to save energy at existing prices that it would be pointless to raise energy prices still further.

[21] Porter and van der Linde (1995) point this out also, noting that lax regulations allow firms to adapt incrementally, without any fundamental change in thinking. Strict regulations, they say, "promote real innovation" (p. 124).

[22] Foreign firms can be subject to the same regulations either if the regulations are product- rather than production-based, or if the foreign country is pressured into adopting the same production-based regulations.