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An Institutional Analysis of Environmental Self-Regulation

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Abstract

An Institutional Analysis of Environmental Self-Regulation

By

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Economic research on environmental self-regulation (ESR) neglects institutional issues. To address this omission, this dissertation studies the influence of free riding on the effectiveness of ESR and the influence of transaction costs and missing markets on the form of ESR.

As noted in chapter one, there are three motivations for ESR: (1) ESR may yield net cost savings to firms; (2) government may change the regulatory burdens for firms that engage in ESR; and (3) ESR can create marketing advantages for firms as occurs when consumers pay more for "green" products. Chapter two offers examples of environmental self-regulation in order to illustrate these three motivations.

Chapter three applies Olson's theory of collective action and the theory of evolutionary games to the problem of free riding in consumer-driven ESR. Free riding may be a problem for environmental self-regulation when consumers, who would otherwise support a firm's environmental efforts through their purchases, choose to free ride on the actions of other consumers. As Olson notes, in large group situations, free riding is primarily overcome through the use of selective incentives. Chapter three explores the use of selective incentives in ESR in greater detail. While chapter three formalizes the concepts through evolutionary game theory, such a formal apparatus yields little in the way of conceptual understanding. This leads to the conclusion that richer formal modeling will require the use of complex simulation models.

Chapter four studies the influence of transaction costs and missing markets on the

organizational form that environmental self-regulation adopts. Firms self-regulate in order to reap benefits from cost savings, government, or markets. These benefits involve transactions with varying attributes, particularly asset specificity and uncertainty. In addition, the markets through which firms attempt to reap benefits operate with poor information and are therefore incomplete or missing. Hence, before environmental self-regulation can consistently occur, firms, consumers, and government need to develop organizational forms that can protect necessary specific investments and can increase the availability and reliability of information. In particular, ESR must adopt contracts with government, uniform standards, or vertical organization, depending on the particulars of the transaction.

The conclusion draws on the concepts of (a) free riding and missing markets and (b) transaction cost to propose circumstances in which ESR is likely to appear and succeed. Both government-motivated and consumer-motivated ESR will appear where the incentives facing the firm are strong, that is, where consumer demand is high or government pressure is strong. In addition, since both government-motivated and consumer-motivated ESR may be subject to free riding, successful ESR will occur either in small groups (such as an industry with only a few firms) or where selective incentives are present. Furthermore, where firms must make specific investments, successful ESR will protect those investments through standardization or contracts with government.

ESR is not a pure alternative to government regulation. The incentives and structures that support ESR can be adopted by government as when the government gives public recognition to firms. Finally, government action may be necessary to create selective incentives, protect assets, and improve missing markets. Only with these institutional supports can ESR function.

To my wife, for her true support

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Chapter 1

Introduction

1.1 Motivations for ESR

The environmental policy world has seen an increase "environmental self-regulation."[1] Traditionally, government regulation has been the main tool of environmental policy in the U.S. Government regulation operates by specifying technologies or emissions controls for regulated industries and enforcing those requirements through fines or jail time. Environmental self-regulation, by contrast, occurs when firms alter their environmental performance for some reason *other than* compliance with existing government regulation. Firms might improve their environmental performance beyond current regulatory requirements or in areas where there are no regulatory requirements at all.

In the neoclassical economic view, expected penalties are the *raison d'être* of environmental improvements. Where environmental improvements are a net cost to firms and environmental harm is not priced, firms save money by reducing their environmental efforts. (The possibility that environmental improvements may be a

[1] Environmental self-regulation goes by other names including corporate environmental management (Boczar 1994), self-regulation (Paterson 1991, Eden 1996), voluntary environmental policy (Norton, Phipps & Fletcher 1994, Arora & Cason 1995), business-led environmental policy (Esty 1997), community-based management (Rupasingha & Boadu 1998), metasystem (Caswell, Bredahl & Hooker 1998), and private interest government (Grant 1987). Self-regulation also occurs in other industries including advertising (Boddewyn 1992), financial markets (Scarpa 1997, McCaffrey & Hart 1998), and food (Grant 1987, Caswell et al. 1998).

net benefit to firms is discussed below.) If firms are improving their environmental performance beyond government requirements, one would like to know why.[2]

Authors have attempted to identify the motivations for ESR (Newman & Breeden 1992, Bansal 1997, Cohen 1998, Lyon & Maxwell 1999). Their suggestions can be grouped into three categories: (1) environmental improvements may yield net savings to a firm by reducing production costs; (2) environmental improvements may induce government to change the regulatory burden on firms; and (3) environmental improvements may create marketing advantages for firms.[3]

The first motivation is that environmental improvements may reduce the production costs faced by a firm because the firm discovers cheaper production technology, uses fewer inputs, or faces lower handling and disposal costs (Bansal 1997).[4] These cost reductions then give the individual firm a competitive advantage (Porter & van der Linde 1995*b*, Bansal 1997).[5]

The observation that environmental improvements can reduce costs is related to the mass balance point of view advocated by industrial ecology (Socolow, Andrews, Berkhout & Thomas 1994). The mass balance argument is that inputs that do not end up as part of the final product will end up as waste (i.e., pollution). Matter is neither created nor destroyed in industrial production, it is merely transformed into either products or pollution. Because pollution stems from wasted inputs, more

[2]Cohen (1998) suggests that firms comply with existing regulation more often than expected penalties would imply. This observation again suggests that firms are responding to other motivations.

[3]Authors sometimes list two other factors that affect a firm's self-regulatory efforts: the opinions of the firm's managers and the internal organization of the firm (Roberts 1975, Shrivastava 1996, Atlas & Florida 1997, Bansal 1997). These additional factors act as modifiers on the three motivations listed above. Different managers will be more or less willing to respond to the three motivations. Firms with different organizational structures will be more or less able to respond to the motivations.

[4]Bhat (1996) includes labor costs on the grounds that the oversupply of workers willing to work for environmental firms will drive labor costs down.

[5]The cost savings motivation should be distinguished from the Porter hypothesis. The Porter hypothesis argues that when firms are subject to strict standards-based environmental regulations, they will be forced to discover environmental technologies that will reduce costs and either reduce or entirely offset the costs of compliance. The Porter hypothesis is a claim about the effect of standards-based regulations. It relies on the cost savings concept but goes beyond it. See Porter & van der Linde (1995*a*).

efficient technologies can reduce both input use and pollution at a stroke.

Evidence for the cost savings motivation comes from case studies of individual firms's pollution prevention efforts. For example, 3M's environmental programs allegedly saved the company $500,000 between 1975 and 1989. Glaxochem Ltd. saved £1 million by reducing its losses of volatile organic compounds (Shrivastava 1996, Bansal 1997) (for other cost savings discussions see Cairncross 1991, Cairncross 1995, Pearce 1997).

Those who doubt this motivation argue that, if cost savings are available, they should already have been discovered by enterprising firms. Even if cost savings are available, the skeptics argue that cost-saving and environment-improving discoveries will be quickly exhausted or will have little influence on important environmental problems (Palmer, Oates & Portney 1995). However, cost-savings may be missed because of organizational problems or capital constraints within the firm (Pearce 1997).

The second motivation for firms to undertake voluntary environmental efforts is that in so doing they may influence the regulatory policy of government (Barrett 1991, Pearce 1997). The influence may be for either stricter or weaker regulation. Stricter regulation may benefit firms by acting as a barrier to entry (Schalop & Scheffman 1983, Bansal 1997). Weaker regulation may benefit firms by reducing their compliance costs (Segerson & Miceli 1998, Dawson & Segerson 2000). The relationship between firms and government may be informal — as when an environmental official makes a speech threatening tighter regulation of an industry if it does not "voluntarily" improve. The relationship may also be formal — as when firms in an industry negotiate for exemptions or forestalled regulation by promising to improve their environmental performance themselves. Firms may discuss their regulatory situation with government individually or through a representative group such as a trade association. An example of a formal environmental quid pro quo is the German pack-

aging ordinance. That law empowers the packaging industry to self-regulate under the explicit threat of legislation (Pearce 1997). In England a similar attempt failed when the packaging industry could not agree on standards (Eden 1996).

The third motivation is that firms may be able to profit from their environmental image or expertise (Bansal 1997). Having a strong environmental image may enhance a firm's standing with consumers, investors, lenders, or business partners. Consumers may be willing to pay premium prices for or buy more of environmentally friendly products. They may do so out of concern for the environment, for social reasons, or because the product is healthier or safer (Peattie 1997).[6]

Green consumerism is the subject of much skepticism. Pearce (1997) quotes Cairncross (1995) as saying that green consumerism simply does not "penetrate far enough." Pearce notes that consumers can easily be confused about the technical issues involved in evaluating the environmental safety of products. It may be more useful to speak of green consumerism in particular markets rather than as a universal phenomenon. For instance, consumer pressure may be more effective in the imported timber market than in the automobile market (Pearce 1997). Arora & Cason (1995) find econometric evidence that green consumerism motivates firms. However this evidence is weak because their model used the extent to which a firm was known to the public as a proxy for consumer pressure. The authors did not attempt to measure changes in consumer behavior in response to firm performance.

Market pressure may come from investors as well. Investors may value the stock of an environmentally clean firm more highly than that of other firms (Khanna, Quimio & Bojilova 1998, Lanoie, Laplante & Roy 1998). They may do this out of environmental concern, for social reasons, or because they expect that environmentally sound firms will face fewer costly regulatory actions or be better managed. Business partners may prefer doing business with environmentally sound firms as well. This

[6]Pressure from consumers and others may also be made manifest in the form of lawsuits, boycotts, or pressure from environmental groups (Bansal 1997, Cameron & Mackenzie 1997).

preference could also be because of environmental or social reasons. It may also be because the environmental actions of a firm's business partner can have regulatory, legal, or marketing consequences for the firm itself (Bansal 1997). Finally, firms may also be able to sell their environmental knowledge directly by advising other firms on environmental matters (Bansal 1997).

1.2 Institutional Economics and ESR

Economic research on ESR has modelled and tested the motivations for ESR but has not considered institutional economic factors. This section reviews existing research and the institutional questions that remain unaddressed.

There have a few attempts to empirically examine some of the motivations for ESR. Atlas & Florida (1997) and WRI (1998) examined the organizational factors that lead firms to engage in environmental self-regulation. Atlas & Florida (1997) found that a firm's propensity to regularly redesign its products is the strongest factor associated with the firm's undertaking *environmental* redesign. Cost reduction and regulatory pressure were not significant in their study.

Arora & Cason (1995) and (1996) studied the factors that motivate firms to participate in the EPA's voluntary 33/50 program (a toxic emissions reduction program). They found that firm's connection to the public was one of the strongest factors. Khanna et al. (1998) studied the influence of stock prices on environmental self-regulation. They found that the public reporting of data from the U.S. Toxic Release Inventory had a significant effect on the stock prices of polluting firms and a subsequent effect on the amount of waste disposed of on site. It did not have a significant effect on the *total* amount of toxic waste generated since firms that reduced on site disposal were simply shifting disposal to other sites.

Economists have also developed two types of formal models of ESR. The first

type of model represents government pressures in support of an ESR. See Segerson & Miceli (1997) and (1998), Hansen (1997), Schmelzer (1997), and Mondello (1997). The Segerson & Miceli model, for instance, is a static game in which regulatory pressure induces a (single) firm to self-regulate. The firm prefers self-regulation because it costs less, by assumption, than government regulation. The model is limited because it cannot represent free riding (there is only one firm) and contains no discussion of how a self-regulatory program might be organized.

The second type of model represents consumer pressures on ESR. See Arora & Gangopadhyay (1995) and Lyon & Maxwell (1999). Arora & Gangopadhyay's model features consumers who value environmentally oriented firms but who vary in their ability to pay. The market divides into two segments with wealthy consumers buying from environmental firms and poor consumers buying from nonenvironmental firms. This model is also limited because the environment is represented as a *low* exclusion cost good (one that consumers must buy from firms directly). This approach assumes away the issue of free riding by consumers.

Though most economic research on ESR ignores institutional issues such as free riding and organization, Cohen (1998) argues that institutional issues are central to the study of environmental performance. He lists several institutional factors including social norms, community pressure, internal incentives, organizational form, and institutional interactions. An extended quote from Cohen states the case for institutional study of ESR forcefully:

> We probably know the least about the most important and fundamental topic in enforcement – why firms comply with the law. Two promising areas of research on this topic appear to be developing: (1) incorporating social norms, community pressure and firm reputation into the analysis, and (2) opening up the "black box" of the firm and incorporating incentives within the organization. These are both complex topics that require an understanding of a diverse set of literatures — including topics such as corporate governance, principal-agency theory and economic models of social norms. This is also an area where economists can learn from other

disciplines and from other empirical studies outside economics. Although recent attempts to empirically estimate the factors that cause firms to voluntarily reduce emissions have been promising, they have often been unable to substantiate the theoretical models that others have proposed. Further empirical and theoretical work in this area could be beneficial.

Another significant gap in our knowledge relates to the interaction of the various institutions that affect compliance behavior. Are citizen suits a substitute or a complement to government enforcement? What role do firm reputation and market forces play in the enforcement equation? Does organizational structure affect a firm's propensity to comply? If so, how should this be taken into account in designing appropriate enforcement policies? Is "information" really an enforcement tool that government agencies can use at a very low cost? If so, what are the social costs and benefits of providing information to the public in an effort to affect firm behavior? How can a diverse set of institutional actors with their own agendas (e.g., EPA, Sentencing Commission, courts, private enforcement activities, market forces) coordinate so that the outcome at least approximates optimality? These are just a few of the questions that arise when we look beyond the simple question of designing an optimal penalty when there are only two actors – a polluter and enforcement agency. Opening up the model to account for real world complexities make our task much more difficult – but also much more interesting (Cohen 1998, pp. 47–48).

1.3 The Plan of the Dissertation

This dissertation argues, with Cohen, that institutions matter to environmental self-regulation. The argument is made by examining two specific institutional influences: (a) free riding and (b) transaction costs and missing markets.

The problem of free riding arises in environmental self-regulation when there are four factors: (1) some consumers are interested in buying from firms with high environmental performance as a means of supporting a clean environment, (2) a clean environment is a high exclusion cost good to consumers, (3) environmental performance imposes a net cost on firms, and (4) there are no organizational structures that can either force firms to have high environmental performance or force consumers to buy from environmental firms. When these factors are combined, individual consumers will have an incentive to free ride on the purchases of other consumers. This

outcome is the classic collective action problem identified by Olson (1971).

Chapter three draws on both old and new approaches in the economic analysis of free riding. The old approach is Olson's 1971 analysis of collective action. Olson established the basic theoretical framework for understanding free riding problems. However, Olson's analysis is largely informal and, as Olson points out, it does not address problems of strategic behavior among members of the group (Olson 1971, p. 43). Indeed, Olson expresses the hope that game theory will prove useful in this regard. The new economic approach used in chapter three is evolutionary game theory. Evolutionary games provide a structure that has been used to model strategic interaction in other free riding situations.

Chapter three has two goals. The first goal is to extend existing economic thinking on ESR by adding free riding issues. Using Olson's theory, chapter three develops several hypotheses about the effect of free riding on the operation of consumer-supported ESR. These hypotheses can then be tested in future research to understand the operation of consumer-driven ESR in greater detail. The main point is that, since the groups of consumers and firms involved in consumer-driven ESR are so large, we expect that consumer-driven ESR will only work when supported by selective incentives such as tie-in sales or peer pressure. The second goal is to represent consumer-motivated ESR in an evolutionary game. As noted above, evolutionary game theory has been used to represent strategic issues in collective action situations (see Sethi & Somanathan 1996). In the case of ESR, evolutionary games provide a modeling environment that can represent the free riding component of collective action and the strategic interaction between players at the same time. This versatility will be apparent in the model developed below. However, evolutionary games are rigid models in the sense that they cannot represent the richness that is present in real-world strategic interactions. If one desires to formally model such situations, it will be necessary to adopt a more complex modeling environment based on computer simulation. Evolu-

tionary games, though versatile, add little to the analysis that is not already present in Olson (1971)'s analysis. Olson was unable to formally model strategic behavior and it appears that game theory, despite Olson's hopes, has difficulty doing so.

There is a wide variety of organizational forms of environmental self-regulation. What causes certain firms to pursue ESR independently while others participate in industry-wide programs? Why do some firms work closely with government while others do not? Chapter four addresses this question by applying a transaction cost and missing market argument.

The purpose of chapter four is to generate hypotheses about when firms will pursue different organizational forms of ESR. Since there is no available data in this area, these hypotheses cannot be tested here. However, transaction cost and missing market economics provide a powerful theoretical structure that has yielded useful hypotheses in other subjects. It is hoped that the same will occur here. As noted, the hypotheses developed in chapter four carry implications for the effective design of self-regulatory programs and for the role of government. ESR does not substitute for government. Government is not likely to disappear in the environmental area. Instead, the role of government may change. Government may find itself at least partly in the business of supporting ESR through bargains and standards.

Chapter two presents necessary background material. Chapter two reviews several examples of ESR including 3M's Pollution Prevention Pays program, Loblaw's green marketing plan, organic agricultural production, European voluntary agreements, the chemical industry's Responsible Care program and the International Organization for Standardization's ISO 14000 series management standards. The conclusion, chapter five, summarizes the argument and discusses its implications for research on ESR and for the role of government in ESR. The concluding chapter gathers the arguments together to suggest conditions that will be favorable to the development of environmental self-regulation and to examine the role of government in ESR.

Chapter 2

Examples of Environmental Self-Regulation

Chapter one defined environmental self-regulation as occurring when firms alter their environmental performance for some reason *other than* to be in compliance with existing government regulation. This chapter expands on that definition by way of several examples. The first three examples — 3M's 3P program, Loblaw Merchants, and organic farming — illustrate ESR performed by firms in relative isolation. The remaining examples — voluntary agreements, the Responsible Care program and its offshoots, and international standards — illustrate ESR as performed by groups. The examples are meant to draw attention to four characteristics of ESR

1. ESR may have a weak or strong connection to existing government programs,
2. ESR may involve changes in environmental performance or merely in management practices,
3. ESR may be performed by individual firms in isolation or by groups of firms in concert, and
4. ESR often involves uniform standards.

Pollution Prevention Pays The 3M company is a leading example of single firm ESR. Its environmental program, "Pollution Prevention Pays" or 3P, was developed in 1975. Before 1989, 3M met government standards in advance of mandated deadlines.

Nonetheless, it remained one of the nations worst polluters because of the nature of its business (manufacturing involving hazardous chemicals). In 1989, the company increased its emphasis on pollution control technology (Saunders & McGovern 1993).

The principles that guide 3M include: (1) prevent pollution at its source, (2) conduct environmental audits, (3) review environmental marketing claims for accuracy, and (4) develop products with minimal environmental effects (Shrivastava 1996, Saunders & McGovern 1993). Between 1975 and 1992 the company implemented 3,007 programs and saved $540 million. These programs reduced air emissions by 134,000 tons, water emissions by 16,900 tons, and solid waste generation by 126,000 tons. These achievements exceeded regulatory requirements (Saunders & McGovern 1993).

One of the main benefits of 3M's efforts is cost savings. The importance of this benefit does not imply that other influences are negligible. 3M's value to shareholders is probably higher as a result of its efforts. Furthermore, 3M is probably less likely to be subject to regulatory actions both because of its absolute performance improvements and because of its *reputation* as an environmentally sensitive firm.

Loblaw International Merchants Loblaw International Merchants, the grocery retailer based in Canada, offers an example of environmental marketing. Loblaw's environmental efforts derived from an earlier initiative, their "President's Choice Line." President's choice was an effort to capture some of the retail grocery market by developing a recognizable value-added brand name to certain higher margin products. The program ran from 1980 through 1989 but lost its value as competitors copied it.

In an effort to regenerate a unique brand image, Loblaw developed a new product line, referred to as "G.R.E.E.N." The line was based on poll information that indicated growing public interest in *both* environmental products and so-called "body-friendly" products.

Loblaw coordinated its product development with two environmental organiza-

tions: Pollution Probe and Friends of the Earth. With their input, Loblaw developed product and package specifications. Pollution Probe acted as a certifier of some of these products. In addition, Loblaw has made some efforts to modify its distribution practices to reduce the overall environmental impact of the company.

Though the introduction of its G.R.E.E.N. line has raised the company's market share, its environmental products account for only 1.5 percent of its sales. Finally, it should be noted that many of the environmental products produced by Loblaw offer primarily health and safety benefits, rather than general environmental benefits. Such products include its health food line; its organic food line; and a line of "child-safe" bitter tasting cleaning products (Shrivastava 1996).

Organic Farming Organic farming as an industry has increased considerably since the 1980s although the proportion of organic farms remains under 0.5% of all farming in most countries (Lampkin 1994*b*, United States Department of Agriculture 1998). Organic farming is difficult to define. Its main goals appear to be (1) the protection and maintenance of natural soil fertility, (2) the reduced use of pesticides and soluble nutrients, (3) and the humane management of livestock. Organic farming in the early part of the 20th century emphasized soil conservation. Since the 1960s, organic farming has acquired a stronger concern for the wider environment. The USDA has recently passed formal standards defining organic farming (United States Department of Agriculture 2001). The rule's provisions apply to production, handling, and labeling. The production components address soil erosion, pesticide use, seed stock, rotation practices, and chemical fallow periods.

Organic farming should be distinguished from low input sustainable agriculture (LISA) and integrated agriculture. LISA aims to reduce input use, but accepts some residual use. It also exhibits less interest in wider environmental concerns. Integrated agriculture aims to increase the use of natural pest management (predator species,

for instance) but also lacks the wider attention to environmental issues that organic farming has. Organic agriculture is fundamentally about long-term environmental sustainability. The environmental issues addressed by organic farming include runoff of pesticides and nutrients, support for wildlife, sustainability of soils, and the preservation of diverse farm animal populations (Bateman 1994).

The market for organic products grew in the 1980s. This growth was driven by two factors. The first were various food health scares. The US saw the scare over alar residues on apples. The UK saw problems with Salmonella, Listeria, and BSE (i.e., mad cow disease). The second factor was a general rise in concern for environmental issues. In the early 1990s, the organic market's growth slowed in Europe due to consolidation and the European recession. The organic market in the U.S. lags behind that in Europe but is growing rapidly (Lampkin 1994*b*, United States Department of Agriculture 1998).

Regulation, both self and government, play a major role in organic farming. The existence of uniform standards are vital to consumer confidence and trade across countries (Anderson 1994). Self-regulatory programs began with the Demeter symbol in Germany in 1928. The number of symbols proliferated in the 1970s including symbols in France, Britain, and Germany. There may indeed be too many self-regulatory standards. In Italy, the presence of many competing symbols raised the need for a uniform national standard (Tate 1994).

National standards appeared in France in 1980. The French program is a legislatively established set of standards with certification managed by private organizations. A similar set of national standards arose in Britain in 1987. It should be noted that most standards require a conversion period of between one and seven years. The period is meant to allow the farm to eliminate residual pesticides. One cannot sell product under the particular label until one has completed the conversion period. U.S. standards were enacted in 2000 (United States Department of Agriculture 2001).

The conversion process can be expensive. There are several sources of conversion costs. (1) Yields may be reduced initially or permanently as a result of adopting organic methods. (2) The farm cannot sell at the premium organic prices during the conversion period. (3) The farm may require initial expenditures on buildings, livestock, manure handling equipment, and so on. (4) The converting farm may need to abandon existing nonorganic equipment or products. (5) The farm may need to buy information (costing the farm cash or search time). Finally, (6) the farm may suffer losses from early mistakes. (Lampkin 1994*a*).

These investments represent specific assets. The risk in organic farming stems from uncertainties over the future demand for organic products. A major risk is that a large growth in organic production will swamp the market and eliminate the organic premium. This occurred in Sweden in 1990 (Tate 1994, p. 24). As Lampkin (1994*b*, p. 3) notes, British farmers express interest in organic methods but their hesitancy to make the change may stem from concerns over the stability of the market.

Some environmental self-regulation occurs in groups. Three examples of this are (1) voluntary agreements between industry and government; (2) industry association program such as Responsible Care; and (3) environmental management standards such as ISO 14000.

Voluntary Agreements The first example of group ESR is what is known as a Voluntary Agreement (VA). VAs come in a wide range of forms (Storey, Boyd & Dowd 1997) but only a brief summary of these forms will be given here. A VA is an environmental standard or goal that is negotiated between government and an industry. The goal may be an environmental performance target, an increased level of research into environmental control technology, or the establishment of a monitoring and reporting system. Generally, the industry is represented by a trade association of some sort. In the negotiations, government offers an incentive to the industry to meet

the negotiated standards. In a "stick" approach, government pledges to reduce the industry's regulatory burden by removing existing statutes or regulations, reducing enforcement effort, or by refraining from imposing more stringent regulations in the future (Segerson & Miceli 1998). In a "carrot" approach, government provides some positive assistance to firms. This assistance may be technical knowledge, cost-sharing, subsidies, or public recognition (Stranlund 1995).

VAs are more common in Europe than in the United States though their use in the U.S. is growing. Some examples of European VAs include a 1996 agreement between German industry and government over greenhouse gas emissions as well as a variety of long term agreements on energy negotiated between the Netherlands and various industry associations in the Netherlands' energy sector. In the United States, one finds the Green Lights program (encouraging use of energy efficient lighting systems), the Voluntary Aluminum Industry Partnership (addressing aluminum industry emissions), and the 33/50 program (encouraging reductions in certain toxics).

The Netherlands VAs generally called for a 20 percent increase in energy efficiency by the year 2000. The agreements specified improvements in several broad areas including energy management, combined heat and power, and modernization. The government promised consistent future regulation, reduced regulation, and financial and technical support. The agreements are contracts under Netherlands law.

In the United States, the agreements tend to rely on "no regrets" motivations. This motivation means that firms can expect a cost savings from participating that generates a positive internal rate of return. In other words, U.S. VAs are relying on the cost savings motivation. U.S. programs rely less heavily on explicit contracts than do European agreements (Storey et al. 1997).

In a "carrot" VA, individual firms receive the subsidies or other inducements directly. In a "stick" VA, the threat of future regulation is directed at the entire industry. As a result, individual firms are not bound by the agreement and may

choose to ignore it (Storey et al. 1997). Why might an individual firm choose to participate? One reason is that the firm feels pressure from consumers to do so. Arora & Cason (1996) find that firms in industries with high levels of public contact are more likely to participate in the U.S. EPA's 33/50 program than firms in industries with little public contact. The implication is that some aspect of public pressure or direct interactions with consumers induces firms to comply.

Another possible reason is that the industry association requires compliance of its members. This answers begs the further question of why firms find membership in the association to be worth the cost of compliance with the VA. The answer is probably that membership provides firms with benefits relating to their business activities. These may be access to markets, technical help, certification, or other benefits. It may also be the case that an industry association has some degree of delegated regulatory power with which to force compliance.

Industry Association ESR A second form of group ESR is referred to here as an independent industry standard. This type is illustrated by the Responsible Care program in its many incarnations.

Responsible Care

Responsible Care is a chemical industry program that was originally developed by the Canadian Chemical Producers Association in 1984 (Shanley, Ondrey & Chowdhury 1997). It has been copied and modified by chemical industry associations around the world. As of 1997, 42 countries' chemical associations had Responsible Care programs (United States Chemical Manufacturers Association 1997).

The United States Chemical Manufacturers Association's (CMA) version, developed in 1988, imposes six codes of conduct on members of the association. The codes concern emergency planning, pollution prevention, accident prevention, safe han-

dling and transportation, worker safety, and "product stewardship" (integrating environmental and safety considerations into the overall design process) (United States Chemical Manufacturers Association 1997). The program includes self-evaluation by companies, an external auditing procedure, and coordination and communication among companies. The CMA is developing performance measures but at present the program is management-oriented, not results oriented.

Finally, all members of the CMA are obligated as a condition of their membership to make "good faith efforts to implement the program" (United States Chemical Manufacturers Association 1997). The Canadian version has a more stringent participation requirement involving improvements in actual environmental performance. In Canada, performance is measured by three person verification teams. The teams prepare a written report based on 63 questions. The report is submitted to the audited company for distribution within the company and to the public.

The Responsible Care program performs significant negotiation and unification functions through its "Partnership Program." Through that program, firms that are not members of the CMA but are involved in some aspect of the chemical industry other than manufacturing, can participate in Responsible Care. The program also establishes links with other industry associations to encourage them to promote Responsible Care among their members. Finally, the CMA promotes verification measures that are developed and checked by independent third parties. Individual companies can undergo an independent audit of their performance (United States Chemical Manufacturers Association 1999).

The Responsible Care program was developed to improve the industry's flagging public image and forestall government regulation (though there was no quid pro quo with government) (Eden 1996, Franke & Wätzold 1996). The industry's image had been damaged through a series of blows running from Rachel Carson's book "Silent Spring" to the tragic, fatal release of methyl isocyanate gas at Bhopal, India in 1984.

A fundamental difficulty with the CMA's efforts is that these objectives of the program (improved public image and reduced threat of regulation) are high exclusion cost goods. The benefits are available to all chemical companies regardless of their participation in the Responsible Care program. To address this problem, Responsible Care attempts to make public relations improvements available only to participating firms. The device that is intended to accomplish this exclusion is the Responsible Care trademark. The trademark is available only to association members that meet the standards as determined by the CMA. As a result, some of the public image benefits can be captured by an individual firm when it uses the trademark in its own advertising. Another set of low exclusion cost goods that are available only to those firms that comply with the program are the benefits of membership in the association itself such as access to technical information and assistance.

Coatings Care

The National Paint and Coatings Association (NPCA) has developed a program called Coatings Care that is patterned on the chemical industry's Responsible Care program. Coatings Care is promoted as a "common" (i.e. standardized) management approach, a source of technical assistance, and a way for a firm to make its environmental efforts "visible" (i.e. to the public). Interestingly, Coatings Care draws attention to the danger of "unfocused and overlapping" environmental strategies and offers in their place a consistent set of practices. Coatings Care is also coordinated with Responsible Care. Compliance with the latter is deemed compliance with the former. Coatings Care's codes of practice cover four areas: manufacturing, transportation and distribution, product safety, and community relations. The program also aims to provide environmental information to customers and the public and "assist" government in the development of environmental standards relevant to the paint industry (National Paint and Coatings Association 1999).

National Pork Producers Council

The National Pork Producers Council (NPPC) runs four environmental programs for its members. The first, the Environmental Assurance Program (EAP), is essentially a consulting program made available to member hog farms. The NPPC promotes the EAP as an information source and a way to increase profits and reduce the risk of litigation. The program includes a technical training component and a guided self-assessment component. The second NPPC program, the National Environmental Dialogue on Pork Production (Dialogue), is an effort to develop comprehensive *recommended* regulations for pork operations. It consists of negotiations between the NPPC, the U.S. Environmental Protection Agency, the U.S. Department of Agriculture and several state environmental agencies. The Dialogue produced a set of recommendations but they are not as yet required either by the NPPC or by government. They are meant to guide the development of environmental standards. The third program is the On Farm Odor/Environmental Assistance Program (OFO/EAP). The heart of this program is a voluntary assessment program (offered at no cost to producers) which uses trained assessors to evaluate the odor and water quality aspects of a hog operation. The program itself was developed under the direction of a third party verification firm. Assessors prepare reports on participating farms which include identification of significant odor or water risks and information to assist in design, management, or cost-sharing assistance. The third party verification firm evaluates a random sample of these assessments to verify that the assessments are performed properly. The final NPPC program is the Odor Solutions Initiative (OSI). OSI is a technology development program that is soliciting proposals for the development of odor sensing and abatement technology. Note that the NPPC's efforts include research and instruction, development of standards, advertising, and lobbying.

ISO 14001 and EMAS The final example of ESR given here is transindustry environmental management standards (EMS) such as the ISO 14001 standard[1] or the European Environmental Management and Audit Scheme (EMAS).[2] ISO 14001 was developed by the International Organization for Standardization (ISO). ISO is an international standards body whose members include over 100 national standards organizations, one from each represented country. Industry representatives and non-governmental organizations also have influence over ISO standards.

ISO 14001 is a *management* standard. It suggests changes in the management of a firm, not in the actual environmental performance of a firm; though performance changes will hopefully follow. To conform to the EMS, a firm must first set its environmental policy and ensure that the policy is appropriate for that firm. This policy-setting is entirely internal; a firm may set whatever goals it wishes.[3] The firm must also commit to comply with existing environmental laws and to continual improvement, though it is ambiguous whether the improvement is to be in the firm's policy or in its environmental performance (Roht-Arriaza 1997). Having set its goals, the firm then must designate management responsibility for achievement, resource provision, training, and emergency planning.

The standard requires periodic monitoring and environmental audits. The audits may be done by the firm itself or an outside auditor. Firms may certify themselves as being compliant or seek certification by third parties. ISO does not certify compliance with its standards (despite some misconceptions to the contrary). Rather, ISO

[1]ISO 14001 and the first part of the ISO 14000 series. ISO 14001 deals specifically with management standards. Other parts of the ISO 14000 series will deal with other issues such as environmental auditing, life cycle assessment, forest products, and product standards. The term ISO 14000 is sometimes used to refer to the management standards alone.

[2]The EMAS program is similar to ISO 14001 though it requires more attention to the content of the company's environmental policy and stricter environmental audits.

[3]This point is worth emphasizing for ISO 14001 is often described as a set of uniform international standards (Powers 1995). The standards in ISO 14001 are uniform, but they are uniform with regard to the process of setting and following environmental policy, not with regard to environmental performance. A firm that sets weak goals and meets them will be just as ISO 14001 compliant as a firm that sets high goals and meets them, though the environmental performance of the two firms may differ widely.

accredits third party certifiers who themselves certify individual firms (ISO 1999).

No portion of ISO 14001 is required by ISO itself (it lacks the power to impose such a requirement in any event). What pressures lead a firm to adopt ISO 14001? Based on early results with ISO 14001 and past results with the similar ISO 9000 series quality management standards, the most important pressure seems to be cross compliance. Under cross compliance, other organizations, such as governments, firms, or funding agencies, require the firms to which they offer subsidies or grants or with which they do business to be ISO 14001 certified (Roht-Arriaza 1997, Powers 1995).[4]

Governments often adopt ISO's standards by referring to them in government rules, a practice that increases the power and relevance of ISO standards. Indeed, ISO plays a large role in the process of establishing uniform standards. A large problem in the effort to create standards is the proliferation of competing uncoordinated standards. Roht-Arriaza (1995) observes that one of the purposes of ISO 14000 was to address this problem of proliferating and uncoordinated environmental standards.

The beginning of this chapter identified four points about ESR. The first concerns the degree of connection between ESR and government. All ESR is distinct from traditional government regulation, however, the difference may be small or large depending on circumstances. Some companies adopt environmental measures that go far beyond the levels required by government and do not involve government oversight or direction. Some companies make environmental improvements in areas that are not even subject to government regulation. As noted above, the 3M company has put considerable effort into reducing toxic emissions beyond required levels (Saunders & McGovern 1993).

On the other hand, some self-regulatory programs are closely tied to government. The EPA's 33/50 program was a program aimed at reducing toxic emissions. It was

[4]This explanation begs the further question of why these groups impose that requirement. If the requirement is imposed by a government or funding agency, the requiring organization may have environmental goals as part of its mandate. If the requiring organization is a firm, it may be responding to pressure from its customers.

a voluntary program and attracted firms by providing public recognition and technical assistance to participating firms. The program did not have explicit regulatory requirements for compliance nor was participation mandated by law. Though voluntary, the program was devised and managed by the federal government (Arora & Cason 1996).

The second point is that ESR may involve changes in environmental performance or in management procedures. The 3M company is an example of the former. 3M changed its choice of inputs, its car-pooling program, its recycling equipment, its emissions control equipment, and the products that it produces. General Electric, by contrast, developed management programs to evaluate the firm's environmental performance, support development of alternative inputs, and assist plant managers in identifying hazards (Saunders & McGovern 1993). In some instances, management is the only change made by self-regulating firms. There are several environmental management standards aimed at improving environmental management. The ISO 14000 series is an example (ISO 1999).

General Electric and 3M are examples of firms undertaking ESR in comparative isolation. Many ESR programs are instead developed and managed by groups of firms. Often an industry association or standards body will take the lead in developing the program. An example of group ESR is the chemical industry's Responsible Care program, described above.

The fourth point is that there is a connection between ESR and uniform standards. One of the primary contributions of group ESR is the development of uniform self-regulatory standards within an industry. Often, industry associations will coordinate their standards with other related industries. Such is the case between the U.S. chemical industry and the paints industry. Government is often active in the development and unification of standards. Standards are often the core of a self-regulatory effort. This is the case with the ISO 14000 series standards.

In short, there is a wide range of environmental self-regulation. A partial explanation of that variation will be the subject of chapter four. Before addressing that topic however, chapter three will examine the effect of free riding on one particular self-regulatory situation — green consumerism.

Chapter 3

Environmental Self-Regulation and the Free Rider

3.1 Introduction

This chapter introduces the problem of free riding into the economic analysis of environmental self-regulation (ESR). Economic research on ESR does not yet consider free riding. Formal models of ESR assume free riding away by either assuming that all goods are low exclusion cost goods or by modeling a single representative agent. Empirical work has focused on the rate of firm participation in ESR but has not tried to uncover the influence of free riding.[1]

The chapter draws on both old and new approaches in the economic analysis of free riding. The old approach is Olson's 1971 analysis of collective action. Olson established the basic theoretical framework for understanding free riding problems. However, Olson's analysis is largely informal and, as Olson points out, it does not address problems of strategic behavior among members of the group (Olson 1971, p. 43). Indeed, Olson expresses the hope that game theory will prove useful in this regard. The new economic approach used in this chapter is evolutionary game the-

[1]Free riding is but one barrier to ESR. Other barriers that are not considered here include technical barriers (e.g., physical limits to technological improvements), cost problems (e.g., lack of capital for environmental technology or reorganization), regulatory problems (e.g., laws and regulations that inhibit self-regulation), cultural problems (e.g., distrust of self-regulation), and transaction cost problems.

ory. Evolutionary games provide a structure that has been used to model strategic interaction in other free riding situations.

This chapter has two goals. The first goal is to extend existing economic thinking on ESR by adding free riding issues. Using Olson's theory, this chapter develops several hypotheses about the effect of free riding on the operation of consumer-supported ESR. These hypotheses can then be tested in future research to understand the operation of consumer-driven ESR in greater detail. The main point is that, since the groups of consumers and firms involved in consumer-driven ESR are so large, we expect that consumer-driven ESR will only work when supported by selective incentives such as tie-in sales or peer pressure. The second goal of this chapter is to represent consumer-motivated ESR in an evolutionary game. As noted above, evolutionary game theory has been used to represent strategic issues in collective action situations (see Sethi & Somanathan 1996). In the case of ESR, evolutionary games provide a modeling environment that can represent the free riding component of collective action and the strategic interaction between players at the same time. This versatility will be apparent in the model developed below. However, evolutionary games are rigid models in the sense that they cannot represent the richness that is present in real-world strategic interactions. If one desires to formally model such situations, it will be necessary to adopt a more complex modeling environment based on computer simulation. Evolutionary games, though versatile, add little to the analysis that is not already present in Olson (1971)'s analysis. Olson was unable to formally model strategic behavior and, as I shall argue, it appears that game theory, despite Olson's hopes, is not able to either.

The ultimate purpose of economic research on ESR is to determine in what situations ESR is likely to be effective and how those situations can be fostered. Since existing economic research ignores a critical component of ESR — free riding — it is limited in its ability to guide policy. Adding free riding to the analysis of ESR

will help us understand in what situations ESR will occur or not occur, what sorts of environmental results ESR is likely to achieve, and how government can contribute to the program of ESR.

3.2 The Problem of Free Riding

Olson (1971) observed that groups that are organized ostensibly to provide a good or service to their members may paradoxically be unable to do so because of the free riding problem.

3.2.1 Olson's Analysis

The problem arises when the good being provided is a high exclusion cost good (Olson uses the term public good). By definition, it is costly to keep individuals from partaking of high exclusion cost goods. In particular, it is costly, if not impossible, to restrict the consumption of high exclusion cost goods to only paying customers. Where the good or service provided by an organization is a high exclusion cost good, it is costly to prevent nonmembers from enjoying the good or service. Thus, any individual beneficiary of the collective good has an incentive to remain out of the group, enjoy the benefits of the collective good, yet pay no membership fees — in other words, to free ride on the contributions of the group's members.

The threat of free riding may or may not lead to underprovision of the collective good. Olson identifies several factors that will contribute to an underprovision problem. The degree to which collective goods will be underprovided depends on (1) the size of the group, (2) the likelihood that an individual member will find it worthwhile to provide the good on his or her own, and (3) the size of the fixed costs that are required to organize collective provision. Olson derives these principles from a formal model (omitted here) and a discussion.

The first point of Olson's discussion is there is a difference between "exclusive" groups and "inclusive" groups. Exclusive groups are those for which the high exclusion cost good is available in fixed supply (and is rivalrous). In the situation of a rival good, if one member of the group obtains some of the good, other members of the good find their shares decreasing. Olson's example is market sales. Assuming a constant demand, when one firm increases its sales, other firms' sales must decrease. Inclusive groups, on the other hand, are those for which the high exclusion cost good is not limited in supply. This situation may be because the good is nonrival, or it may be because the amount of the good produced will simply increase as more members join the group. Olson uses the example of lobbying. Though one firm may obtain a benefit from collective lobbying, other firms do not see their benefit decrease as a result. Indeed, the more firms that join the group and contribute to its lobbying efforts, the more lobbying benefit will be created. Hence, inclusive groups will seek to expand their membership. Exclusive groups, on the other hand, will seek to limit their membership. In the example of market sales, a firm would prefer to act as a monopolist and have all market sales for itself. Of course, some groups may be exclusive and inclusive at the same time. An industry may be exclusive with regard to sales, but inclusive with regard to lobbying.

Group size matters in the provision of high exclusion cost goods. Larger groups are less likely to be able to provide such goods than small groups are. There are three factors that block the provision of high exclusion cost goods by large groups. The first is that in large groups, each individual member obtains a small fraction of the total benefit and thus has little incentive to contribute to the provision of that benefit. The second is that in large groups, it is unlikely that any individual will obtain a large enough benefit to justify providing the entire high exclusion cost good on his or her own. Third, in order to provide high exclusion cost goods, it is generally necessary to create organizational structure (e.g., to coerce members to contribute

to the cost of producing the good). However, organizational structures involve fixed costs. Since these costs are likely to be higher with large groups, it is less likely that a large group will be able to create the necessary structure.

Olson closes with a taxonomy of groups. For exclusive groups, the continuum is the now familiar one: pure monopoly — oligopoly (with homogeneous or differentiated products) — monopolistic competition — pure competition. For inclusive groups, the continuum is analogous. At the end corresponding to monopoly, we have individuals providing a good entirely on their own. This case involves goods with low exclusion costs and no economies of scale. For instance, an individual surfacing a private road. Further along one step on the scale we find "privileged groups" where one individual finds it worthwhile to provide the high exclusion cost good on his or her own. An example of this is an individual who finds it personally worthwhile to surface a local road that is also used by others. As we move closer toward large organizations we find "intermediate groups" where no individual takes over the provision burden but where the group is small enough that shirkers can be easily identified. Corresponding to pure competition we have "latent groups." Latent groups are large groups in which shirkers cannot be identified. Latent groups will provide high exclusion cost goods only where there are separate and selective incentives to motivate individual contribution. An example of this last category is the public road system.

The point about "selective incentives" needs to be explained in greater detail. A selective incentive is one that is applied to an individual in response to that individual's behavior. In other words, a selective incentive is a *low* exclusion cost benefit to individuals. An individual can benefit from selective incentives only by contributing to the group itself. A selective incentive can be used to support the provision of a high exclusion cost good. One such method the "tie-in sale." In a tie-in sale system, a group offers a low exclusion cost product for sale and then uses part of the proceeds to fund a high exclusion cost benefit. For instance, many environmental groups

encourage membership by offering magazine subscriptions or tote bags to members. The subscriptions are available only to paying members but a portion of the members' dues are used to support high exclusion cost benefits such as environmental advocacy.

Another group of of selective incentives is referred to as social incentives. These include social status, peer pressure, and other forms of social sanction or reward. Social incentives, like other selective incentives, can be either positive (rewarding participation) or negative (punishing nonparticipation).

Perhaps the greatest limitation of Olson's analysis is one that he acknowledges: he is not able to incorporate strategic interaction among the group's members and nonmembers into his formal model. He expresses the hope that game theory will allow formal analysis of strategic interaction in groups to be performed (p. 43). However, as advances in game theory have demonstrated, strategic interaction in small groups is fundamentally indeterminate (Myerson n.d., Weibull 1995, Vega-Redondo 1996, Horowitz, Just & Netanyahu 1996, Samuelson 1997). We are never quite sure what a small group will do. Another problem with game theory is its rigidity. The choices available to the players in formal games are limited and confining. As a result, game theoretic models offer little conceptual insight beyond that of informal analysis. (Evolutionary games do offer clear formalization and a foundation for more advanced modeling.) This point will recur in the analysis of evolutionary games below.

3.2.2 Free Riding and ESR

ESR involves collective action problems of the type analyzed by Olson. This chapter focuses on the free riding problem involved in a particular form of ESR: namely, ESR supported by consumer purchases. The problem arises when there are four factors: (1) some consumers are interested in buying from firms with high environmental performance as a means of supporting a clean environment, (2) a clean environment is a high exclusion cost good to consumers, (3) environmental performance imposes

a net cost on firms, and (4) there are no organizational structures that can either force firms to have high environmental performance or force consumers to buy from environmental firms. When these factors are combined, individual consumers will have an incentive to free ride on the purchases of other consumers. This outcome is the classic collective action problem identified by Olson (1971).

Consider a case where consumers wish to support clean air and choose to do so by buying from firms with strong clean air programs. Any consumer can reap the benefit of improved air without having to buy from particular firms. If clean air programs are costly[2] (and if those costs are passed on to consumers), individual consumers will have an incentive to free ride on the environmental purchases of other consumers. Therefore, firms that market their positive influences on high exclusion cost environmental goods will be at a competitive disadvantage as consumers shift their purchases toward other firms. There is some evidence in favor of this possibility. For instance, there is evidence that firm environmental rhetoric outpaces firm environmental improvements (Steinzor 1998). Firms may be trying to capture the benefits of a green image without spending the money necessary to make substantive environmental changes (see Cairncross 1995, Helvarg 1996, Pearce 1997).[3]

Existing formal models of consumer-driven ESR do not consider collective action problems. Formal models of consumer pressure are generally vertical product differentiation models (Lyon & Maxwell 1999). In these models, consumers choose between

[2]Note that the first motivation for environmental self-regulation listed in chapter one is that firms may reap cost *savings* from doing so. In that case, and if firms pass those savings on to consumers, then the free riding consumer problem will not occur.

[3]Government pressure is similarly subject to free riding. Where government threatens stricter regulation *of an entire industry* if the industry does not improve its environmental performance, an individual firm can reap the benefit of the government's forbearance as long as overall industry performance improves sufficiently. Thus, individual firms have an incentive to free ride on the improvements of other firms. Note that industry-wide threats are common. For one thing, formal threats directed at an individual firm must be made under the authority of existing law. Statutes and regulations usually cannot be written to affect only an isolated firm. Thus, a regulator can threaten a firm with more frequent inspections but not with new law aimed squarely at that firm. Also, informal threats are often made at an entire industry in the hope that industry leaders will organize self-regulatory action (see Eden 1996). Free riding on government pressure is part of the analysis in chapter four.

two competing firms. One firm offers products with a high level of environmental performance; the other with low. All consumers prefer buying products with high levels of environmental performance. Because of variable income constraints, not all consumers are able to exercise their preference. As a result, the market splits. Some firms specialize in producing goods with high environmental performance and serve the wealthy segments of the market. The remaining firms specialize in producing goods with lower environmental performance and serve the poorer segments of the market (see Arora & Gangopadhyay 1995).

One should note that in these models, consumers obtain *direct* utility from the environmental attributes of the products they buy. This assumption means that, when a someone consumes a good with high environmental quality, the act of consumption itself yields utility to that consumer. This assumption is odd because, if the consumer is buying a good only for its positive environmental effects, it should be the improved environment, not the good itself, that yields utility to the consumer. One could argue that it is the personal knowledge that one has bought an environmental good that yields utility. This gaining of utility from a feeling that one has "done good" may indeed occur, but it will not be a full solution to free riding problems in general, particularly among citizens who have been trained in economics. Existing consumer models are representing environmental quality as a low exclusion cost good — one that consumers can obtain only by buying from environmental firms. In fact, *environmental* quality is a high exclusion cost good — one that consumers can obtain from the environment itself, not from firms.

3.2.3 Olson and ESR

What does Olson's analysis suggest for the operation of ESR? The first point is that there are two separate groups involved in consumer-driven ESR. The first group is the group of consumers itself. This group aims to produce an improved environment

through consumer purchases. As noted, an improved environment is a high exclusion cost good to consumers. Furthermore, consumers are likely to be an inclusive group vis à vis the environment. Except for highly rivalrous environmental goods like access to national parks, most of the environmental goods that consumers are likely to show interest in will be produced in greater quantity when more green consumers join the movement. Hence, green consumers will have no incentive to keep other consumers from joining their movement.

The other group that is involved in consumer-driven ESR is of course the firms themselves. Leaving aside the possibility of environmentally-concerned managers, firms are interested in the higher profits that are obtainable from green products. This group is an exclusive group in the sense that if one firm makes a green sale, that sale is not available to other firms. Each firm therefore has an incentive to limit the number of green firms in existence (but to increase the number of green customers that *it* serves).[4]

Because the groups involved (consumers and firms) are large, we expect that support of environmental improvement by firms will only occur where there are tie-in sales, peer sanctioning, or some other form of specific incentive. An example can be found in low-input and organic agriculture.[5] Organic agriculture has at least three main goals: (1) the protection and maintenance of natural soil fertility, (2) the reduced use of pesticides and soluble nutrients, (3) and the humane management of livestock. Each of these goals has a high exclusion cost component to it.

Consider pesticide and nutrient use. Reduced use of pesticides and nutrients cre-

[4]Note that the firms and consumers both face a collective action problem, but that those problems pull in opposite directions. Consumers wish to eliminate free riding by other consumers in order to support the environment. Firms on the other hand, wish to eliminate other firms in order to obtain the profits from green sales themselves. In order to improve the environment through green sales, one must be able to solve the collective action problem faced by consumers, yet not solve the collective action problem faced by firms.

[5]Organic agriculture generally involves no chemical input use at all. Agriculture that makes reduced use of chemical inputs is referred to as low-input agriculture. As discussed in the following paragraphcs, organic agriculture is more concerned with high-exclusion-cost benefits than low-input agriculture is.

ates both high exclusion cost and low exclusion cost benefits for consumers. The high-exclusion-cost benefits are environmental benefits. Fertilizers such as phosphorous may be transported off site in runoff and collect in local lakes, contributing to eutrophication. Pesticides may injure local species of nontargetted insects, mammals, or birds. A reduction in the agricultural use (or at least, runoff) of these products can benefit the environment. Reduced use of pesticides and fertilizers may also have low-exclusion-cost benefits. These substances may accumulate on or in food and harm the person who eats it through of poisoning, allergic reaction, hormone disturbance, or contribution to cancer.

Note the connection between the high and low-exclusion-cost benefits involved in agriculture (i.e., the environmental and health effects). A reduction in pesticide use can have positive effects on the environment and positive health effects. Indeed, organic foods are often marketed as being better for the environment *and* better for health. Note also that the connection between environmental and health effects is not perfect. There are ways to reduce the environmental effects of pesticides without reducing their health effects (or vice versa). A farmer may choose to reduce runoff rather than pesticide use. A farmer may choose to use more precise application methods that result in the same dose of a pesticide on the plant but less drift away from the plant. The point is that the farmer may need to choose which goal to pursue: environmental *or* health improvements. Whether the farmer can pursue both at once is a technical matter related to such factors as the physics of pesticides or post-harvest handling methods.

Another example of specific incentives in the environmental self-regulation area can be found in the role of capital markets in influencing firm environmental behavior. Khanna, Quimio & Bojilova (1998) note that public revelation of firm environmental performance can influence a firm's stock price (Khanna et al. observed stock prices following the publication of Toxic Release Inventory data). Furthermore, this stock

price change in turn influences firms to reduce their on-site toxic releases. The implication is that investors are choosing stocks in part based on the environmental performance of firms.

Why might investors do this? One possible reason is that they value the environment as such and wish to support environmentally-responsible firms. The rise in socially responsible investing testifies to this interest. Another possible reason is that investors feel that firms with poor environmental performance may yield a lower return to the investors. Poor environmental performance may warn of the likelihood of an enforcement action or may signify poor management practices and reduced general performance by the firm.

Investors who purchase stocks in order to improve the environment may be able to free ride on the actions of other investors. An investor can reap the benefits of an improved environment without having to make environmentally-conscious investments him or herself.[6] On the other hand, investors who are interested in improved firm performance can only reap that benefit by buying the firm's stock directly.

Khanna et al. (1998)'s analysis suggests that investors may be interested in firm performance rather than overall environmental performance. Khanna et al. found that the stock price influence had a strong significant effect on firms' on-site toxic releases and transference of toxics off-site. However, the stock price influence had a negligible effect on *total* toxic waste generation. It appears that stock price pressure induces firms to move their waste rather than to eliminate it through pollution prevention efforts. This finding hints at the possibility that investors are merely interested in environmental problems as they affect the firm on site (an issue of direct concern to investors) rather than as they affect the broader environment (or that they are unaware of the shifting from air pollution to pollution of other media).

[6]Free riding will only be a problem if the stock of environmentally-conscious firms is less attractive to investors. Such stock may offer a smaller dividend or increase in value slowly. If a firm's environmental efforts yield net cost *savings* to a firm (the first motivation for ESR) then the stock of that firm should be more attractive to investors.

Given the size of the groups involved in green consumerism, environmental problems that lack a related specific incentive will likely not be reduced by consumer-driven ESR. For instance, green consumerism will likely not appear as a solution to global warming because there are no low-exclusion-cost benefits for consumers that can be related to reduced carbon emissions.[7] On the other hand, environmental problems that have a related specific incentive will be more likely to exhibit green consumerism solutions. For instance, cosmetics that are produced in an environmentally-friendly way will likely also be relatively free of contaminants and therefore be of interest to health-minded consumers.

Environmental problems that can only be solved by direct attack will not be likely to profit from green consumerism. On the other hand, environmental problems that can be partly solved through the side effects of other actions may be amenable to a green consumerism approach. For instance, the environmental problems associated with toxic substances may respond well to green consumerism because an effort to reduce toxic *in saleable products* will likely have a strong spillover effect on toxic releases from the plant. This outcome is because the most effective way to reduce toxics in products is to eliminated toxics from manufacturing entirely. The "safe" disposal of nuclear waste will only occur through direct attention to the problem of migration of radioactive material. There are no industrial spillover effects that can reduce the migration problem.

Peer sanctioning can also serve as a specific incentive. Peer sanctioning occurs when consumers pressure or reward one another for supporting the environmental efforts of particular firms. The sanction or reward may take the form of mere social pressure (words of encouragement or abuse) or may take the form of payments or attacks on individuals. As Olson observed, large groups are less likely to rely on peer pressure because of the difficulty that individuals have in identifying free riding

[7]The switch from ozone-depleting aerosol cans to pressurized cans is not a counter example since the switch did not involve additional cost to consumers.

members. Conversely, the social pressure that operates in small groups can induce serve as an inducement to individual change. This point may be a partial explanation of the fact that organic produce is more prevalent in community coops where the members come to know one another more closely.

3.3 Evolutionary Game Models of ESR

Olson's analysis yields important hypotheses about the role of free riding in ESR. However, one wonders whether these results can be formalized in a useful way. This section creates such a formal model using evolutionary game theory. This form of model was chosen because it has been used with success in modeling peer sanctioning in common pool resource situations (Sethi & Somanathan 1996). It is also the tool that Olson mentioned with hopefulness. This section explains and analyzes the model. Following sections discuss the usefulness of evolutionary game theory in analyzing free riding.

3.3.1 An Evolutionary Model of Tie-in Sales

We can represent consumer free riding with a formal model. Consider a model with n firms and m consumers. Firms produce a consumption good and in so doing reduce environmental quality. In the low-input agriculture example used above, the consumption good is a food product such as produce, meat, or dairy. The environmental quality is the quality of water, air, or soil influenced by the farm.

As part of their production of the consumption good, firms choose the level of two inputs, denoted E and C. High levels of input C create low-exclusion-cost benefits for consumers which they can obtain only by purchasing from firms that use high levels of input C. Input C represents investments in low-input agricultural production that yield health or taste benefits (less frequent pesticide spraying, fewer antibiotics, etc.).

High levels of input E create a high-exclusion-cost benefit for consumers in the form of an improved environment (runoff control measures, for instance). Consumers value the effects of input E, but the benefits can be enjoyed by consumers even if they do not themselves buy from firms that use high levels of input E.

High levels of input E have a high positive influence on a firm's environmental performance. High levels of input C also have a positive influence on the environment, but the influence is weaker than the influence of input E. The relationship between the two influences is given by $\tau \in [0, 1]$. The environmental effect yielded by input C is a fraction, τ, of the effect yielded by input E. Restricting τ to this range assumes that environmental efforts such as runoff control are *more* effective at improving the environment than are health-oriented efforts such as integrated pest management. One could develop more complex relationships between the C and E.

For simplicity in modeling, each input is restricted to two levels: high, h or low, l. Because each firm makes two choices (high or low levels for each input), firms have four strategies from which to choose: high levels of input E and high levels of input C; high levels of input E and *low* levels of input C; low levels of input E and high levels of input C, and low levels of both inputs. Each consumer purchases one unit of the consumption good. Consumers have four strategy choices; namely from which type of firm to buy. In other words, consumers have already elected to buy the consumption good; they are simply choosing which firm to buy from.

Let the proportion of firms selecting each strategy be represented as follows: $f_{h,h}$ is the proportion of firms which employ high levels of each input, $f_{h,l}$ is the proportion of firms which employ high levels of input E and low levels of input C, $f_{l,h}$ is the proportion of firms which employ low levels of input E and high levels of input C, and $f_{l,l}$ is the proportion of firms which employ low levels of each input. Define $\vec{f} = \{f_{h,h}, f_{h,l}, f_{l,h}, f_{l,l}\}$ to be the vector of these proportions. Consumer proportions are similarly defined as the proportion of consumers that buy from each firm type

$(\{h,h\},\{h,l\},\{l,h\}$, and $\{l,l\})$. Define $\vec{c} = \{c_{h,h}, c_{h,l}, c_{l,h}, c_{l,l}\}$ to be the vector of these proportions. (See table 3.1 for a list of the model's parameters.)

Table 3.1: *Parameters in the formal model.* $\diamondsuit$

Population Parameters	
$\vec{f}[0]$	Initial population distribution of firms
$\vec{c}[0]$	Initial population distribution of consumers
n	Number of Firms
m	Number of Consumers
Firm Payoff Parameters	
I_h^E	High level of input E
I_l^E	Low level of input E
I_h^C	High level of input C
I_l^C	Low level of input C
c^E	Cost of input E
c^C	Cost of input C
Consumer Payoff Parameters	
η^C	Marginal utility to the consumer from consuming a product produced with input C
η^E	Marginal utility to the consumer of environmental improvement
Environmental Effectiveness of Input C	
τ	Extent to which input C improves the environment (given as a fraction of the effectiveness of input E)

In an evolutionary game model, one tracks the relative payoffs of each strategy over time. Let the payoffs to firms selecting each strategy be represented as follows

(each is a function of time, t, which is suppressed):

$$\pi^f_{h,h} = \text{the payoff to firms choosing } h,h$$
$$\pi^f_{h,l} = \text{the payoff to firms choosing } h,l$$
$$\pi^f_{l,h} = \text{the payoff to firms choosing } l,h$$
$$\pi^f_{l,l} = \text{the payoff to firms choosing } l,l.$$

Similarly, the payoffs to consumers are represented as

$$\pi^c_{h,h} = \text{the payoff to consumers choosing } h,h$$
$$\pi^c_{h,l} = \text{the payoff to consumers choosing } h,l$$
$$\pi^c_{l,h} = \text{the payoff to consumers choosing } l,h$$
$$\pi^c_{l,l} = \text{the payoff to consumers choosing } l,l.$$

What is a good way to calculate these payoffs? A consumer's payoff should depend on the utility he or she receives from his or her purchase and the price of the purchase. (Recall that each consumer buys exactly one unit of the consumption good but chooses from which firm to buy.) A firm's payoff should depend on the price it receives for its product, the number of units it sells, and its costs.

First, consider consumer utility. A consumer's utility increases in the levels of inputs E and C. However, because the benefit created by high levels of input E is a high-exclusion-cost benefit, consumers receive utility from the *total* use of input E across all firms, not from the level of input E used by the firm from which they buy. The marginal utility to consumers of an improvement in environmental quality is given by η^E. The marginal utility to consumers of input C is given by η^C. Each term is positive.

Second, consider per firm sales. Since there are four separate markets (one for

each combination of inputs), there are four different sale prices. In each market, the level of demand is given by the proportion of consumers buying in that market times the total number of consumers. Thus, in the (h, h) market, there are $c_{h,h} \cdot n$ units of demand. The number of firms in a particular market is given by the proportion of firms in that market times the total number of firms m. Therefore, each firm makes

$$s_i = \frac{m \cdot c_i}{1 + n \cdot f_i} \tag{3.1}$$

total sales (for $i \in \{\{h,h\},\{h,l\},\{l,h\},\{l,l\}\}$).[8]

Third, consider firm costs. A firm faces two costs: base production costs (the costs of the inputs that are *not* modeled here) and costs of inputs E and C. Because we are interested in the differential effects of inputs E and C on the market, we assume that base production costs are equivalent for all firms. The costs of inputs E and C are represented simply as marginal costs: c^E is the cost of input E and c^C is the cost of input C.

Fourth, consider prices. The sale price should reflect some base price for the consumption good itself (independent of the quality attributes created by inputs E and C), the costs of each input, and the supply and demand in the given market. We may assume that the base price is a constant p since the total quantity of the consumption good is not changing in the model and because the analysis here concerns the differential effects of input choice. (This assumption is similar to the assumption that base production costs are constant.) We may also assume that the additional costs of inputs E and C may be passed directly on to consumers. This assumption is warranted here because it is the loss to firms that matters and that loss will occur with or without pass-through pricing.[9] Therefore, the revenue that a firm receives is

[8]The addition of one to the denominator simply creates an upper bound of $m \cdot c_i$ when f_i approaches zero.

[9]The model could be extended to incorporate a fully formed market in which only a portion of firm's costs are passed on to consumers.

a function only of its total sales (given by s_i for $i \in \{\{h,h\},\{h,l\},\{l,h\},\{l,l\}\}$) and the base price (input prices are passed on to consumers). More formally, the payoff to each firm strategy is given by

$$\pi^f_{h,h} = s_{h,h} \cdot p \tag{3.2}$$

$$\pi^f_{h,l} = s_{h,l} \cdot p \tag{3.3}$$

$$\pi^f_{l,h} = s_{l,h} \cdot p \tag{3.4}$$

$$\pi^f_{l,l} = s_{l,l} \cdot p. \tag{3.5}$$

for $i \in \{\{h,h\},\{h,l\},\{l,h\},\{l,l\}\}$

The payoffs to each consumer strategy are given by

$$\pi^c_{h,h} = -p - c - I^E_h \cdot c^E - I^C_h \cdot c^C + \eta^C \cdot I^C_h + \eta^E \cdot \mathcal{E}[\vec{f}] \tag{3.6}$$

$$\pi^c_{h,l} = -p - c - I^E_h \cdot c^E - I^C_l \cdot c^C + \eta^C \cdot I^C_l + \eta^E \cdot \mathcal{E}[\vec{f}] \tag{3.7}$$

$$\pi^c_{l,h} = -p - c - I^E_l \cdot c^E - I^C_h \cdot c^C + \eta^C \cdot I^C_h + \eta^E \cdot \mathcal{E}[\vec{f}] \tag{3.8}$$

$$\pi^c_{l,l} = -p - c - I^E_l \cdot c^E - I^C_l \cdot c^C + \eta^C \cdot I^C_l + \eta^E \cdot \mathcal{E}[\vec{f}]. \tag{3.9}$$

where p is the base price of the consumption good, c is the base production cost of the good, I^E_h is the high level of input E, I^E_l is the low level of input E, I^C_h is the high level of input C, I^C_l is the low level of input C, c^E is the marginal cost of input E, c^C is the marginal cost of input C, η^C is the marginal utility gain from input C, η^E is the marginal utility gain from environmental improvement, and $\mathcal{E}[\vec{f}]$ is the *total* environmental effect of all firms. ($\mathcal{E}[\cdot]$ is interpreted as a benefit to consumers so it represents some level of environmental cleanup or other effort.) $\mathcal{E}[\vec{f}]$ is given here as

a proportional sum of the input choices of firms:

$$\mathcal{E}[\vec{f}] = n\big((f_{h,h} + f_{h,l})I_h^E + (f_{l,h} + f_{l,l})I_l^E + (f_{h,h} + f_{l,h})\tau I_h^C + (f_{h,l} + f_{l,l})\tau I_l^C\big). \quad (3.10)$$

Note the appearance of the tying term $\tau \in [0, 1]$. Use of input C has a positive effect on total environmental effects, but not as great an effect as use of input E.

The average payoff for all firms is given as

$$\bar{\pi}^f = \frac{f_{h,h}\ \pi^f_{h,h} + f_{h,l}\ \pi^f_{h,l} + f_{l,h}\ \pi^f_{l,h} + f_{l,l}\ \pi^f_{l,l}}{f_{h,h} + f_{h,l} + f_{l,h} + f_{l,l}} \quad (3.11)$$

and the average payoff for all consumers is given as

$$\bar{\pi}^c = \frac{c_{h,h}\ \pi^c_{h,h} + c_{h,l}\ \pi^c_{h,l} + c_{l,h}\ \pi^c_{l,h} + c_{l,l}\ \pi^c_{l,l}}{c_{h,h} + c_{h,l} + c_{l,h} + c_{l,l}}. \quad (3.12)$$

The changes in the proportions of firms and consumers adopting each strategy are given by the following dynamic system.

$$\dot{f}_i = f_i(\pi^f_i - \bar{\pi}^f) \quad (3.13)$$

$$\dot{c}_i = c_i(\pi^c_i - \bar{\pi}^c) \quad (3.14)$$

for $i \in \big\{\{h,h\}, \{h,l\}, \{l,h\}, \{l,l\}\big\}$.

Strategies which earn a payoff that is higher than the average will grow and those which earn a payoff that is lower than the average will shrink. Note that the terms of these formulations are functions of time t. For the population shares $\vec{f}$ and $\vec{c}$ to have their intended interpretation, we require that, for all t, the sum of the proportions

equal one and no proportion be less than zero thus

$$\sum_i f_i = 1, \tag{3.15}$$

$$\sum_i c_i = 1, \tag{3.16}$$

$$f_i = 0, \text{ and} \tag{3.17}$$

$$c_i = 0 \tag{3.18}$$

for all $i \in \{\{h,h\},\{h,l\},\{l,h\},\{l,l\}\}$. These assumptions can be made for $t = 0$ and easily demonstrated for all $t > 0$.

To complete the model, we require a measures of total cost, total environmental improvement, and overall "welfare" (a combination of the preceding two). Total costs are given as

$$C[\vec{f}] = n\big((f_{h,h} + f_{l,h})I_h^C c^C + (f_{h,l} + f_{l,l})I_l^C c^C + (f_{h,h} + f_{h,l})I_h^E c^E + (f_{l,h} + f_{l,l})I_h^E c^E\big) \tag{3.19}$$

which is the number of firms times the proportional effort-cost for each input. Total environmental improvement is $\mathcal{E}[\vec{f}]$ in equation 3.10. Welfare can be given as the total benefits from environmental improvement and the use of input C less total costs as follows,

$$W[\vec{f}] = \eta^E * \mathcal{E}[\vec{f}] + \eta^C\big(I_l^C(f_{h,h} + f_{l,h}) + I_l^C(f_{h,l} + f_{l,l})\big) - C[\vec{f}] \tag{3.20}$$

3.3.2 Model Illustration

To illustrate how the model runs, let us try it with the set of parameters given in table 3.2. The resulting proportions, payoffs, and total environmental improvement

are given in figures 3.1 through 3.6. The first four graphs depict the proportions of firms and consumers and the payoffs to firms and consumers as functions of time. The fifth graph depicts the total level of environmental improvement $\mathcal{E}[\vec{f}]$. The sixth graph depicts welfare $W[\vec{f}]$.

The firm and consumer proportion graphs (figures 3.1 and 3.3) represent the fraction of firms adopting each of the available strategies. For example, in figure 3.1, the proportion of firms using high levels of each input begins relatively high ($f_{h,h} = 0.4$). However, because consumers are unwilling to buy from these firms, the proportion of firms using high levels of both inputs declines over time.[10] (Note that time is arbitrary and does not correspond to "years" or "days.")

The firm and consumer payoff graphs (figures 3.2 and 3.4) represent the profit obtained by each type of firm. Note that payoff, like time, is an arbitrary measure and does not correspond to dollars. In figure 3.2 we see that firms that use high levels of both inputs have a relatively high initial payoff. Over time, however, the payoff declines as consumers switch to buy from other firms.

The salient points of model one are these. First of all, the consumer population comes to consist only of consumers who buy from firms which use low levels of input E and high levels of input C. This is because, even though a consumer values the result of input E (an improved environment), the consumer can receive that benefit without buying from firms that use high levels of input E. However, the fact that input C has some positive influence on the environment means that there is some positive environmental effect. Recall that τ measures the environmental effect of input C as a fraction of the (higher) environmental effect of input E. Since τ is assumed to be less than one in the current model, the environmental effect of input C is not as great as

[10]Observe that the proportions of $\{h,h\}$ firms and $\{h,h\}$ consumers *rise* initially. This rise occurs because $\{h,h\}$ firms are more attractive to consumers than either $\{h,l\}$ or $\{l,l\}$ firms. As consumers abandon the latter two types of firms, some consumers switch to $\{l,h\}$ firms and some switch to $\{h,h\}$ firms. As time continues further, those who switched to $\{h,h\}$ firms switch to $\{l,h\}$ firms. Because the dynamics employ such gradual changes, the proportion of $\{h,h\}$ consumers and firms each experience an initial rise.

Table 3.2: *Parameters values in an illustrative model.* ◇

Population Parameters	
$\vec{f}[0]$	$= \{0.4, 0.3, 0.2, 0.1\}$
$\vec{c}[0]$	$= \{0.4, 0.3, 0.2, 0.1\}$
n	$= 10$
m	$= 100$
Firm Payoff Parameters	
I_h^E	$= 2$
I_l^E	$= 1$
I_h^C	$= 2$
I_l^C	$= 1$
c^E	$= 0.5$
c^C	$= 0.5$
Consumer Payoff Parameters	
η^C	$= 4$
η^E	$= 4$
Environmental Effectiveness of Input C	
τ	$= .2$

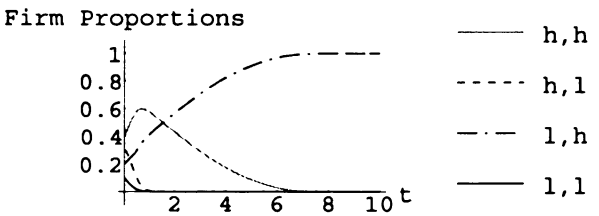

Figure 3.1: The proportion of firms playing each of four strategies (E, C) under an illustrative model. ◇

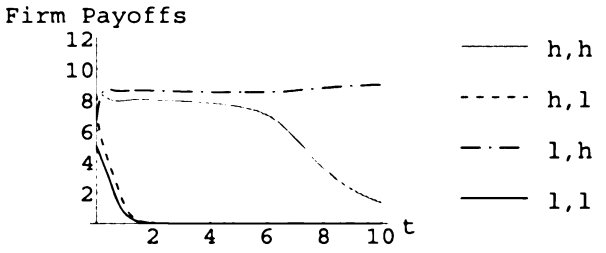

Figure 3.2: The payoff to firms playing each of four strategies (E, C) under an illustrative model. $\Diamond$

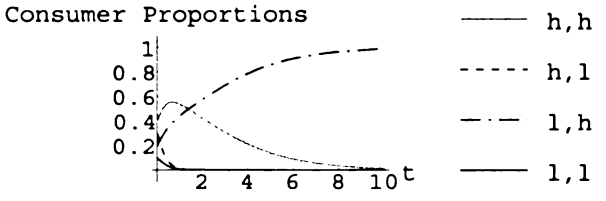

Figure 3.3: The proportion of consumers playing each of four strategies (E, C) under an illustrative model. $\Diamond$

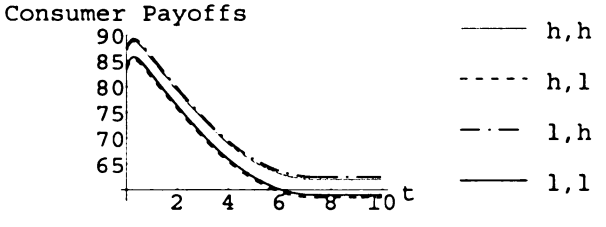

Figure 3.4: The payoff to consumers playing each of four strategies (E, C) under an illustrative model. $\Diamond$

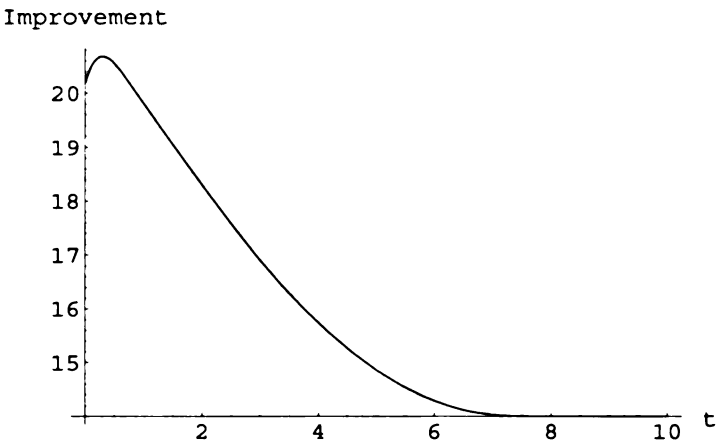

Figure 3.5: The total level of environmental improvement under an illustrative model (see section 3.3.1 on page 43). ◊

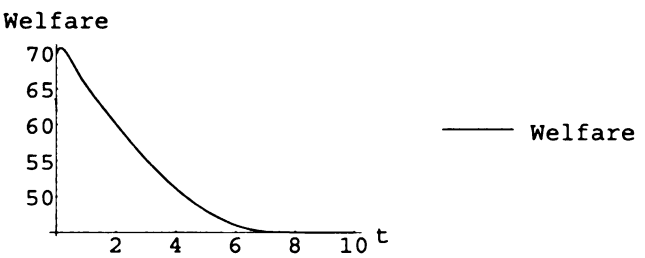

Figure 3.6: The welfare level under an illustrative model (see section 3.3.1 on page 43). ◊

the effect of input E.

If τ were raised through a technical change, the positive environmental effect of input C would rise as well. In the low-input agriculture example, input E is an effort to control the runoff of agricultural chemicals while input C is an effort to reduce the residue of such chemicals on food. If low-input farmers presently use a technique of applying pesticides to the soil surrounding plants but not to the plants themselves, the total amount of pesticide runoff will be reduced. However, if farmers also choose a pesticide that degrades quickly, their actions will have an even stronger positive effect on pesticide runoff. That change can be construed as an increase in τ. An increase in τ is illustrated in figures 3.7 and 3.8.

In the low-input agriculture example, we might expect that if consumers value residue-free foods, they will come to buy more from low-input producers and farms will respond by shifting to low-input food production. This shift will have positive environmental effects to the extent that low-input methods improve water quality, but if the effects are weak, environmental improvement will not be as great as one would hope. If a technical change occurred that increased the effect, one would expect environmental improvement to rise.

3.3.3 Model Equilibria

There are three equilibria in this model. The first (referred to as the $\{l, h\}$ equilibrium) is the one demonstrated in figures 3.1 through 3.6. It is the equilibrium consisting only of $\{l, h\}$ consumers and $\{l, h\}$ firms. This equilibrium is stable for a range of parameter values. This equilibrium results in moderate levels of environmental performance and welfare (as defined in section 3.3.1) because consumers have shifted their purchases toward firms that use high levels of input C.

The second equilibrium (referred to as the $\{l, l\}$ equilibrium) is one in which all consumers and firms choose strategy $\{l, l\}$. This is illustrated in figures 3.9 through

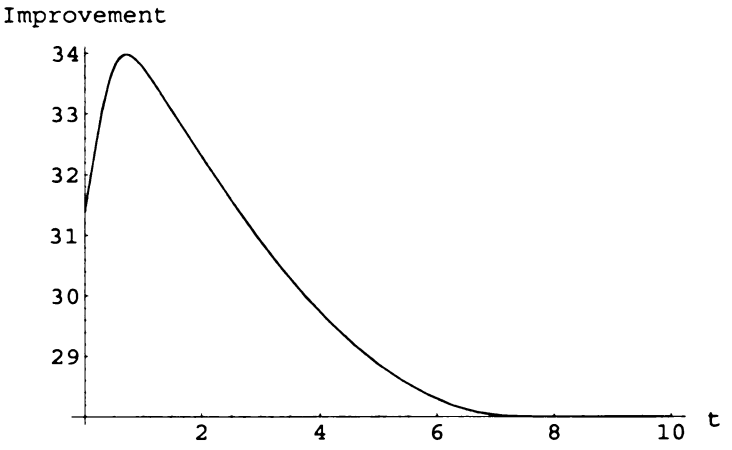

Figure 3.7: The total level of environmental improvement under an illustrative model with τ raised to 0.9. Environmental improvement rises initially since the proportion of (h,h) firms rises initially (see note 10). $\Diamond$

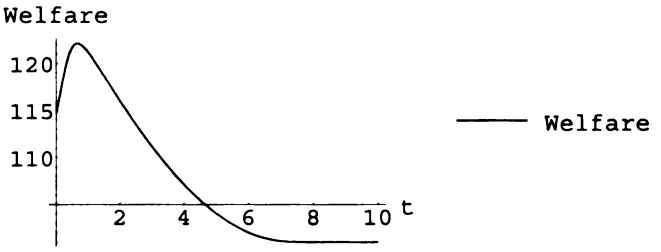

Figure 3.8: The welfare level under an illustrative model with τ raised to 0.9. $\Diamond$

3.11. This equilibrium occurs when the cost of input C is sufficiently high relative to consumers' benefits η^C to deter firms from using high levels of input C. In the figures shown, the cost of input C, c^C, has been raised to 5. This equilibrium is also stable for a range of parameter values. This outcome represents the case where low-input agriculture is too expensive to be profitable. Thus, even the modest environmental gains from high levels of input C are not realized.

The third equilibrium is a curiosity of the model form used here. Where the price of input C is at a *precise* moderate level, it is possible to have some consumers and firms choose the strategy $\{l, h\}$ and others choose $\{l, l\}$. This equilibrium is unstable. The slightest change in the cost of input C will result in the model deviating to one of the other (stable) equilibria. This third equilibrium merely represents the boundary between the two other equilibria.

Several of the parameters in the model have no effect on end states. These are the parameters affecting input E. Because individuals free ride, their valuation of E and the high and low levels of E do not affect their decisions. Higher costs of E serve only to drive consumers and firms away from its use faster, but, as long as the cost of E is positive, E use will equilibrate at low levels. The critical issue for input C is the difference between the cost of C, c^C, and the benefit of C, η^C. If the cost of C is too high relative to its benefit, consumers abandon it. Where the cost of C equals the benefit, consumers are indifferent and a mixed state arises. The high level of C has no effect in this model because marginal utility and marginal cost are constant. If the utility provided by input C declines marginally, then higher required levels of input C would also drive consumers away from firm that use high levels of C in production.

Referring to the low-input agriculture example, parameters affecting the cost of runoff control (input E), the level of runoff control, and the marginal utility of environmental improvement have no effect on the resulting state because everyone free rides on runoff control. They do have an effect on how quickly the state is reached,

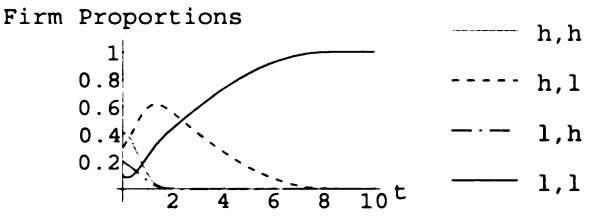

Figure 3.9: Firm proportions under state $\{l,l\}$. $\Diamond$

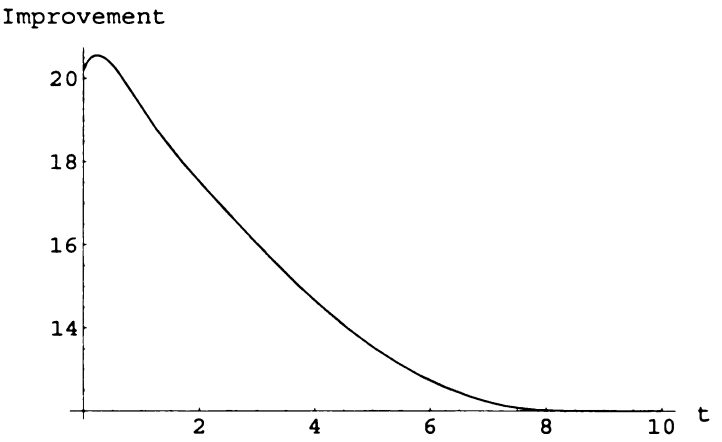

Figure 3.10: Environmental improvement under state $\{l,l\}$. $\Diamond$

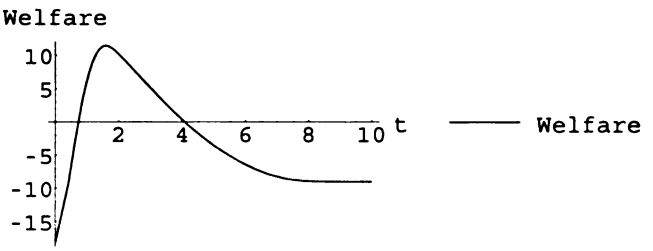

Figure 3.11: Welfare under state $\{l,l\}$. $\Diamond$

however. Parameters relating to low-input production methods, on the other hand, do have an effect on the equilibrium state reached. If consumers value foods grown with low-input methods enough, if the effort put into low-input production is not so high that it raises costs excessively, and if the cost of low-input methods is not too high, a low-input agriculture market can arise that has some positive environmental effect. What are some reasons that these parameters might vary? Consumer utility is dependent on preferences which are influenced by health knowledge, advertising, and social factors. The cost of low-input agricultural production is influenced by a host of technical factors and by institutional factors affecting the markets for low-input agriculture.

What about the level of input E? In reality, levels of inputs are more continuously variable than they are represented here, and it may be that firms will reduce their use of environmental inputs if it appears that the market cannot support high levels. However, if levels of environmental inputs inputs are required by law or by an industry-wide standard (as occurs in the legislative definition of "organic food"), it may be that the resulting product is too expensive for consumers. If this is the case (and it is a mere conjecture here), then restrictions on organic methods may have unintended consequences for general environmental quality.

3.3.4 Social Sanctioning

Tie-in sales, modeled in the preceding section, are but one form of selective incentive. Another form is social sanctions among consumers. Social sanctioning occurs when one member of a group penalizes (or rewards) another member of the group for failing to contribute (respectively, for contributing) to the collective good. This form of specific incentive can be modeled in the existing game framework as by adding one additional class of consumers and two additional variables.

The additional class of consumers is the class that purchases from firms that have

high environmental performance (i.e., the $\{h, h\}$ firms) and that sanction consumers who do not buy from those firms (i.e., the $\{l, h\}$ and $\{l, l\}$ consumers). We may denote the proportion of these sanctioning consumers as $c_{h,h,+}$. The level of the sanction can be specified in a variety of ways. For simplicity, consider a fixed sanction of s. Each sanctioning consumer imposes a sanction of s on each consumer that buys form firms with low environmental performance. The imposition of sanctions is generally costly. Let the cost of imposing the sanction be given by c_s. Thus, for each sanction imposed, a sanctioning consumer has her or his payoff decline by c_s.

It might seem implausible to have any consumers persist in sanctioning where sanctioning is costly. However, as Sethi & Somanathan (1996) show, there are evolutionarily stable states in which some individuals do sanction. One such state is illustrated in figures 3.12 through 3.15. For the figures, the starting proportion of consumers in each group were set at $c_{h,h,+} = 0.3, c_{h,h} = 0.2, c_{h,l} = 0.2, c_{l,h} = 0.2$, and $c_{l,l} = 0.1$. The sanction was set at $s = 1$ and the cost of the sanction was set at $c_s = 1$. For a general analysis of the stable states of this type of model, see Sethi & Somanathan (1996).

3.3.5 Limits of Game Theoretic Models

Compare the implications of Olson's analysis and the evolutionary game model. In brief, Olson's theory suggests that for most green consumerism situations — in which there are large groups of consumers and firms — green consumerism will only be effective to the extent that there are selective incentives present. Olson provides specific reasons for this relating to the likelihood that an individual firm or consumer will obtain direct benefit from its actions in a free riding situation. Where there are large groups and high exclusion cost resources, the most powerful influences on actors are likely to be specific incentives.

Evolutionary game theory essentially represents this prior conclusion in a formal

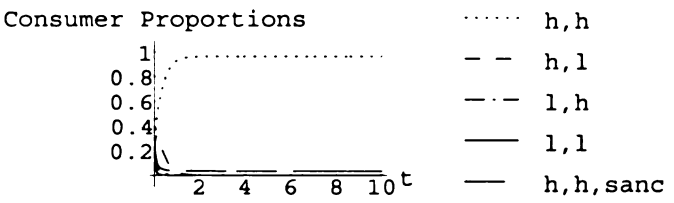

Figure 3.12: Consumer strategy choices in an evolutionarily stable state. In this state, most consumers choose (E, C) strategy {h, h}. However, some consumers choose strategy {h, h, sanc} in equilibrium. ◇

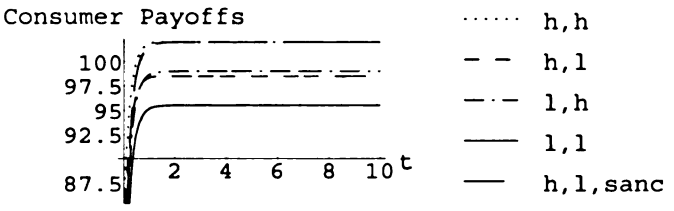

Figure 3.13: Payoffs to alternative consumer (E, C) strategies in an evolutionarily stable state. ◇

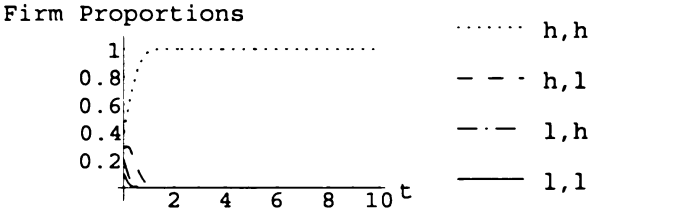

Figure 3.14: Firm strategy choices in an evolutionarily stable state. All firms choose (E, C) strategy {h, h} in response to the choices made by consumers. ◇

framework. Evolutionary games can present Olson's argument in detail and can be tailored to represent different types of incentives (e.g., tie-in sales, peer sanctioning, etc.). However, evolutionary games add little to Olson's analysis.

There are two reasons for the limited usefulness of evolutionary games. The first is that evolutionary games are rigid. An evolutionary game is a small set of differential equations. (There are between eight and ten equations in the models presented above.) Since systems of differential equations are usually not solvable, the modeler is constrained to choose a model using few equations that are in a simple form. Hence, although evolutionary games can represent the interaction of several agents (unlike traditional static models which are generally representative agent models), the modeler is usually limited to fewer than ten individual types.

Furthermore, like optimal control models and other forms of determinate dynamic models, evolutionary games have a small number of solutions. In the typical evolutionary game there are generally three possible results: all players choose one strategy, all players choose the alternate strategy, and some players choose one strategy and some the other. There is no ongoing interaction in such a model.

Full formal modelling of ongoing strategic interaction requires the use of computer simulation. Computer simulation allows the modeler to represent as many *individually unique* agents as the computer's calculation power allows. These agents may choose from a much wider range of strategies. They may even "learn" and develop strategies in some sense. Simulation models need not result in a limited number of solutions. Rather, the model can yield processes and changes that were not anticipated by the modeler. Of course, such models lack the simple solutions that are the hallmark of traditional economic modelling. A complex simulation model may have thousands of possible outcomes, many of which the modelers will never discover.

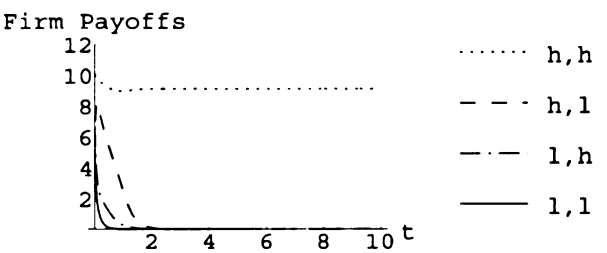

Figure 3.15: Payoffs to alternative consumer (E, C) strategies in an evolutionarily stable state. $\diamondsuit$

Chapter 4

The Organization of Environmental Self-Regulation

4.1 Introduction

If the three motivations for environmental self-regulation listed in chapter one — cost-savings, consumer pressure, and government pressure — are effective, firms will make an effort to self-regulate. Their efforts may involve investments in environmental control technology, improvements in production technology, or changes in management structure. However, it is apparent from the examples in chapter two that firms also adopt a range of organizational structures for their self-regulatory efforts. Some firms pursue ESR independently. Other firms develop formal agreements with government. Other firms participate in industry-wide self-regulatory programs. Still others participate in the development of uniform standards.

How can we understand this variation in the organizational forms of ESR? What causes certain firms to pursue ESR independently while others participate in industry-wide programs? Why do some firms work closely with government while others do not? This chapter argues that the variation in ESR organizational form can in part be explained through a transaction cost and missing market argument.

At present, there is little analysis of ESR organization in the literature. Glachant (1997) examines the effectiveness of three alternative regulatory forms — command-

and-control regulation, market-based instruments, and voluntary agreements between industry and government. Glachant argues that each option will require the gathering and processing of information about firms' environmental control costs. Depending on the particulars of the industry (how homogenous are the firms? how much shared uncertainty is there about environmental control?) one of the options will be more efficient at gathering and processing the required information than the others. For instance, voluntary agreements will be most information-efficient in industries with homogenous firms and great shared uncertainty about proper environmental solutions.

Eden (1996) relies on transaction costs arguments (though not by that name) to explain the failure of the UK packaging industry to adopt self-regulatory standards. In that case, the UK packaging industry was invited by the government to develop a set of self-regulatory standards. They failed to do so and instead shipped the responsibility for packaging regulation back to government. Eden argues that because of the industry's structure, the transaction costs of establishing a self-regulatory program were prohibitively high and the effort failed.

Dawson & Segerson (2000) use a multifirm model of voluntary agreements under free riding. The authors find that, despite the potential for free riding, there is sufficient incentives in the model for subgroups of firms to participate in voluntary environmental self-regulation. Furthermore, it is possible for the voluntary form to generate lower transaction costs than an emission tax.

Neither of the above two papers provides a systematic analysis of the organizational form of ESR. Such an analysis will be helpful for two reasons. First, a clearer understanding of why firms adopt different organizational forms for their self-regulatory efforts will help analysts to understand the range of ESR forms and decide which industries or firms are likely candidates for ESR. Second, an understanding of ESR organizational form will help industry and government policy makers design better self-regulatory programs and support self-regulation more effectively.

The purpose of the chapter is to generate hypotheses about when firms will pursue different organizational forms of ESR. Since there is no available data in this area, these hypotheses cannot be tested here. However, transaction cost and missing market economics provide a powerful theoretical structure that has yielded useful hypotheses in other subjects. It is hoped that the same will occur here. As noted, the hypotheses developed in this chapter carry implications for the effective design of self-regulatory programs and for the role of government. ESR does not substitute for government. Government is not likely to disappear in the environmental area. Instead, the role of government may change. Government may find itself at least partly in the business of supporting ESR through bargains and standards. (A detailed discussion of the role of government is reserved for chapter five.)

4.1.1 Transaction Costs and Missing Markets

This chapter relies on the concepts of transaction costs and missing markets, subsets of the New Institutional Economics. Transaction cost economics (TCE) begins by noting that economic activity is founded on transactions. A transaction occurs "when a good or service is transferred across a technologically separable interface" (Williamson 1985). More generally, transactions occur when two parties exchange the rights to economic goods. Using an example from ESR, a transaction occurs when a consumer pays money for a good that has been produced using high environmental standards. The consumer is exchanging money for environmental performance. Similarly, a transaction occurs when a firm improves its environmental performance in exchange for reduced regulation by government.

Transactions face transaction costs. Though the set of all transaction costs is large (see Williamson 1998), most theoretical power is contained in a smaller subset. Which costs are relevant to a particular subject depends on the subject under study. This chapter examines asset specificity, uncertainty, and free riding. Each of these problems

will affect the transactions that underly environmental self-regulation. Asset specificity and uncertainty are mainstays of transaction cost economics (Williamson 1989). They seem to have the greatest predictive power of the many possible transaction costs. Free riding is also a common transaction cost. They are also related to the information problems that are at the heart of the missing market analysis. As such, they are a point of contact between the two forms of analysis.

Specific assets are "durable investments that are undertaken in support of particular transaction, the opportunity cost of which investments is much lower in best alterative uses or by alternative users should the original transaction be prematurely terminated" (Carroll, Spiller & Teece 1999, p. 91) (quoting Williamson 1985). The problem with specific assets is that, once the investment is made, the investor cannot easily recover the investment except through the original transaction. If that transaction is terminated (either through inadvertence or bad faith by the other party), the specific investment will be lost. Economic actors will hesitate to make specific investments without protection for the underlying transaction.

Uncertainty generally acts to enhance the risk of specific assets. Where the future is uncertain, the risk that a transaction will be prematurely terminated is greater and a party's hesitancy to make specific investment is increased. Free riding may occur when the benefit of a transaction is a high exclusion cost good that is available to economic actors even if they do not engage in the transaction itself. Chapter three examined the effects of free riding in the context of green marketing. It also may occur, for instance, when government pressures an industry to improve its environmental performance. Government offers to exchange reduced regulation for environmental performance. If the offer is predicated on the industry *as a whole* improving its performance, then any individual firm can free ride on the efforts of other firms.

Note that a shared element of the transaction costs listed is information. The first transaction cost listed, asset specificity, is a problem where there is uncertainty about

the future. If the future were known, there would be no risk in investing in a specific asset and hence no transaction cost. Free riding is a form of information problem where the high exclusion cost involved is due to observation difficulties. Signalling problems are a form of information problem. Parties to a transaction have poor information about the behavior of their trading partners.

The information problems involved in transaction costs are related to the parties to a specific transaction. Information costs also play a role in the missing markets approach. An example of a missing market can be found in developing countries. In contrast to developed countries, developing countries generally have poor or absent markets for credit. The main reason for missing credit markets is information. Lenders find it costly to verify the credit worthiness, payment status, or even whereabouts of their customers. As a result, lenders are less willing to lend and credit markets fail. Note that the problem is not that customers are less credit worthy than those in developed countries but that lenders have a more difficult time determining creditworthiness. Missing markets arise where there are information or signalling problems that make it costly for individuals to verify the behavior of their trading partners. In the ESR context, consumers who want to buy from environmental firms, may be unable to verify whether a firm's actual performance matches its rhetoric.

Individuals do not sit still in the face of missing markets. As noted in the development literature, many institutions that appear to be inefficient from the point of view of neoclassical theory, can be seen as solutions to missing markets. For example, the institution of sharecropping, often seen as mere exploitation by landlords, can be seen instead as a way to provide incentives to both tenants and landlords where markets in tenant effort and credit are missing (Hoff, Braverman & Stiglitz 1993). Missing markets generally arise in situations of asymmetric information (i.e., moral hazard or adverse selection). In such a situation, an individual will be unwilling to sell the good in question and consequently, there will be no market for the good.

In addition to transaction costs and asymmetric information, the organizational structure of environmental self regulation may be influenced by attributes of the "production function" for the self-regulatory good. In particular, where firms develop a self-regulation or things related to a self-regulation, the development of the self-regulation may show increasing returns to scale. Increasing returns to scale occur when the marginal cost of a transaction declines as the transaction is repeated. For instance, Bennett (1996*a*) notes that the research activities of Chambers of Commerce show increasing returns to scale. Bennett suggests that this in part explains the existence of Chambers of Commerce. Chambers can perform research activities more efficiently than individual firms could on their own. For instance, where firms need to develop technology in order to reap cost savings, the production function for the new technology may show increasing returns to scale. This relationship will create a pressure for firms to develop new technology jointly or through a centralized research organization.

In summary, the literature on organizational form has identified three influences on organizational form. First, what transaction costs are relevant to the underlying transactions that the organization is attempting to perform? Second, is the organization serving as a substitute for a missing market? Third, is the organization producing a product, the production function for which shows increasing returns to scale? This chapter examines the transaction costs, missing markets, and production attributes that are relevant to ESR. It then describes the range of organizational forms that ESR adopts and proposes connections between those forms and the three types of influence listed. The discussion section proposes several hypotheses about when different ESR forms will arise and also proposes four "archetypal" forms of ESR as a way to summarize the essential elements of the argument.

4.2 The Organization of ESR

This section is organized by the three motivations for environmental self-regulation (cost savings, governments, and markets). Returns to scale are most relevant for the cost savings motivation, which will be addressed first. Transaction costs and missing markets play the largest role in the government and market motivations.

4.2.1 Environmental Technology and Cost Savings

If a firm wishes to alter its environmental performance in order to reap cost savings or respond to government or market pressures, it must make or buy the technology necessary to do so. If that technology does not exist, it must develop it itself or pay to have someone else develop it.

The acquisition of technology may involve organizational issues but these issues will not be unique to the ESR context.[1] The development of environmental technology, on the other hand, may have implications for how ESR is organized. Different organizational forms may be more efficient at the technology development process itself. A firm that needs to develop environmental technology must choose how best to pursue the development. Individually? Through a conglomerate? Through a virtual corporation (see Teece 1996).

A full analysis of what organizational forms are best at developing different environmental technologies is beyond the scope of this dissertation.[2] However, some points

[1]For example, the acquisition of technology involves making the technology or buying it from suppliers. As is the case with any technology acquisition situation, where the sale of technology requires specific investments by suppliers, suppliers may wish to protect themselves through vertical organization or hybrid organizational forms such as complex contracts. These organizational forms have little to do with the environmental context in which they take place.

[2]Teece (1996) develops a theory relating organizational form to technology development. He identifies several attributes of technology development including (1) the degree of uncertainty in the new technology, (2) the dependence of the technology on previous innovations, (3) the cumulative nature of the technology's development, (4) irreversibilities in the development path, (5) and the relationships between the technology in question and other technologies. Teece argues that different organizational forms will be more adept at developing certain types of technologies than other organizational forms. For instance, he argues that innovations that change the configuration of both

should be made here. First, environmental technology development involves uncertainty. Technology development requires an investment in development processes but it is not clear whether effective technology will in fact be discovered and developed to usefulness. There is fundamental uncertainty about whether a new technology will work, how much it will cost, whether the investment in its development is worth the effort, and whether other new technologies will render it obsolete. In this situation, the specific assets necessary to develop new technology — which include physical, human, and dedicated assets — are a risky investment. This situation will be particularly true for a firm that is not already in the business of technology development. When such a firm chooses to invest in environmental technology development, it risks the loss of its assets if the development effort does not succeed.

How might a firm proceed that needs to develop environmental technology, but hesitates to make the specific investments necessary? It may be preferable for the firm to *buy* new technology from another firm. As long as the development technology is not also specific to that second firm, the agreement will be possible. In other words, the firm that specializes in environmental technology development must have a sufficiently large client base to warrant its own investments. If there are thin markets for environmental technology development and extreme uncertainty in the need for new technology, cost-saving innovations may be precluded entirely.

Second, the development of environmental technology may exhibit economies of scale. If the results of environmental technology research are broadly applicable, there may be economies of scale from joint research activities. In other words, firms will find it worth their while to jointly fund technology development activities. This argument is similar to that given by Bennett (1996*a*) about the research activities of Chambers of Commerce. Where an individual firm would not find it worth while to develop

the main technology and a wide range of related technologies (so-called systemic innovations) will be best handled by either multiproduct integrated firms or by alliances based on shared ownership. This result is because of the need to coordinate the development of the main technology and the related technologies.

market research facilities, groups of firms may do so jointly through Chambers. An example of joint research is found in the pork industry's Odor Solutions Initiative. The industry association has taken the lead in promoting odor control research. Once an effective solution is found, it will be widely applicable to hog farms across the United States. However, any individual farm lacks the expertise and resources to undertake such research on its own.

There are also examples of government taking the lead in technology development. The U.S. voluntary agreement programs discussed by Storey, Boyd & Dowd (1997) feature government-led technology development. Firms are induced to participate by the promise of cost-savings from that technology. This is a case where, even if cost-savings are available in theory, it may require organized efforts to develop the necessary technology.

To repeat, this chapter cannot complete a full discussion of which governance structures are best suited to which types of environmental technology development. However, it is clear that technology development plays an important role in self-regulation and will affect the organizational form that it adopts. Finally, it should be clear that the acquisition and development of environmental technology will play a role in each of the motivations for ESR. Firms will need to acquire or develop new technology whether they are doing so to reap cost-savings, to reduce regulation, or to obtain a market benefit.

4.2.2 Government Motivations for ESR

The government motivation for ESR will involve more organizational issues than the cost-savings motivation. The basic transaction is between a firm (or the representative of a group of firms) and government. The firm offers an altered environmental practice in exchange for a benefit from government such as reduced regulation.[3]

[3]As Schalop & Scheffman (1983) note, firms may alter their environmental performance in order to encourage *stricter* regulation that will serve as a barrier to entry. This reasoning may be the

For this exchange to be interesting, the self-regulatory approach must offer benefits to both firms and government over government regulation. The required benefits may arise from the lower costs of self-regulation. Segerson & Miceli (1998) suggest that self-regulatory approaches provide more flexibility in meeting targets and can therefore achieve those targets at lower cost to firms. Self-regulatory approaches may be cheaper for government to implement as well. This result would be the case where the administrative procedures (drafting, notice and comment, negotiation, enforcement, and general administrative activities) are cheaper under self-regulation than full government regulation.

To fulfill the exchange, the firm will need to invest in environmental control technology of some sort. This investment may include machinery, management practices, or supply and materials handling changes. Some of these changes will require specific investments; others will not. For instance, a firm can comply with existing ozone standards by simply switching inputs. The change does not require adjustments to equipment or management practices. By contrast, sulfur dioxide control equipment may be highly specific. It may be the case that changes in management are less specific than investment in technology. If so, this may explain some of the interest in management-based self-regulatory programs.

It should be noted that the environmental performance of firms is not a single variable. There is not one single activity of "abatement." Rather, there are many choices of what pollutants to abate and by what means to abate them (e.g., eliminate at source or capture and dispose elsewhere). The technology necessary to solve a given environmental problem will generally not be effective against another environmental problem.

If the government backs out of its agreement, the firm's investments may be

motivation behind the pork industry's self-regulatory efforts. It has also been alleged to be the motivation behind stricter landfill regulations in California. Large landfill operators lobbied for strict regulation knowing that small operators lacked the capacity to meet those regulations (Wolff 2000).

useless. Investments meant to control emissions of a certain pollutant will not be useful to the firm if the government changes its policy to focus on a different pollutant. Changes in policy such as that are common enough. Ozone was not an issue 20 years ago nor were carbon emissions. Now they are significant concerns. If a firm's investments are still useful to fulfill existing regulation or if they yield cost-savings or marketing benefits, then they are not specific investments. If the only benefits of the investments stem from the specific agreement with government, then they are specific investments.

We expect to see three types of specific assets in environmental control technology: (1) *physical specific assets* such as the particular type of machinery chosen; (2) *human specific assets* such as the knowledge about how to operate, measure, and adjust the control technology; and (3) *dedicated assets* as when the firm makes investments in its environmental programs that it simply would not have made otherwise.

Uncertainty about the future makes specific assets more risky. A firm may be uncertain about which environmental problems will be of concern in the future, whether government policy will change, or whether other firms will lobby to alter the firm's agreement with government.

In general, firms can protect their specific assets by merging with their trading partners. It is not likely that firms that are interested in reducing government pressure will merge with government in order to protect the specific assets required. Instead, we expect to see either explicit contracts between firms and government or the development of uniform technical standards.

Contracts between firms and government occur in the case of voluntary agreements. Voluntary agreements make the exchange of environmental improvement for reduced regulation explicit. In the Netherlands, the government negotiates explicit, binding agreements with firms in the power industry. The agreements specify energy efficiency improvements in exchange for regulatory protection and financial and

technical support. These agreements offer clear and binding protections for industry.

In the U.S., by contrast, binding restrictions on government do not occur. Instead, U.S. voluntary agreements rely on the cost savings motivation. In the U.S., government contributes to the development of cost saving environmental technology. This occurs in the Green Lights, Energy Star, and XL programs (Davies & Mazurek 1996).

The difference lies in the degree of specific investments required. In the European energy sector's voluntary agreements, industry is being asked to make extensive and specific investments in energy efficiency. Though the increased efficiency may benefit firms, it is apparently not sufficient to generate a positive internal rate of return, unlike the U.S. programs (Storey et al. 1997).

Note that the free riding problem discussed in chapter three is relevant here. As noted in chapter three, government pressure creates the incentive for individual firms to free ride. Chapter three discussed that problem where there is no coercion of individual firms available. Since the topic of this chapter is organization, one should note that free riding can be mitigated in a voluntary agreement where the industry association involved is granted some degree of enforcement power by government. Alternatively, the agreements could be made between government and individual firms or small groups of firms as occurs in the Netherlands energy agreements (Storey et al. 1997). Segerson & Miceli (1998) raise the possibility that the voluntary agreement (contract with government) structure will be ineffective where large numbers of firms are involved. Note again that U.S. programs avoid free riding by offering cost-savings, not reduced regulation, as the motivation for participation.

Another way to protect the specific assets involved is through the development of uniform standards. Standards, by definition, call for uniformity and stability. If the environmental effort being contemplated by a group of firms can be made the subject of a standard, then their investments will be part of a relatively more stable system. Standards that have been adopted by a large group of firms are more likely to remain

relevant and be acknowledged by government. A firm that invests to meet a standard has a greater assurance (but by no means perfect) that its investments will remain useful.

In the government context, it may be helpful if the standards are ratified by government. Ratification may be done either in law or in the contracts being made with industry. Standardization occurs in the European voluntary agreements. For example, consider a French program designed to increase the ease of recycling automobiles. The program, begun in 1993, aims to reduce the percentage of nonrecyclable components to 10 percent by 2002. The task requires extensive coordination among various firms involved in auto manufacture and disposal. These firms includes parts suppliers, material producers, assemblers, dismantlers, shredders, and recyclers. Before a supplier can switch to a different material, it must make certain that the material will be processable by firms down the chain. Similarly, before a dismantler can call for a change in manufacturing practices to increase ease of recycling, it must make sure that the new practices are cost effective for assemblers. Because the changes contemplated involve specific assets, uniform standards in recycling are essential to the success of the French voluntary agreement (Lyon & Maxwell 1999).

Standardization provides coordination benefits in three ways. (1) Standards allow firms to coordinate their activities with one another. This is the point just illustrated with the French case. (2) Standards help firms convey their message of environmental improvement to others more consistently and convincingly. A standard defines environmental quality in the specific context and provides tools (possibly limited to be sure) for verifying performance. (3) Standards allow firms to use consistent technology. Standards help create stronger markets for equipment, parts, and service. It should also be noted that standards exhibit increasing returns to scale. When more firms and governments adopt a standard, the standard's coordination benefits become more valuable to each firm.

The question of technology development introduced in the discussion of cost-savings is also relevant here. Firms that wish to respond to government offers of reduced regulation may need to develop new environmental technology in order to do so. As noted for cost-savings, technology development comes in different forms, each of which may be best undertaken by a different governance structure. Again, detailed study of this question is omitted here.

Note finally that, in some situations, the transaction costs involved in responding to government pressure may be too great. Alternatively, the costs of creating a responsive organization may also be too great. In these cases, the government pressure motivation will be ineffective. One will need to fall back on no regulation or full government regulation. This was the case in the UK packaging industry, mentioned earlier (Eden 1996).

To summarize, the transactions that are part of government's attempt to motivate ESR involve three important attributes. First, firms will likely be required to invest in specific assets in order to receive benefits from government. Second, where government's influence is directed at an entire industry rather than at individual firms, there will be an incentive to firms to free ride. Third, uniform standards and the development of environmental technology may each benefit from increasing returns to scale. We hypothesize that these transaction attributes lead to explicit contracts with government, the formation of industry associations with some degree of regulatory and negotiating power, and uniform standards.

4.2.3 Marketing Motivations for ESR

The analysis of market incentives for ESR is similar to the analysis for government incentives but with missing markets playing a greater role. The transaction here is between a firm and a market partner. The partner may be a consumer, another firm, or a shareholder. The market partner offers money in exchange for changed

environmental performance. Chapter three assumes that the market partner is not trying to buy environmental improvements as such but is instead interested in some low exclusion cost benefit such as product safety. Whether that assumption is true or whether consumers are willing to spend money for high exclusion cost goods is an empirical question and is beyond the scope of this dissertation. Regardless of the customer's motivation, firms will still need to make investments in order to meet the requirements of that customer.

For example, a firm that wants to control the environmental effects of its products may require its suppliers to abide by certain environmental practices. It may require the use of control technology, a change in management practices, or some other change. A consumer may pay more for (or only buy) products that are not tested on animals. For a firm to meet this requirement, it will need to establish alternative testing procedures. A shareholder may invest exclusively in firms that have strong clean air programs, requiring specific investments.

As was the case with government, part of the specificity of the investments stems from the fact that consumers may change their minds. An environmental marketing strategy that focuses on the firm's toxic emissions may become irrelevant if the public's attention shifts to greenhouse gases. Furthermore, a firm may receive different pressures from consumers, shareholders, and other firms. The investments that please shareholders may not also please consumers. As in the government case, we expect to see physical, human, and dedicated specific assets.

It should be noted that not all market pressures will require specific investments. The Body Shop, an international cosmetics company founded in England in 1976, pursues an aggressive environmental strategy. However, much of its strategy is based on the firm's contributions to environmental causes and on the ingredients in its products. These investments are not specific (Shrivastava 1996, ch. 5).

Uncertainty will be a magnifier here as it was for government. Where the firm is

unsure of its future regulatory burden or of the future interests of its market partners, it will hesitate even more to make specific investments.

What organizational forms should we expect to arise? There are two cases. First, where the firm is transacting with only a very few others, some degree of hierarchical organization will be possible. This may be the case where a firm wants to control the environmental performance of its suppliers in order to ensure the environmental integrity of its final product. Where the suppliers must make specific investments in order to meet the wishes of the firm, they may seek protection in the form of vertical organization or a set of contracts. This form occurs in the food industry where certain brand name suppliers (such as Gerber or Albertsons) impose strict health requirements on their suppliers. Gerber, for instance, is particularly concerned about the presence of pesticides and other chemicals in their baby food products. By placing environmental and processing restrictions on its suppliers, Gerber can reduce the risk of a contamination incident that will damage its reputation.

Where the firm is transacting with a large number of individuals (e.g., green consumerism), integration and complex contracts will be impossible. Here the likely solution will be standardization. Standards can protect specific investments by making environmental goals more stable. When firms in a market have strong and clear uniform standards, it is less likely that consumers will change their minds suddenly and start buying based on different environmental issues.[4] This protection can be made more solid when the standards are enacted in law as has occurred in the U.S. and some European organic agriculture standards.

From the missing markets perspective, consumers want to buy a particular good (environmental performance by firms) but have difficulty doing so. There is no market in which consumers can buys such a good. The reason for the missing market is the

[4]An important question is to what extent firms consumers define standards and to what extent firms do. Standards qua consumer protection would indicate that consumers should play a major role. Standards qua asset protection would indicate that firms should play a major role.

information problem that underlies other missing markets: consumers cannot reliably distinguish firms with true environmental performance from firms that are merely pretending. As a result, a consumer demand goes unmet. The organizations that support environmental self-regulation serve as a substitute to the missing market in question.

Another benefit of standardization in the market context stems from its signalling function. Recall that in the government motivation case, standardization can serve to define the government's requirements more clearly and to coordinate the technological efforts of groups of firms. The problem faced in markets is that consumers will not know what environmental quality means and will not be able to verify that a firm is providing it. Standards can solve both problems. By defining environmental quality explicitly, standards tell consumers what they are buying. By establishing some verification or assurance procedure, standards tell consumers that they are not being defrauded. Thus, standards can serve to alleviate the missing markets problem.

In summary, where the market motivation stems from a few customers, hierarchy or complex contracting may be expected. Where the market motivation stems from many customers, uniform standards may be expected.

4.3 Discussion

4.3.1 ESR Governance Structures

In this section, I would like to summarize what has been discussed and list the most important hypotheses about ESR organizational form. ESR can be motivated by cost savings, government pressure, or market influences. The government and market motivations each rely on transactions between firms and either government or market partners. In these transactions, firms exchange their improved environmental performance for either reduced government regulation or money. In order for a firm

to complete these two transactions, it must make investments in environmental technology. The firm may either acquire existing environmental technology by making it or buying it from suppliers or the firm may develop new technology or pay a supplier to develop it.

The cost savings motivation does not depend on transactions with government or market partners. Instead, the firm that is seeking cost savings can obtain them simply from adopting technology with higher technical efficiency. However, the cost-savings motivation still requires acquisition or development of technology.

The transactions involved in ESR are illustrated in figure 4.1. There are four transactions of interest: (1) the acquisition of environmental technology, (2) the development of environmental technology, (3) the exchange of environmental performance for reduced government regulation, and (4) the exchange of environmental performance for money from a market partner.

The factors that affect these transactions are given in table 4.1. They are (1) asset specificity, (2) uncertainty, (3) returns to scale, (4) free riding, (5) and missing markets. Table 4.1 indicates which attributes are likely to be relevant to the four types of transactions involved in ESR. The leftmost column lists the transaction costs that play a role in environmental self regulation. The three types of asset specificity — physical, human, and dedicated — are listed separately in italics. The remaining columns list the four types of transactions occur in environmental self regulation: acquiring environmental technology, developing environmental technology, negotiating with government, and participating in environmental markets. A dot is placed at the intersection of each transaction cost - transaction pair when the transaction cost is likely to be a significant factor in the transaction in question. Thus, physical asset specificity is likely to be relevant to the transactions involved in acquiring environmental technology, but free riding is not. [5]

[5]The technology development column is incomplete because there are other attributes of technology development that will affect the organizational forms that develop technology. These attributes

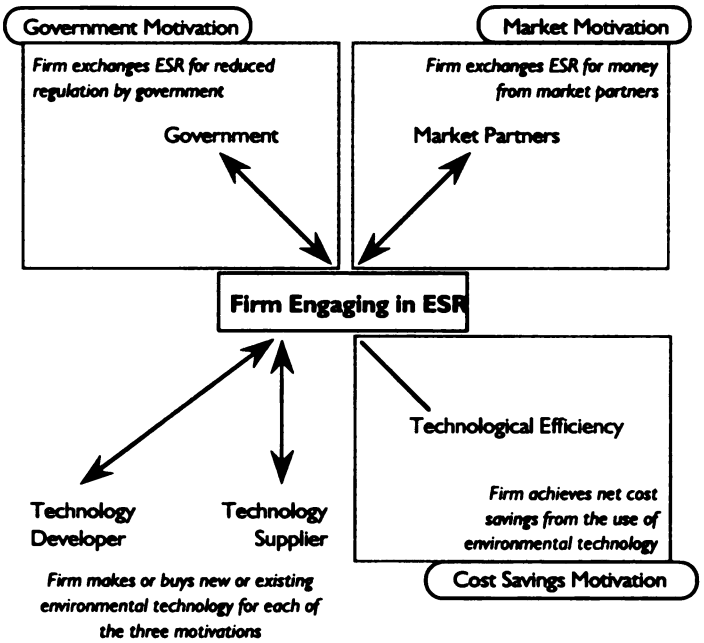

Figure 4.1: The transactions involved in ESR. A firm that is interested in ESR (shown in the center of the figure) obtains benefits for its ESR efforts from government, from market partners, or from increased technical efficiency itself. The government and market motivations involve transactions (depicted by arrows). The market motivation involves technical efficiency itself (depicted by a line). In order to make an ESR transaction with government or a market partner, the firm must also invest in environmental technology either by acquiring existing technology or developing new technology (shown at the lower left). ◊

Table 4.1: *Influences on ESR Form. For the three motivations for ESR, the following influences on ESR organization form are relevant. The presence of a "•" indicates the importance of an influence.* ◇

	Transaction			
Transaction Cost	Acquiring Env. Tech.	Developing Env. Tech.	Government Negotiations	Environmental Markets
Asset Specificity *Physical*	•	•	•	•
Human		•	•	•
Dedicated	•	•	•	•
Uncertainty	•	•	•	•
Free Riding			•	
Missing Markets			•	•
Returns to Scale		•	•	•

Table 4.1 indicates which transaction attributes are likely to be important to which transactions. This is a general analysis. It is impossible to estimate the magnitudes of these attributes here since the transactions under consideration are too general. There is also no specific data available on the transaction costs involved in ESR. Future work should examine a particular instance of transaction, such as an explicit bargain between industry and government in a voluntary agreement. There, the transaction costs involved in the bargain can be assessed more precisely.

Note that the acquisition of environmental technology faces only specific assets. The transaction cost problems involved in the acquisition of technology relate to the interaction between the technology supplier and the firm not between the firm and the motivation of cost savings. In other words, the firm obtains its benefit from physics in the abstract (if the motivation works, investment in environmental technology yields cost savings to the firm) not from any trading partner. The government and market motivations, by contrast, have the firm receiving benefits from a third party. In those cases, the transaction costs relate to the source of the benefits (government or market

are beyond the scope of this dissertation. See Teece (1996) for a discussion.

Table 4.2: *Transaction costs and governance structures. For each type of transaction cost, they governance structures that it leads to are indicated.* ◇

Transaction Attribute	Governance Structure
Specific Assets and Uncertainty	*Market Motivation*
	Vertical integration (if few firms) Standards (if many firms)
	Government Motivation
	Contracts with government Standards
Free riding on government pressure	Industry association enforces agreement
Scale in technology development	Industry association develops technology
Missing markets	Uniform standards

partners). The firm proposes to invest in environmental technology, but faces the risk that its investment will become worthless. It is the attempt to protect that value of the environmental investment as such that drives organization in the government and market cases.

We have identified five types of governance structures involved in ESR (not counting the structures involved in technology acquisition, which are not unique to ESR): (1) Markets themselves (i.e., no higher organization); (2) contracts between government and firms or an industry association (e.g., voluntary agreements); (3) industry associations that develop ESR programs for their members; (4) vertical integration in a supply chain; and (5) the establishment of uniform standards (either privately or in law). These organizational forms are not exclusive. Standards may be used in conjunction with the other forms as well as separately.

When will expect to see each of these governance structures? Table 4.2 shows the transaction costs under discussion and the governance structures to which they lead.

Will we ever see markets alone? For this to occur, the transaction costs identified would have to be weak in a particular situation. This may occur in certain green markets. The Body Shop's products are successfully marketed as environmen-

tal products without the addition of standards or other governance structures. Note the absence of relevant transaction costs in this situation. The technology required to develop and manufacture these products requires relatively few specific assets. The company's environmental efforts are largely based on the absence of animal testing, specialized packaging, brand name, and the dedication of company profits to environmental causes. None of these activities are specific. Also, there are missing markets problems. Consumers who visit the Body Shop appreciate the company's environmental image, but are not greatly concerned about the verifiability of the company's environmental claims. Those claims are modest in any event.

Markets will have a harder time functioning on their own where the listed transaction costs are larger. The organic foods market serves as an example. Here, the assets required for organic production become more specific. Some organic standards require farms to use no pesticides for a series of years before entering the organic market. The environmental and health effects of agriculture are difficult to assess and are poorly defined. Finally, there are significant missing markets problems. As a result we see more uniform standards and government-ratified standards in organic agriculture.

Vertical integration may occur where there is a market motivation with specific assets and few individuals involved, such as a firm requiring environmental performance from its suppliers. Consider the Gerber and Albertsons examples from above. Where there are many individuals involves, as in green consumerism, we expect specific assets to lead to standards.

Where environmental improvement requires investments in specific assets and relies on the government motivation, we expect to see protective contracts with government, such as formal voluntary agreements. We may also expect to see the use of standards in this situation. Missing markets problems with consumers also motivates the development of standards.

Where there are returns to scale in technology development, we expect to see some unified development effort, such as technology development by an industry association. This effort occurs in the pork industry in the United States and in the Responsible Care program. An industry association may also play a role in reducing the problem of free riding on government pressure. This role will require that the association have some degree of enforcement power over its members. The power could derive from a delegation from government or from the association's inherent power if its members feel compelled to stay in the association or derive sufficiently large benefits from staying in the association.

Note that standards are motivated by several different transaction attributes at once: (1) benefits from uniform technology, (2) protection of specific assets for firms responding to government pressure, (3) increased stability in the wants of consumers, and (4) missing markets problems for consumers.

4.3.2 ESR Hypotheses

I would like to close the discussion by listing four primary hypotheses about how environmental self-regulation is likely to function.

1. Vertical integration (or complex contracts) between a firm and its suppliers. A vertical integration form of ESR will likely arise where a firm wishes to control the environmental performance of its suppliers and that control requires specific assets. It is only likely where the firm and its supplier have few other trading partners. A supplier that has many thousands of customers will not be able to enter into a vertical integration or complex contract structure with just one of them.

2. Contracts between industry and government. Contracts between industry and government will likely arise where firms can obtain regulatory relief but must

make specific investments to do so. Higher asset specificity and greater uncertainty about government's future actions will lead to stronger contracts. (Use of standards may also appear in this situation. See the fourth archetype below.)

3. Industry association ESR. Industry associations will likely develop their own ESR programs for one of three reasons. First, an industry association may be able to reap positive returns to scale from technology development and therefore provide cost-saving environmental technology as a benefit to members. Second, an industry association may participate in a government-industry contract in order to reduce free riding by participating firms (assuming that the industry association has some degree of power over members). Third, an industry association may take the lead in the development of uniform standards (see the fourth archetype below).

4. Uniform standards (private or in law). Uniform standards may play a role in both the market and government motivations for ESR. Standards may be a separate form of ESR or they may be a tool of ESR that can be used by other ESR forms forms. Standards will likely arise in one of three situations. First, standards may arise where firms wish to respond to green consumerism but want to clarify and make permanent the standards by which they will be judged. (The need for clear signals supports the use of standards in this situation as well.) Second, standards may arise where firms want consistency and predictability in their negotiations with government. These standards may require formal ratification by government. Third, firms may develop standards in the hopes that government will enact those standards into law and thereby raise a barrier to entry for competing firms.

Chapter 5

Conclusion

5.1 Summary

Institutions matter to environmental self-regulation. Consider the institution of property rights. One of the main motivations for firms to engage in environmental self-regulation is that they expect to receive a financial benefit from their customers; and their customers expect to receive an environmental benefit in exchange. However, before a benefit of any kind can be received, the partners to the exchange must have defined the property rights to that benefit. When a firm tries to sell its positive environmental affects as an attribute of its main products, it is trying to sell a good that has poorly defined property rights. Hence, consumers have the opportunity to free ride on other consumers — obtain the environmental benefit without paying the higher product price. This is the classic free rider problem analyzed by Olson.

Chapter three examined the free riding problem in ESR by applying Olson's theory as well as the more recent theory of evolutionary games. The most important point was that, since consumer-driven ESR involves large groups of consumers, we expect that selective incentives will be necessary to overcome the free riding problem. There are several examples of selective incentives being used in consumer-driven ESR.

A form of tie-in sale occurs where a firm markets a product that has individual health or other benefits that attract consumers, but that has a positive spillover

effect on the environment as well. Some forms of organic produce may exhibit such an effect. Social pressure is another form of selective incentive. Individuals who choose environmental products may receive direct benefits from their peers in the form of praise or other social connections. In that case, it is the social pressure that is motivating the environmental purchase, not the prospect of environmental improvement itself.

We see some industry associations developing selective incentives in the form of exclusive benefits for member firms. Industry organizations, such as trade associations, often provide exclusive benefits to their members. Exclusive benefits are benefits that are only available to member firms. Examples include technical assistance, individualized market research, member directories, publications, discounts on supplies, access to social networks, and legal assistance. Because these benefits are low exclusion cost goods, the industry association that provides them can restrict their use by nonmembers.[1]

If an industry association develops a set of environmental practices for its member firms to follow, it can attempt to attach exclusive benefits to those standards. Rather than rely on consumer or government pressure to motivate its member firms to comply, an industry association can require participation by its member firms. As long as the association's exclusive benefits are valuable enough, it will be able to induce compliance with the environmental standards.

The chemical industry's Responsible Care program adopts this approach. National chemical associations provide technical assistance and other exclusive benefits to their members. As part of membership, the associations require compliance with the Responsible Care program. Member firms are also allowed to use the Responsible

[1]Industry associations also provide collective benefits; benefits that are available even to firms that do not join the association. These benefits include lobbying on behalf of the industry, the development of industry-wide technical standards, advertising on behalf of the industry, and general research. Because these benefits are high exclusion cost goods, the industry association finds it more difficult to restrict access to them.

Care trademark in their advertising. To the extent that the use of the trademark benefits firms that use it,[2] the trademark is another exclusive benefit available only to members. Of course, firms will tailor their efforts toward obtaining the exclusive benefits and not toward the environment as such. See Bennett (1996*a*) and Bennett (1996*b*) for similar points in the case of Chambers of Commerce.[3]

Government can also create exclusive benefits. For instance, the government can develop voluntary environmental programs that provide technical support, public recognition, or other benefits to participating firms. These side benefits are meant to encourage firms to work toward the underlying goal of environmental improvement. Whether such a policy will be successful in attracting participants depends on the value of the proffered benefits which, in turn, depend on the property rights of those benefits. If firms feel that they benefit from public recognition of the industry as a whole, regardless of their own performance, they may be induced to free ride on the efforts of other firms and not participate in the government's program. On the other hand, if the program relies on cost-saving technical assistance, firms will have to participate in order to obtain those benefits.[4]

Olson's theories provided a useful structure with which to analyze free riding in ESR. However, there has been a shift toward more formal modelling of free riding situations, such as the evolutionary game analysis performed by Sethi & Somanathan (1996). Evolutionary games are able to represent a free riding situation in more detail than traditional static models. Though an evolutionary game can represent

[2]Arora & Cason (1995) find that firms with greater direct consumer contact are more interested in the positive publicity associated with voluntary environmental programs.

[3]Furthermore, the *industry association* that creates the exclusive benefits may also ignore the environment. An industry association profits from the exclusive benefits that it provides. Therefore, an industry association has an incentive to provide benefits that yield a high return and that attract members. Requiring members to undertake environmental activities may reduce the association's membership. This is not to say that no associations provide high-exclusion-cost benefits. Indeed, one purpose of associations is to fund high-exclusion-cost benefits with proceeds from low-exclusion-cost benefits.

[4]Government can also support the operation of green markets by defining standards, providing tax and regulatory incentives to environmental firms, or offering demonstration and technical support to environmental firms.

tie-in sales and peer pressure effects on free riding, the models add little in the way of conceptual detail to the work of Olson. This outcome is because evolutionary models cannot represent the richness of large group interactions. They can, at best, represent the choices of a handful of different types of individuals. A more realistic formal model of consumer-driven ESR will need to be developed using computer simulation, if at all.

Free riding is an important element in the analysis of ESR. Another important element is the problem of transaction costs and missing markets. Transaction costs (particularly asset specificity) and missing markets (lack of information about products) create problems for ESR that need to be solved through organizational changes in the self-regulatory enterprise itself. ESR is based on exchanges between firms and consumers (in the case of market-driven ESR) or policy makers (in the case of government-driven ESR). These exchanges are a form of market. Where transaction costs or information problems limit the functioning of the market, the participants in ESR can overcome the limitations through organizational changes.

The following attributes are of interest. First, the transaction cost of asset specificity (with its exacerbating factor: uncertainty) can render otherwise desirable investments in environmental technology untenable for a firm. A firm that wants to make environmental investments to improve its standing with consumers or policy makers, will hesitate to do so where the investments are specific and where consumers or policy makers may yet renig on their commitments. In this case, a form of organization that assures the firm of a return on its investment will be necessary. For example, government-motivated ESR that requires specific investments by firms will be more likely to occur where the commitments by government have the force of law and are therefore less likely to be changed.

The second important attribute is the information problems associated with the environmental claims being made by ESR firms. Since good information on environ-

mental claims is costly to obtain, markets for environmental attributes tend to be missing. As a result, even if consumers were willing to buy from environmental firms, they cannot be sure of their purchases. A common organizational solution to this problem is the development of uniform standards. Independently verified standards reduce uncertainty on the part of consumers. Standards can also address the problem of specific assets. Standards serve to lock-in the responsibility of firms and increase the likelihood that their specific assets will be useful in the future.

5.2 Favorable Conditions for ESR

Recall from the introductory chapter that there are three basic motivations for a firm to engage in ESR: (1) environmental improvements may yield net savings to a firm by reducing production costs; (2) environmental improvements may induce government to change the regulatory burden on firms; and (3) environmental improvements may create marketing advantages for firms. The arguments developed in chapters three and four can be used to identify likely conditions under which each type of ESR will arise and function.

First, consider what conditions will support the cost-savings motivation for ESR. Obviously a prior technical condition for the cost savings motivation to operate is that technical improvements are in fact possible. Furthermore the technical improvement must directly affect a cost center within the firm, typically input use. Industries whose environmental problems are only weakly related to input use will be poor targets for the cost savings motivation. For instance, power generation from fossil fuels creates carbon dioxide as a byproduct. Since carbon dioxide is a necessary byproduct of combustion, the only way to reduce its production is to reduce fuel use. However, this strategy directly reduces the amount of saleable product that the industry can create. By contrast, a company such as 3M is able to reduce many of its inputs

without reducing the amount of saleable product it created.

The above is not an economic one but a physical one. The physical possibility of technical improvement is not sufficient. In addition, it is necessary for firms to have the information and resource capacity to recognize and invest in cost savings. This is more than a statement about ordinary capital constraints. It is also a statement about the organizational capacity of the industry in question.

As noted in chapter four, technology development involves uncertainty and investment in specific assets. To the extent that cost-saving technologies show those traits, we expect to see them developed by specialized development firms or by industry associations or governments. These organizations are better able to address the problems of uncertainty and specificity than the ordinary firm. In addition, technology development often shows returns to scale. This fact also will lead toward technology development by specialized development firms, industry groups, or government. (See Teece (1996) for greater detail on the organizational factors involved in technology development.)

Under what conditions will government-motivated ESR arise? A necessary prerequisite is that the government have a high degree of influence over firms. For example, government power will be enhanced where the target firms are already subject to strict regulation or where an industry has polluted enough to be under the threat of new regulation. Government pressure is also likely to be higher for politically sensitive problems such as toxics.

Situations where government has a strong influence over firms are not necessarily those that will result in ESR. Where firms are able to free ride on the performance of other firms — avoiding government pressure by living in the shadow of well-performing firms — the strongest government pressure will be ineffective at motivating firms and government will need to fall back on traditional regulation. As seen in chapter three, free riding problems of this type can be overridden with specific incentives.

For instance, firm free riding can be overcome where government pressure is explicitly tied to individual firm performance. This tying may occur by offering technical assistance or public recognition[5] to firms based on their individual performance. Free riding by firms will be less of a problem in small industries where the overall performance of an industry is more strongly affected by individual firms. One way to use that principle in the design of government-motivated ESR is to adjust regulatory pressures by small geographic regions or by industry subsectors. Another option is to grant some degree of oversight and enforcement power to an industry association. Relief from government pressure can be given only to firms that adopt a specific industry code.

From chapter four, we see that government-motivated ESR will function best where the required investments in environmental technology are either not specific or can be protected. The problem of asset specificity arises because the technical changes that firms must make to achieve environmental improvements are generally expensive and are tailored to particular environmental problems. To resolve this problem and allow specific self-regulatory investments to occur, we expect to see government-motivated ESR involve the use of binding contracts between industry and government. Such contracts give industry the assurance that their investments will be rewarded. Uniform standards may also play a role by clarifying which environmental problems and technologies are of interest to government. European voluntary agreements are an example of explicit agreements between industry and government.

Market-driven ESR faces similar issues. First, before market-driven ESR can arise, consumers must have sufficient influence over firms to make environmental change attractive. Strong buying power, boycott power, or other influences will be required as a prerequisite to market-driven ESR.

However, as was the case with government-driven ESR, influences alone are not

[5]Government sponsored public recognition is a form of consumer-driven ESR and illustrates the overlap between the types of ESR.

sufficient. Even in markets with strong demand for environmental improvement, free riding can stand in the way of effective ESR. Market based ESR is more likely where the problem of consumer free riding can be overcome. Overcoming free riding may occur in small markets, such as niche markets, where there is a strong core of individuals that are willing to support the high exclusion cost good of the environment. One sees this relationship in the case of organic food.

For large markets, selective incentives will be necessary to overcome the free riding problem by consumers. One approach is the tie-in sale whereby consumers obtain a direct benefit (e.g., a health benefit) from a product that also offers high environmental benefits. Where the environmental benefits are closely associated with the environmental benefit, consumers can effectively support environmental improvement without the limitations of the free riding problem. Market based ESR will also be more likely where the environmental investments required are either nonspecific or are protected through uniform standards (possibly government-ratified ones).

5.3 ESR and Government

Environmental self-regulation is often portrayed as an "alternative" to government regulation. While ESR is certainly different than traditional government regulation, ESR does not replace government. Except in simple cases, the free riding, information, and transaction cost problems involved in ESR will necessitate a role for government. Furthermore, the effect of self-regulatory structures is to create winners and losers. As is the case in any win—lose situation, those affected will seek the aid of government in furthering their cause.

ESR that relies on cost savings may function without significant government intervention where the technology in question involves few of the issues identified in chapters three and four. For instance, where returns to scale in technology develop-

ment are negligible or where the technology requires few specific investments.

Where cost-savings involves technologies that have more complicated institutional issues, government will be called upon to play a larger role. Where the development of cost-saving technology involves uncertainty, government can support its development through demonstration projects, investments in research and development, or tax and regulatory support for environmental innovation. Where cost-saving technology development shows economies of scale, government can help capture those economies by centralizing and subsidizing the research and development effort.

Even where cost-saving technology is available, there may be barriers to adoption that government can help overcome. Firm's fears about investing in technology can be reduced through programs that buy back obsolete technology or give tax credits for installation of new technology. Government can also ease the transition to new technology by offering financial and technical assistance or insurance for the risk associated with new technologies.

Some environmental technologies may require changes in a broad range of connected industries. For instance, efforts to increase the proportion of cars that can be recycled may require innovation in parts, assembly, disassembly, and recycled products markets. Where so many connected innovations are required, government can create partnerships and overall plans to encourage such innovation.

Government has an obvious role to play where ESR is motivated by government threats. However, even where a government threat is powerful, if firms must invest in specific assets in order to respond to that threat, they may be unable to do so. In such a case, government can increase the effectiveness of its threats by offering a binding agreement with industry. If government's promise to refrain from stricter regulation is a reliable one, industry will be more willing to make specific investments in the bargain.

Similarly, strong government threats will be useless where firms feel that they can

free ride on the environmental improvements of other firms. Problems of firm free riding can be lessened where the threat can be targeted to specific firms. Alternatively, government may be able to provide some delegated power to an industry association which may have more control over its individual members.

Free riding may undermine the market motivation for ESR. Government can mitigate the effects of free riding by supporting the development of products that are individually attractive to consumers but that have positive spillover environmental effects as well. A similar result can be obtained through the development of uniform standards. When government participates in the develop of product standards — such as the definition of organic or standards for consumer product safety — it can include environmental factors in the standards. Products that meet standards, whether statutorily required standards or voluntary ones, have a market attraction that other products do not. Environmental characteristics can be bundled with the standard to result in a product that is bought simply because it meets a standard but that has a positive environmental effect because of the environmental components of that standard.

Market-motivated ESR is subject to significant information problems. In particular, since environmental characteristics are so difficult to observe, independent verification of a products attributes may be necessary. In some cases, the only entity that is trustworthy enough and that has broad enough powers to maintain a reliable standard will be government.

In short, there are many situations in which ESR simply will not function without the support of government. Where firms or consumers will free ride, where firms are held back by transaction costs, or where firms or consumers lack adequate reliable information, government can contribute.

There is one final point to be made about the relationship between ESR and government. It has been noted that the transaction cost problems associated with

ESR create a role for government or for quasi-governmental private organizations such as industry associations. In addition, the conflicts that draw individuals to lobby and participate in government will also draw individuals to lobby and participate in ESR. Despite the presence of the cost-savings motivation, most environmental solutions involve net costs. Firms will, in general, try to avoid paying these costs. Citizens (including employees of firms!) will try to avoid suffering the environmental damage created by firms. When these goals meet, there will be conflict. If that conflict is met within the halls of government, individuals will join in to lobby for their side. If that conflict is met within a self-regulatory program, individuals will again join in to lobby for their side. To the extent that self-regulatory programs are successful at addressing environmental issues, they will attract lobbying and political pressure. Thus, even where ESR is separate from the existing structure of government, it cannot separate itself from the conflict-laden *process* of government.

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