Final Report

The Economics of Tailored Regulation and the Implications for Project XL

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1. Introduction

Launched with considerable fanfare in March 1995, Project XL (which stands for eXcellence and Leadership) is the flagship of the Environmental Protection Agency's regulatory reinvention initiative. It is a voluntary program in which individual facilities negotiate agreements that allow them to replace or modify specific regulatory requirements on the condition that these changes improve their environmental performance. A common XL project waives a facility's Clean Air Act Title V obligations to obtain new permits every time the production process is modified in exchange for the facility's commitment to an plant-wide emissions cap set below the baseline level of aggregate emissions (for example, the Intel and Merck agreements). A second common project waives the designation of a facility's wastes as "hazardous" in exchange for investments in specified pollution control or pollution prevention technologies (for example, the Molex and Hadco agreements).

By all accounts, Project XL has had a troubled history. It has repeatedly fallen short of self-imposed performance benchmarks. EPA's initial goal was to have 50 XL projects approved by the end of 1996. However, by December 1999, four years after this deadline, only 15 projects had been approved, 16 were in an intermediate stage of project development, and 15 more had been accepted for initial review. Key reasons for this halting progress have been an inability to attract proposals, and delays in the project approval process. Fewer than 12 proposals per year were received in the first four years of the program, and fewer than five proposals per year were approved in each of the first five years of the program. Since December 1999, project approval has accelerated significantly, however.

Given the problems that Project XL has encountered, some analysts have predicted that it will not survive. Even if it does not, Project XL deserves serious study because it is likely to be a prototype for future programs. Certainly this is how the project has been billed. When unveiled by President Clinton in1995, Project XL was touted as a "regulatory blueprint for the future" (Phillips, 1995), a characterization that was reflected in press reports. For example, according to the New York Times, Project XL is "…widely seen as a prototype for a much broader—and still largely unexplored—change in how the nation regulates industry" (Cushman, 1996).

While there is some hyperbole involved in such characterizations, there is also considerable validity. A compelling argument can be made for the *general* approach to regulation Project XL exemplifies. This approach has five defining characteristics. It is:

- facility-specific,
- voluntary,

- performance-based, i.e., replaces command-and-control standards with performance standards that guarantee "superior environmental performance,"
- requires a stakeholder process that involves community representatives in negotiating the regulatory agreement,
- emphasizes diffusing regulatory innovations among non-participating firms.

We refer to this approach as "tailored regulation" (TR). TR is viewed by many as a means of mitigating several well-recognized drawbacks of command-and-control regulation. Command-and-control regulation often dampens incentives for innovation in pollution control; dictates the means by which facilities should control pollution without due consideration to firm-specific attributes; and dictates how much pollution facilities should control, again, without due consideration to heterogeneity across firms.

Economists have long recognized these problems with command-and-control regulation. The solution they often propose is to replace command-and-control with economic incentive instruments like emissions fees and tradable permit systems. But for a variety of technical, enforcement-related, and political reasons, widespread application of these regulatory instruments is impractical in the short term. TR amounts to a more limited reform. Although it generally fails to eliminate the problem of the regulator dictating how much heterogeneous facilities should abate, it does create incentives for innovation in pollution control and it does eliminate one-size-fits-all regulation regarding the means by which facilities control pollution.

There is quite a bit of support for TR. Evidence includes recommendations in a number of influential policy reports (for example, Enterprise for Environment, 1998 and National Academy of Public Administration Report, 1997), state-level initiatives such as New Jersey's "Gold Track" program, and proposed federal legislation to provide the underpinnings of a broad-based TR program (often referred to as the "Second Generation" initiative).

2. Objectives

Even though there are good reasons to support TR, there are also a number of potential problems. How should the regulator set appropriate performance standards for individual facilities? What is the appropriate legislative foundation for TR? Are the transactions costs associated with TR prohibitive? On the face of it, the prospect of regulatory agencies negotiating environmental regulations with thousands of individual facilities would seem very costly, perhaps prohibitively so. Finally, what effect will TR have on intra-industry competition? Allowing facilities participating in TR to operate under a different set of guidelines than non-participants begs the question of whether there might be adverse competitive impacts.

The first two issues—how to set and monitor TR standards, and how to provide a legislative foundation—have already received considerable attention (for example, see Steinzor, 1998; Hausker, 1999; Caballero, 1998; and Mank, 1998). However, the second two issues have attracted virtually none. These issues have been the focus of our research.

3. Activities

The following activities were undertaken in the course of this project:

Year 1 (January 1998 – December 1998)

Empirical Research

- Compiled publicly-available data on a sample of 15 participants in Project XL
- Developed and pre-tested a survey instrument
- Administered a telephone survey to over 30 individuals split between representatives of the facilities and EPA regional offices involved in XL project negotiations

Theoretical Research

- Reviewed literature on voluntary regulation, negotiated regulation, the nexus between industrial organization and environmental regulation, mechanism design, and technology choice
- Developed preliminary analytical models and results
- Met with EPA Office of Reinvention personnel to discuss research
- Presented preliminary model at June 1998 World Congress of Environmental and Resource Economists, Venice, Italy.

Year 2 (January 1999 – December 1999)

Empirical Research

- Analyzed survey data on sample of 15 XL participants
- Reviewed literature on Project XL, and developed an historical summary
- Drafted paper detailing findings, "The Cost of Developing Site-Specific Environmental Regulations: Evidence from EPA's Project XL."
- Presented findings at EPA, Office of Reinvention

Theoretical Research

- Completely reworked analytical model
- Drafted paper detailing findings, "The Economics of Tailored Regulation: Will Site-Specific Environmental Regulation Necessarily Improve Welfare?"
- Presented draft paper at Western Economic Association Annual Meetings, San Diego, CA
- Presented findings at EPA, Office of Reinvention

Year 3 (January 2000 – December 2000)

Empirical Research

- Revised and updated paper in light of referee reports from *Environmental Management*
- Presented findings at public Resources for the Future Seminar, "EPA's Project XL: A Summary of Findings from Recent RFF Research."

Theoretical Research

- Revised paper in light of referee reports from the *Journal of Environmental Economics and Management*
- Presented paper at Fondazione Eni Enrico Mattei Workshop on "Voluntary Approaches, Competition and Competitiveness" in Milan, Italy (invited presentation)
- Presented findings at public Resources for the Future Seminar, "EPA's Project XL: A Summary of Findings from Recent RFF Research."

4. Research summary

4.1 Empirical research on transactions costs

The broad question this research addresses is, What can we learn from Project XL about transactions costs associated with TR? More specifically, we have attempted to answer the following questions:

- What is the magnitude of the transactions costs associated with project development?
- What stages of the project development process are perceived as being the most costly?
- What issues associated with that process are perceived as being the most costly?
- Why are transactions costs higher for some facilities?

Defining transactions costs

By "transactions costs" we simply mean the costs of developing XL projects. We include legal fees and the monetized value of person-hours spent on developing a project proposal, stakeholder negotiations, interacting with local regulators, interacting with the EPA regional office, and obtaining final approval. We do not include capital investments associated with XL agreements. Furthermore, we include only costs incurred by the facility and EPA regional office. We do not include costs incurred by EPA headquarters, local regulators or other stakeholders (simply because collecting this data would be too costly). Therefore, our estimates of transactions costs represent a lower bound on the true value of transactions costs.

Data

The data for this study comes from a Fall 1998 telephone survey administered to one representative from each of the 11 sample facilities, and one representative of the EPA region involved in negotiating the XL agreement. In addition, we use some publicly available data on the sample facilities.

The projects in our sample are: Berry, Hadco, Intel, Lucent, Merck, Molex, OSI-Witco, Weyerhaeuser, Imation, 3M, and IBM. We selected only private facilities because they are the principal focus of Project XL. Also, we chose only facilities that submitted proposals to the EPA in the first six months of the program. We did this because, to the extent possible, we wanted to analyze the experience of facilities that had completed the project development process (so we could capture all the costs involved), and because at the time we conducted our survey, there were very few completed (or nearly completed) XL projects.

The fact that our sample only includes the very first cohort of program applicants has both advantages and disadvantages. On one hand, it allows us to control for subsequent changes in project development rules and guidelines. On the other hand, it begs the question of whether our findings are descriptive of the process that currently exists. Some of the problems the facilities in our sample encountered have may have been mitigated by subsequent changes in program procedures. For example, over the years there have been several clarifications of the guidelines governing superior environmental performance and stakeholder involvement. Nevertheless, for reasons discussed below, we believe our findings are still very relevant.

What is the magnitude of the transactions costs associated with project development?

The average transactions costs for our sample facilities were $350,000. Average transactions costs for the EPA regional offices were $110,000. Thus, total average per project transactions costs were $460,000.

We used the cost data to divide our sample into two groups—"high-cost" projects and "low-cost" projects—based on whether the transactions costs associated with each project were above or below the sample median ($540,000). We did this to try to determine why certain projects were more costly than others. The high-cost projects were Imation, Intel, Lucent, Merck, Weyerhaeuser, and 3M. The low-cost projects were Berry, Hadco, IBM, Molex, and Osi-Witco.

What stages of the project development process are perceived as being the most costly?

To address this question we divided the project development process into six stages and asked each of our survey respondents to tell us what percentage of the transactions costs arose in each of these stages. Table 3 gives the results (the numbering of the Tables is that which appears in Blackman and Mazurek 2000).

Table 3. Average percentages of firms' costs associated with each project development stage

Stage	All firms (n = 11)	High-cost firms (n = 6)	Low-cost firms (n = 5)	t-statistic
Preliminary proposal	18.6	5.0	35.0	(-4.187)**
Stakeholder negotiations	20.2	16.2	25.0	(-1.291)
Interact w/ local regulators	13.4	17.0	9.0	(2.619)*
Interact w/ EPA region	22.5	24.5	20.0	(0.904)
Final approval	24.4	37.5	8.6	(6.714)**
Other	1.1	0.0	2.4	(-3.537)**

*Difference between high- and low-cost firms significant at 5 percent level.
**Difference between high- and low-cost firms significant at 1 percent level

(Source: RFF survey 1998)

The key finding is that for the entire sample, about half of transactions costs arose from interacting with EPA regions and from obtaining final approval from EPA headquarters, while only about a fifth of transactions costs arose from stakeholder negotiations. By looking at the differences between the responses of the high-cost and low-cost firms, one can see clearly that the high-cost firms spent more time obtaining final approval than the low-cost firms. Thus, the bottleneck for high-cost firms appears to have been obtaining final approval. This finding reinforces the conventional wisdom that interacting with EPA—and in particular obtaining final approval—has been the principal source of transactions costs. But it also runs counter to the conventional wisdom that stakeholder negotiations are a major source of transactions costs. (See Blackman and Mazurek 2000 for results from the survey of EPA regional offices)

What issues associated with the project development process are perceived as being the most costly?

To address this question, we compiled a list of the issues most frequently mentioned in the literature as sources of transactions costs and asked our survey respondents to choose one of these issues as most important and one as second most important. Table 5 gives the results.

Table 5. Importance to firms and EPA regions of 10 sources of project development costs

Source of costs	*No. times selected 1st or 2nd most important by… Firms*	*EPA regions*[a]
A. "Superior environmental performance" requirement unclear	5	4
B. Design stakeholder negotiating process flawed	1	0
C. EPA lacks statutory authority to implement FPAs	2	4
D. Lack of coordination among EPA offices	6	5
E. Lack of coordination between state and local regulators	0	1
F. Lack of coordination between EPA and other regulators	3	2
G. Lack of coordination with other EPA regulatory reform initiatives	0	0
H. Industry competitors blocked FPA approval	0	1
I. National environmental advocates blocked FPA approval	1	2
J. Other program design issues	4	5

[a] Two EPA regional offices were involved in Hadco process

(Source: RFF survey, 1998)

The issues most often selected by facilities were A (requirement of superior environmental performance unclear) and D (lack of coordination among EPA offices). The issues most often selected by EPA regions were A, D (the same two items selected by facilities), and C (EPA lacks statutory authority to implement the FPA). Thus, EPA management problems were identified by our respondents as being the most important sources of costs.

Why are transactions costs higher for some facilities?

To address this question, we collected publicly-available data on 23 characteristics of our sample facilities and their proposals—four characteristics of the project proposal, six characteristics of the firm, nine characteristics of the facility, and four characteristics of the negotiating process—and then we tried to see if there was a correlation between these characteristics and the costliness of their proposals. Ideally we would like to have used multivariate regression analysis to see which of these characteristics drove costs. However, our sample simply was not big enough: we have twice as many explanatory variables as observations. Therefore, we looked for simple correlations between these characteristics and our two cost categories and relied on intuition to sort out the results.

As explained in detail in Blackman and Mazurek (2000), having gone through this process we came to the conclusion that differences in the complexity of proposals—*not* the characteristics of the facility, firm, or negotiating process—drove differences in transactions costs across firms. Table 6 presents the relevant results.

Table 6. Proposal characteristics by cost category

Firm	*Principal flexibility requested*	*Multiple facilities?*	*Principal media affected by flexibility*	*Legal lever*
High-cost				
Imation	caps 4 C.A.P.s + other A.P.s; permit preapproval	no	air	under development
Intel	caps 5 C.A.P.s + H.A.P.s; permit preapproval	no	air	alternative permits
Lucent	permit preapproval	yes	air, water, s. & h. wastes	site-specific rule
Merck	aggregate cap 5 C.A.P.s; caps 3 C.A.P.s; permit preapproval	no	air	site-specific rule; permit variance
Weyerhaeuser	cap on H.A.P.s & water effluents; consolidated reporting; waiver review	no	air, water	existing waiver mechanism
3M	caps on 5 C.A.P.s + H.A.P.s; permit preapproval	yes	air	wanted site-specific rule
Low-cost				
Berry	consolidated permitting	no	air, water, s. & h. waste	generally applied int. statements
Hadco	delist wastewater sludge	yes	water, s. waste	existing waiver mechanism
IBM	alternative wastewater treatment	no	water	determination of equivalent treatment
Molex	delist wastewater sludge	no	water, s. waste	existing waiver mechanism
Osi-Witco	deferral of new technology standards for h. waste	no	air, water	existing waiver mechanism

Abbreviations: C.A.P. = criteria air pollutant; H.A.P. = hazardous air pollutant; s. & h. = solid and hazardous.

(Sources: see Blackman and Mazurek 2000)

The results are striking. Every one of the facilities in the high-cost category requested either an agreement covering more than one facility or a waiver of the requirement to get new air permits every time the production process changes (in exchange for an aggregate cap on air emissions). By contrast, none of the facilities in the low-cost category requested such a waiver, and only one submitted a proposal involving more than one facility. It is important to note that the projects involving aggregate caps on air emissions were quite complex. They entailed difficult questions about how to set the caps, whether there could be trading among different pollutants, and how often to require repermitting, and monitoring. Other projects did not have to deal with these questions.

Relevance of results to current program

As discussed above, the XL project approval process has been modified considerably since its inception. If we were to conduct our analysis on a more recent cohort of participants, would results be the same?

The only way to know for sure is to do a follow-up survey. However, it is quite likely that while the magnitude of transactions costs would be lower, the sources of these costs that we have identified would remain the same. In particular, two of our key findings are likely to persist: (i) interaction with EPA, not the stakeholder process, is the project development activity that gives rise to the lion's share of transactions costs, and (ii) the complexity of project proposals drives the magnitude of transactions costs.

The reason is that—notwithstanding EPA's attempts to clarify guidelines and to "reengineer" the approval process—the key problems that underlie these findings have not yet been resolved. With regard to problems associated with final approval, the experience of recent project participants clearly illustrates that the EPA has not eliminated this bottleneck. Of the 16 projects waiting for final approval in December 1999, two had been waiting more than four years, three had been waiting more than three years, and five had been waiting more than a year. Lack of a legislative foundation for Project XL and a lack of buy-in among EPA staff have been widely blamed for raising the costs of obtaining final EPA approval. Both problems persist (Inside EPA, 1999; The Reinvention Report, 1999).

Key problems that have raised project development costs for firms submitting complex proposals also remain unsolved. For example, the EPA's attempt to establish clear guidelines regarding "superior environmental performance" have fallen short of their goal since they have waffled on the critical issue of how baseline environmental performance should be measured (Cabellero, 1998, 406). Also, difficult issues that inevitably arise in evaluating proposals for plant-wide caps on air emissions—how to set the caps, whether to allow cross-pollutant trading, how often to require repermitting, and how to monitor compliance—remain difficult to address except on a case-by-case basis.

Policy Implications

What do our findings imply about the viability of Project XL and, more broadly, the viability of TR? They constitute 'good news' in some respects and 'bad news' in others. The good news is that, although we found that the costs of project development have been significant, our survey results indicate that the one part of the process that many critics have identified as a potentially most costly and most difficult to manage efficiently—stakeholder negotiations—has not been a major component of costs. Rather, a considerable percentage of costs have been due to problems with EPA's management of the initiative.

But our results constitute bad news as well. We found that the complexity of the project proposal may well have been the key determinant of project development costs.

To the extent that complexity is correlated with innovation—and judging from our sample there does appear to be a strong correlation—this implies that innovative proposals are likely to be the most costly. This does not bode well for EPA's prospects of remedying one of the often-cited weakness of Project XL: its inability to attract proposals that, if transferred, could have a significant impact on the efficiency of the regulatory system as a whole.

A second troubling implication of our findings is that, given that participating in Project XL has been costly and that pushing through the most beneficial type of project agreements has been especially costly, one would expect the initiative to be biased in favor of large firms. Such firms have financial and human resources and economies of scale and scope that lower the costs and increase the benefits of participation relative to smaller firms. The fact that virtually all of the firms in our sample are relatively large (see Table 7 in Blackman and Mazurek 2000) confirms this hypothesis.

It is important to note that in certain respects this 'anti-competitive bias' may be inevitable if not beneficial. According to the EPA, the goal of the program is to transfer regulatory innovations that are tested in Project XL. For example, efforts are now underway to make air emissions caps broadly available (Inside EPA, 1998). Presumably, small firms will eventually be able to take advantage of the efforts of larger firms to spur regulatory reform. Hence, the competitive advantage that large firms get from participation in Project XL could in theory be temporary and best thought of as a return on their investment in regulatory reform, analogous to the return that inventors get from patents.

The policy prescriptions that flow from these conclusions are straightforward. In order to achieve either the ambitious goal of making Project XL a viable 'regulatory blueprint' for site-specific regulation, or the less ambitious objective of ensuring that it serves as an effective test-bed for policy innovations, EPA must clearly demonstrate that the cost of project development can be reduced. Despite EPA's many reforms, there is as yet no extensive record to indicate that the process will be less costly for future participants. The challenge for EPA will be to change the negative perceptions of both sets of stakeholders by ushering a second group of XL participants through the project development process in short order and at relatively low cost. Just as important, EPA must demonstrate that costs can be reduced for innovative proposals as well as prosaic ones, that small firms can participate, and that the benefits of regulatory innovations can be transferred.

Our study also suggests that given the need to find ways of reducing the costs associated with developing XL projects, EPA would benefit immensely from developing reliable mechanisms to track costs—both those incurred by firms and by the EPA. As yet, there is little public information available, and very little analysis of the costs incurred by EPA headquarters.

4.2 Theoretical research on competitive issues associated with TR

Unlike the very concrete issue addressed in our study of transactions costs, the question addressed in this research is more hypothetical since it explores the implications of a large-scale application of TR. Consider a program akin to that advocated by the supporters of the "Second Generation" initiative: a permanent nationwide program with the five characteristics of TR discussed in the introduction (facility-specific, voluntary, sets performance standards that guarantee superior environmental performance, entails a fixed transactions cost due to the stakeholder process, and promotes the diffusion of regulatory innovations). Our question is, would such a program necessarily improve social welfare?

There are several reasons to believe it would. First, by allowing firms to substitute performance standards for inefficient command-and-control regulations, TR can generate significant cost savings for industry. In addition, the superior environmental performance rule assures that environmental quality will not deteriorate. Finally, TR generally improves consumers' surplus because firms' cost reductions translate into price reductions.

Notwithstanding these benefits, one potentially troubling feature of TR is that it enables participating firms to operate under a different set of guidelines than their competitors. Therefore, intuition suggests TR could conceivably have detrimental welfare impacts by providing cost savings—and hence a competitive advantage—to selected firms.

Our modeling effort finds that TR can reduce welfare in this way. Counter-intuitively, the principal means by which this may occur is the diffusion of regulatory innovations to non-participants.

Model framework

For readers who are technically inclined, we very briefly provide a flavor of the modeling framework used to derive our results (see Blackman and Boyd, 2000 for details). We use a Cournot duopoly model. Firms maximize profit by choosing how much output to produce, and whether to participate in a command-and-control regulatory regime, or a TR regime. Their choices are constrained by three exogenous factors. First, the TR agreement must ensure superior environmental performance. Second, the regulator sets rules regarding whether and how the regulatory flexibility offered in the TR agreement is diffused to competing firms. And finally, firms must pay a fixed transactions cost to participate in TR. This modeling framework generates three key results.

Result #1. Transactions costs constrain welfare improvements

The higher are transactions costs, the harder it is for the regulator to generate participation in TR and to motivate superior environmental performance. The logic behind this result is simple: Given fixed transactions costs, to get firms to participate, regulators must offer TR agreements that lower production costs. Moreover, the higher are fixed transactions costs, the larger must be the production cost reductions. But when the regulator is forced to offer relatively large production cost reductions, she has less leeway to set high environmental performance standards.

Result #2. TR can reduce welfare via "market stealing"

Our second key result is that it is theoretically possible for a TR agreement to *reduce* welfare by reducing total industry profits. This can happen because of a phenomenon known as "market stealing."

To understand this phenomenon—which is well-known in the industrial organization literature—imagine a sector comprised of just two firms with identical market shares. One of them gets a TR agreement and one does not. The market share and the profit of the firm that gets the TR agreement goes up and the market share and profit of the firm that does not goes down. The firm that gets the TR agreement is the "winner" and its rival is the "loser." TR's impact on total industry profits will be negative when the winner's gain is smaller than the loser's loss. This happens when the winner is "less efficient" (has a lower profit margin) than the loser. So essentially, one can get a welfare loss when TR agreements are given to inefficient firms which profit at the expense of efficient ones (and when this social cost is larger than the gain in consumer surplus).

That may seem like a far-fetched story, especially since most firms that participate in Project XL—our TR prototype—are large market leaders who are not likely to be inefficient (see Blackman and Mazurek, 2000). But the possibility of TR leading to welfare losses via market stealing is far less remote when one takes into account the diffusion of TR agreements.

Result #3. Diffusion of TR agreements may entail costs as well as benefits

We model the diffusion of TR agreements as the ability of firms which do not formally participate in TR to get the same TR agreements that participants get without paying the fixed participation cost. In such situations, diffusion has two important disadvantages. First, it can reduce industry profits via "market stealing" even if only efficient firms participate formally. The reason is that the regulator is essentially giving a competitive advantage to relatively inefficient firms.

Second, diffusion dampens incentives for firms to formally participate. Clearly, if firms can get the benefits of TR via diffusion, they have less incentive to participate. There is a strong analogy to firms' incentives to invest in developing new products. Such incentives are dampened when firms know their rivals can appropriate the fruits of their investments (the basic argument in support of patent protection).

Policy implications

Our findings suggest that regulators can ensure TR attracts participants and enhances welfare by carefully choosing which firms can participate, the cost savings offered to each firm, and the extent to which TR agreements are allowed to diffuse to non-participating firms. With regard to the selection of firms and the terms of the agreement, the regulator can avoid welfare losses by ensuring that relatively inefficient firms are not singled out for participation or particularly advantageous agreements. Even if this strategy can be successfully implemented, it has an important drawback: it implies that regulators should provide cost-breaks to market leaders, a policy that smacks of inequity and would likely run into stiff political opposition. Moreover, such a policy could result in the exit of smaller firms and increased market concentration. We have focused on demonstrating how TR can have adverse welfare impacts even abstracting from exit. Nevertheless, intuition suggests that while TR administrators should ensure that inefficient firms are not the principal beneficiaries of the TR regime, they should also ensure that efficient firms are not helped to such an extent that their competitors are forced to exit the market.

Happily, in practice, even if regulators do not actively select relatively efficient firms to participate, political-economic considerations are likely to favor their participation. With in-house environmental management and lobbying capabilities and relatively easy access to investment capital, large market leaders (which are presumably relatively efficient) can more easily pay the fixed cost of participation in TR. The Project XL experience thus far would appear to confirm this hypothesis. Blackman and Mazurek (2000) found that of the first eight firms to implement XL agreements, six were among the top three firms in their industries in terms of market share. Does this mean that regulators can ignore the threat of welfare losses due to market stealing? Probably not. TR's emphasis on the diffusion of TR agreements among non-participants implies that inefficient firms need not formally participate in TR in order to steal market share from their competitors—market stealing that results from diffusion may lead to welfare losses.

Hence, from the point of view of social welfare, the regulator's diffusion policy is critical. Diffusion has a number of potential costs. We found that it can lead to welfare losses from market stealing, and can also dampen firms' incentives to participate. In some situations, when diffusion is costless, it may not be possible to induce participation no matter how attractive the terms of the TR agreement. Therefore, the regulator may want to limit diffusion in order to both prevent market stealing and to generate formal participation. Widespread formal participation has clear advantages. It always has a positive impact on consumers' surplus and—assuming that performance standards under TR are more stringent than under command-and-control—on the environment.

But diffusion of TR agreements clearly has economic benefits as well. It reduces firms' marginal costs and therefore inevitably enhances consumers' surplus. This benefit *may* be sufficient to offset any potential loss in producers' surplus. Hence, in setting a diffusion policy, the regulator must balance potential welfare benefits against costs. This calculation is likely to vary across industries.

Finally, our findings highlight the desirability of minimizing the fixed costs of participating in TR. Given that TR agreements must reduce operating costs in order to induce participation, there is clearly a trade-off between the amount of cost-reducing regulatory flexibility an agreement entails, and the amount of environmental benefit it requires. But we have seen that lower participation costs imply that regulators can induce participation with less attractive offers. Therefore, one means of allowing for more of each type of benefit is to find ways of reducing the fixed costs associated with participation. Although we have modeled fixed participation costs as exogenous, in practice, regulators should have some control over them. For example, in the case of Project XL, empirical research has indicated that management problems at EPA as well as uncertainty about the statutory foundation of the initiative are key contributors to participation costs, so it seems reasonable to assume that regulators have some ability to reduce these costs.

5. Changes in Research Plan

In our original January 15, 1997 proposal, we envisioned seven tasks:

i. Develop a rigorous mathematical representation of the simple diagrammatic model used to make the static efficiency case for TR.
ii. Review the relevant analytical literatures
iii. Develop two analytical models that incorporate the real-world characteristics such as uncertainty, imperfect information, and rent seeking, that are needed to address practical questions about the design of TR (What types of firms would TR favor? What are the implications? What policy prescriptions are implied?)
iv. Conduct an empirical analysis of XL projects to underpin and perhaps to test the predictions of the analytical models.
v. Analyze the strengths and weakness of TR *vis a vis* command and control and economic incentives on the basis of the list of criteria presented in section 2.1 above.
vi. Draft a list of recommendations for designing and implementing TR.
vii. Develop an annotated list of areas for future research.

Of these seven tasks, we completed, or essentially completed, five. We developed two analytical models—although only one was brought to fruition (task iii); conducted an empirical analysis of Project XL (task iv); developed recommendations for designing and implementing TR (task vii); reviewed the relevant analytical literatures (task ii); and developed a list of future areas for research (task vii, see below).

During the course of the project, our research plan was modified in a number of respects. Most important, the analytical modeling component of the project (task iii) proved considerably more difficult, time-consuming, and expensive than anticipated so that funding was inadequate to complete all of the tasks originally envisioned. As discussed in the proposal, ours is the first attempt to develop a rigorous analytical model of TR. As is always the case with this type of research, we pursued a number of "dead ends" before settling on what we felt was the most appropriate model. For example, a good deal of the theoretical effort in the first year of the project was devoted to constructing a model that had as one of it principal features bargaining between firms and regulators. Ultimately, we decided this framework would not enable us to address the issues of greatest concern to policy makers, and would not stand on its own as an independent model in part because there is already a considerable economics literature on bargaining in environmental regulation. Therefore, we abandoned this bargaining model in favor of the model presented in Blackman and Boyd (2000).

In general, we focused our resources on those tasks we felt were most important. For example, regarding the strengths and weakness of TR *vis a vis* command-and-control and economic incentives (task v), Blackman and Boyd (2000), addresses in detail the advantages and disadvantages of TR *vis a vis* command-and-control, the predominant form of regulation in the United States and world-wide. Most of the issues raised by the simple diagrammatic model presented in our January proposal (task i) are embedded in the model presented in Blackman and Boyd (2000).

Regarding the use of the empirical study to test the predictions of the analytical model (task iv), for a number of reasons we were unable to complete this in the manner envisioned. Given time constraints, we undertook the empirical and analytical components of the project simultaneously instead of sequentially. However, we did devote considerable effort to finding evidence of the effects of TR on intra-industry competition. We tested for and confirmed the hypothesis that TR is likely to attract large, market leaders. Unfortunately, we were unable to make much progress in finding evidence for adverse competitive impacts. One important reason is that, at the time we conducted our survey, fewer than 20 XL projects were being implemented.

6. Future Research

Our empirical and theoretical research could be extended in the following ways.

- Empirical study of transactions cost associated with Project XL using a larger sample. There are now far more XL projects being implemented than when we conducted our survey. As discussed above, a new empirical study of transactions costs is needed to see whether recent program modifications have reduced transactions costs.

- Empirical study of the determinants of project approval. It may now be possible to examine the determinants of project approval by comparing the characteristics of projects that have been approved and those of projects that have been rejected.

- Empirical study of competitive effects of TR. Given the much larger number of XL projects now in implementation, it may be possible to find evidence to confirm or refute some of the competitive impacts of TR our analytical model predicts.

- Analytical models of TR that accommodate firm exit. To keep our analytical model tractable, we were forced to disregard the possibility that TR agreements could lead firms to exit. A model specifically designed to examine this issue would be useful to further explore the potential effects of TR on intra-industry competition.

- General interest paper. A general interest paper on TR that further develops the static efficiency argument laid out in our January 1997 proposal would be useful.

7. Publications

Empirical study

A. Blackman and J. Mazurek. 2000. "The Cost of Developing Site-Specific Environmental Regulations: Evidence from EPA's Project XL." *Environmental Management.* Vol. 27, No. 1, 109-121.

This paper is also available electronically on RFF's website as *Resources for the Future Discussion Paper 99-35* at http://www.rff.org/disc_papers/PDF_files/9935rev.pdf

Analytical Study

A. Blackman and J. Boyd. 2000. "Tailored Regulation: Will Site-Specific Environmental Regulation Improve Welfare?" Under review at the *Journal of Public Economics.*

This paper is available electronically on RFF's website as *Resources for the Future Discussion Paper 00-03* at http://www.rff.org/disc_papers/PDF_files/0003rev.pdf

Finally, the paper is also available as *Fondazione Eni Enrico Mattei (FEEM) Working Paper 76.2000* at http://www.feem.it/web/activ/wp/abs00/76-00.pdf

8. Presentations

Empirical study

December 1999. Resources for the Future Wednesday Seminar. Washington, DC. "EPA's Project XL: A Summary of Findings from Recent RFF Research."

January 1999. EPA Office of Reinvention. Washington, DC. "Transactions Costs Associated with Participation in Project XL."

Analytical Study

May 2000. Fondazione Eni Enrico Mattei Workshop on "Voluntary Approaches, Competition and Competitiveness." Milan, Italy. Invited presentation, "Tailored Regulation: Will Site-Specific Environmental Regulations Improve Welfare?"

December 1999. Resources for the Future Wednesday Seminar. Washington, DC. “EPA's Project XL: A Summary of Findings from Recent RFF Research.”

July 1999. Western Economic Association Annual Meetings. San Diego, CA. “The Economics of Tailored Regulation.”

June 1998. World Congress of Environmental and Resource Economists. Venice, Italy. “The Economics of Tailored Regulation”

9. Supplemental Keywords

air, clean technology, public policy, community-based, social science, mathematics, analytical.

10. Relevant Websites

Our research papers are available on each of the websites listed below.

www.rff.org
www.feem.it
www.ssrn.com

10. References

RFF research summarized in this report

A. Blackman and J. Mazurek. 2000. “The Cost of Developing Site-Specific Environmental Regulations: Evidence from EPA’s Project XL.” *Environmental Management.* Vol. 27, No. 1, 109-121. This paper is also available electronically on RFF’s website as *Resources for the Future Discussion Paper 99-35* at http://www.rff.org/disc_papers/PDF_files/9935rev.pdf

A. Blackman and J. Boyd. 2000. “Tailored Regulation: Will Site-Specific Environmental Regulation Improve Welfare?” Under review at the *Journal of Public Economics.* This paper is available electronically on RFF’s website as *Resources for the Future Discussion Paper 00-03* at http://www.rff.org/disc_papers/PDF_files/0003rev.pdf Finally, the paper is also available as *Fondazione Eni Enrico Mattei (FEEM) Working Paper 76.2000* at http://www.feem.it/web/activ/wp/abs00/76-00.pdf

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