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FRAMING ENVIRONMENTAL POLICY INSTRUMENT CHOICE

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I. INTRODUCTION

The student of environmental policy is exposed to a myriad of policy instruments the government can employ: emissions taxes, abatement subsidies, marketable allowances, regulation based on performance standards or technology, property rights, deposit-refund schemes, information programs, liability rules, and a number of related policy tools. When Congress crafts environmental legislation or administrative agencies promulgate rules to implement environmental policy goals, they must choose from among these policy tools. In an ideal world, they would employ those instruments that will allow the government to meet its goals at the lowest possible cost subject to external constraints.

One consistent message from the environmental economics literature is that incentive-based instruments are a more cost-effective means to achieve environmental goals than alternative policy instruments such as technology-based standards.[1] In practice, however, this

1. *See, e.g.*, ROBERT N. STAVINS ET AL., PROJECT 88—ROUND II: INCENTIVES FOR ACTION: DESIGNING MARKET-BASED ENVIRONMENTAL STRATEGIES 92 (1991) [hereinafter PROJECT 88].

counsel has only rarely been heeded.[2] In the United States, environmental protection schemes have evinced more diversity than uniformity with respect to key characteristics. Perhaps this diversity should not be surprising. Consider the wide variety of activities that policy instruments are designed to promote: nonpoint source water pollution control, protection of wetlands, reduction of sulfur dioxide emissions, clean-up of hazardous waste sites, and protection of endangered species. Given this tremendous variation among environmental goals and the means of achieving those goals, is there any reason to expect that when it comes to implementation we can exercise a one-size-fits-all approach to instrument choice?

In fact, what we observe is a plurality of instruments and combinations thereof that have steadfastly defied economists' and policy analysts' prescriptions.[3] Part of this deviation between normative prescription and actual practice can be attributed to political considerations,[4] and part to legal constraints. However, there may also be normative justifications for choosing instruments outside the increasingly standard incentive-based dyad of taxes and marketable allowances. While those instruments may minimize the direct cost of producing environmental services, such as emissions abatement, they do not necessarily minimize the total social costs. To see this, however, requires a reformulation of the standard evaluation criteria that are applied in most policy instrument studies and a broadening of the range of instruments under consideration.

The purpose of this article is to provide a conceptual framework for understanding the policy instruments that the government uses when it implements environmental policy goals. Unlike other surveys that focus on the contrasts among instruments, the emphasis here is on exploring the continua of instruments that are available for a variety of applications. In the process of developing the framework, the article will advance key ideas related to the choice and structure of evaluation criteria, the design and role of a taxonomy of instruments, and the application of lessons from a variety of distinct literatures.

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2. *See, e.g.,* Dieter Cansier & Raimund Krumm, *Air Pollutant Taxation: An Empirical Survey*, 23 ECOLOGICAL ECON. 59, 59 (1997).

3. *See* ROBERT W. HAHN, A PRIMER ON ENVIRONMENTAL POLICY DESIGN 59 (1989) [hereinafter HAHN, ENVIRONMENTAL POLICY DESIGN].

4. *See* Robert W. Hahn & Albert M. McGartland, *The Political Economy of Instrument Choice: An Examination of the U.S. Role in Implementing the Montreal Protocol*, 83 NW. U. L. REV. 592, 609 (1989); *see also* HAHN, ENVIRONMENTAL POLICY DESIGN, *supra* note 3, at 58-59; Robert W. Hahn, *Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor's Orders*, 3 J. ECON. PERSP. 95, 107-12 (1989).

Many studies of policy instruments have identified evaluation criteria by which the performance of policy tools may be judged.[5] This article expands the insights from those analyses by recognizing that two key criteria can be added to their lists: (1) the differential effects of policy instruments on the system of public finance and (2) legal constraints that may render optimal solutions (from a cost-minimization perspective) infeasible. Reformulating the evaluation criteria as a cost-minimization problem provides additional insight into the nature of the tradeoffs that the policymaker faces in choosing among the various instruments.[6]

This article also demonstrates that the taxonomies of policy instruments can be re-framed to bring out several factors. First, while liability rules, property rights, taxes, marketable allowances, and subsidies are often grouped together as incentive-based approaches,[7] the new framework separates the first two from the latter three to emphasize the fundamentally different role that the government plays.[8] Second, whereas recent studies have often depicted instrument choice as a matter of command-and-control versus incentive-based instruments,[9] the new framework suggests that this approach is a false dichotomy, stemming in part from an overly narrow depiction of the range of instruments.[10] Third, several studies have focused on the quantity-versus-price relation between marketable allowances and taxes,[11] both of which are coercive tools of the government. This new framework demonstrates that the duality relationship of quantity-versus-prices also exists when government uses its enterprise tools of subsidies and contracts.[12] Fourth, whereas broad review studies of instrument choice have largely focused on how policy tools provide incentives for efficient pollution abatement, this framework also ad-

5. *See* discussion *infra* Part II.A & Table A1 in Appendix.

6. *See* discussion *infra* Part II.B.

7. *See, e.g.*, Robert N. Stavins, *Harnessing the Marketplace: We Have to Do More With Less*, EPA J., May-June 1992, at 21, 21-22 [hereinafter Stavins, *Harnessing the Marketplace*].

8. *See* discussion *infra* Part III.B.2.

9. *See, e.g.*, ROBERT N. STAVINS, MARKET-BASED ENVIRONMENTAL POLICIES 1-2 (Resources for the Future Discussion Paper 98-26, 1998) [hereinafter STAVINS, MARKET-BASED ENVIRONMENTAL POLICIES].

10. *See* discussion *infra* Parts III.B.3.c.

11. *See, e.g.*, Martin L. Weitzman, *Prices vs. Quantities*, 41 REV. ECON. STUD. 477 (1974); Howard K. Gruenspecht & Lester B. Lave, *The Economics of Health, Safety, and Environmental Regulation*, *in* 2 HANDBOOK OF INDUSTRIAL ORGANIZATION 1507, 1516-19 (Richard Schmalensee & Robert D. Willig eds., 1989).

12. *See* discussion *infra* Part III.B.3.d.

dresses the question of who bears the costs of unabated pollution.[13] Finally, the new framework suggests that information-related programs, identified as separate categories of instruments in the policy literature,[14] are in fact addressing different goals, not employing different instruments.[15]

By restructuring the evaluation criteria and taxonomies of environmental policy and economics studies, this new framework facilitates the application of the lessons from several distinct literatures: New Institutional Economics (transaction cost economics),[16] public economics,[17] and administrative and constitutional law.[18] Applying lessons from the first two bodies of work elucidates the continuous, rather than distinct, nature of the relation among the instruments. Applying lessons from administrative and constitutional law illustrates the legal constraints on the instrument choice problem.

In addition to these specific points, this article advances a more general theme. In the recent past academics and policy analysts have emphasized the important efficiency advantages of incentive-based instruments for addressing pollution abatement. In that process the focus of the discussion has narrowed to a subset of environmental policy tools—specifically, marketable allowances and emissions taxes.[19] While it is important to remember the allocative efficiency advantages of incentive-based instruments, there is also a reason that other, seemingly less efficient, instruments exist. Those reasons are not purely political or distributional. In some settings, instruments such as command-and-control regulation and government production may provide greater overall economic efficiency than their incentive-based counterparts. The optimal choice of policy instrument to implement a particular pollution abatement goal depends upon the nature of the pollutant, the kind of harm the pollutant causes, the available control technologies, the number and type of polluting entities,

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13. *See* discussion *infra* Part III.B.3.b.

14. *See, e.g.*, Hans Bressers & Pieter-Jan Klok, *Fundamentals for a Theory of Policy Instruments*, 15 INT'L J. SOC. ECON. 22, 32-34 (1988).

15. *See* discussion *infra* Part III.B.3.g.

16. *See* discussion *infra* Part IV.B.

17. *See* discussion *infra* Part IV.C.

18. *See* discussion *infra* Part IV.D.

19. For exceptions, see Daniel H. Cole & Peter Z. Grossman, *When is Command-and-Control Efficient? Institutions, Technology, and the Comparative Efficiency of Alternative Regulatory Regimes for Environmental Protection*, 1999 WIS. L. REV. 887 (1999); Gloria Helfand, *Standards versus Standards: The Effects of Different Pollution Restrictions*, 81 AM. ECON. REV. 622 (1991) [hereinafter Helfand, *Standards versus Standards*].

and the type of market failure. In short, when it comes to environmental policy instrument choice, one size does not fit all.

This discussion focuses on the normative issues related to environmental policy design, and addresses only tangentially the important questions of political economy. The discussion is based on the assumption that Congress or an administrative agency has adopted a new pollution abatement goal and is searching for the policy instrument(s) that will most efficiently implement the program.[20] The treatment is broad brush in nature, attempting to synthesize the vast amount of analysis available in the environmental policy literature.

Most instrument choice studies first describe the many policy tools available and then provide evaluation criteria for comparing the instrument. This analysis reverses that order on the premise that the taxonomy should be structured to facilitate the evaluation.

II. EVALUATION CRITERIA

Articles that review policy instruments and the instrument choice problem often provide criteria to assess the relative merits of the various policy instruments.[21] This section provides a brief overview of the criteria from several studies, suggests logical relations among the criteria, and identifies useful additions to the list. This leads to a reformulation of the criteria as a constrained cost-minimization problem.

A. *Standard Treatment*

Table A1 provides a sampling of the evaluation criteria described

20. While this study is narrowly focused on pollution abatement to maintain tractability in the discussion, the principles are perhaps much more broadly applicable to environmental protection, natural resource management, and social regulation generally.

21. *See, e.g.*, Giandomenico Majone, *Choice among Policy Instruments for Pollution Control*, 2 POL'Y ANALYSIS 589 (1976); Peter Bohm & Clifford S. Russell, *Comparative Analysis of Alternative Policy Instruments*, *in* 1 HANDBOOK OF NATURAL RESOURCE AND ENERGY ECONOMICS 395 (Allen V. Kneese & James L. Sweeney eds., 1985); Robert W. Hahn & Robert N. Stavins, *Incentive-Based Environmental Regulation: A New Era from an Old Idea?*, 18 ECOLOGY L.Q. 1 (1991) [hereinafter Hahn & Stavins, *A New Era?*]; U.S. DEP'T OF ENERGY, REP. NO. DOE/EH-0103, 1 A COMPENDIUM OF OPTIONS FOR GOVERNMENT POLICY TO ENCOURAGE PRIVATE SECTOR RESPONSES TO POTENTIAL CLIMATE CHANGES: METHODOLOGICAL JUSTIFICATION AND GENERIC POLICY INSTRUMENTS (1989) [hereinafter U.S. DOE, COMPENDIUM]; PROJECT 88, *supra* note 1; OFFICE OF TECH. ASSESSMENT, U.S. CONGRESS, REP. NO. OTA-ENV-634, ENVIRONMENTAL POLICY TOOLS—A USER'S GUIDE (1995) [hereinafter OTA REPORT]; INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 1995: ECONOMIC AND SOCIAL DIMENSIONS OF CLIMATE CHANGE (James P. Bruce et al. eds., 1996) [hereinafter CLIMATE CHANGE 1995].

in a number of the studies. What is perhaps most interesting about these lists is that they are generally unstructured. Referring to the criteria listed in his own work, Majone commented:

> The first observation to be made about the criteria is their heterogeneity of values; the second is their lack of specificity. The heterogeneity is exemplified by the difficulty of reconciling political feasibility with the conditions for economic efficiency. The lack of specificity is particularly obvious in the case of the polluter-pays principle, which, as usually interpreted, rules out only the subsidies alternative; and even this limitation is weakened by a number of exceptions.[22]

Although the studies use different terms, they are actually surprisingly consistent on a conceptual level. All studies listed in Table A1 refer to some form of efficiency or cost-effectiveness, while three refer to some form of dynamic incentives to innovate and develop new abatement technologies. All of the studies also include criteria related to the administrative burden, information requirements, or monitoring costs associated with particular instruments. The studies all include criteria related to political feasibility, distribution and equity effects, or public acceptance. Four studies incorporate effectiveness or efficacy as a criterion. Interestingly, only two of the six studies reviewed in Table A1 explicitly list flexibility, or adaptability in the face of change,[23] as an important criteria for evaluating policy tools. This later point is particularly important, because the ability to adapt to change can be an important factor that favors non-incentive-based instruments under certain circumstances.

B. *Expansion and Reformulation of the Evaluation Criteria*

Two important criteria are conspicuously absent from the lists in Table A1. First, there is no mention in those lists of the costs that are imposed on society by the distortionary effects that taxes have on production and consumption decisions. Generally, when the government intervenes in the market, for example, by taxing production or consumption, it distorts prices, the signals by which the market allocates resources. This can lead to significant social welfare losses known as "excess burden."[24] If the instruments have a differential

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22. Majone, *supra* note 21, at 600-01.

23. North has referred to such adaptability in the face of change as "adaptive efficiency." *See* Douglass C. North, *Dealing with a Non-Ergodic World: Institutional Economics, Property Rights, and the Global Environment*, 10 DUKE ENVTL. L. & POL'Y F. 1, 12 (1999) [hereinafter North, *Institutional Economics*].

24. *See, e.g.*, ANTHONY B. ATKINSON & JOSEPH E. STIGLITZ, LECTURES ON PUBLIC

impact on the system of public finance, then it is important to include that effect in the evaluation criteria.

Second, while all of the studies in Table A1 include criteria for some type of political constraint, none include legal constraints. It is important to recognize that for some applications, instruments that may be theoretically most cost-effective are not available due to legal constraints.[25]

If the objective of the instrument choice exercise is to minimize the social cost of achieving a given environmental goal (as it is assumed to be in the normative context of this framework), then the evaluation criteria can be structured as a constrained optimization problem. Under the cost-minimization formulation, we can identify three types of economic costs: production costs (PC), implementation costs (IC), and public finance impacts (TX). The stylized policy problem then becomes:

Minimize (PC + IC + TX)
Subject to the constraints:
Pollution abatement requirement
Legal constraints
Political constraints

Production costs (PC) refer to the actual capital, training, operation, maintenance and management costs of producing emissions abatement or other environmental services. They are generally included in evaluation criteria as *static efficiency*,[26] *dynamic incentives*,[27] or *cost-effectiveness*.[28] These are the costs that are most commonly addressed in the environmental economics literature.

Public finance impacts (TX) have not generally been mentioned in discussions of environmental policy instrument choice. In this cost-minimization problem, TX refers to the costs imposed on the system

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ECONOMICS 367-70 (1980); Alan J. Auerbach, *The Theory of Excess Burden and Optimal Taxation*, *in* 1 HANDBOOK OF PUBLIC ECONOMICS 63, 67-73 (Alan J. Auerbach & Martin Feldstein eds., 1985).

25. *See* discussion *infra* Part IV.D.

26. *See* Bohm & Russell, *supra* note 21, at 399; U.S. DOE, COMPENDIUM, *supra* note 21, at 2-2 (1989).

27. *See* Bohm & Russell, *supra* note 21, at 400; PROJECT 88, *supra* note 1, at 10 ("Will the policy give industry incentives to develop new environment saving technologies or will it encourage firms to retain existing inefficient plants?").

28. *See* PROJECT 88, *supra* note 1, at 10; *see also* OTA REPORT, *supra* note 21, 23-24; B.S. Fisher et al., *An Economic Assessment of Policy Instruments for Combating Climate Change*, i*n* CLIMATE CHANGE 1995, *supra* note 21, at 397, 406.

of public finance related to instruments' revenue-raising requirements, including excess burden and administration costs.

Transaction or implementation costs (IC) have been analyzed in the transaction costs/contracts literature,[29] but this work has not been extensively applied to environmental policy.[30] The evaluation criteria in Table A1 include terms for *information requirements*,[31] *ease of monitoring and enforcement*,[32] *demand on government resources*,[33] and *adaptability and flexibility* in the face of changes in tastes, technology, resource use, and the economy.[34] Lessons from the environmental economics and New Institutional Economics literatures both provide insight into how policy instrument selection affects implementation costs.[35]

The first constraint in the cost-minimization formulation is that the instrument employed to implement environmental policy must accomplish the desired policy goal or target level of abatement. That is, the instrument must provide *efficacy* or *assurance that the goals will be met*.[36] In addition, legal and political constraints limit the range of instruments that can be used under particular circumstances. The cost-minimizing instrument, in other words, may not be in the feasible set. Table A1 includes references to *political constraints*,[37] *under-*

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29. *See generally* OLIVER E. WILLIAMSON, THE ECONOMIC INSTITUTIONS OF CAPITALISM (1985).

30. There is a potential for confusion regarding the scope of transaction costs. Some studies excluded government transaction costs because of the studies' focus on the private-sector costs of trading marketable allowances. *See, e.g.*, Robert N. Stavins, *Transaction Costs and Tradeable Permits*, 29 J. ENVTL. ECON. & MGMT. 133, 135 (1995). Others distinguished between *implementation costs* (government-private) and *transaction costs* (private-private). *See, e.g.*, Fisher et al., *supra* note 28, at 406. Since the focus of this article is on government programs, we will use the term *implementation costs* to refer to the "costs of acquiring and using information as well as negotiating, monitoring, and enforcing" the program rules and goals. *See* Louis De Alessi, *On the Nature and Consequences of Private and Public Enterprises*, 67 MINN. L. REV. 191, 193 (1982).

31. *See* Bohm & Russell, *supra* note 21, at 399-400; U.S. DOE, COMPENDIUM, *supra* note 21, at 2-2; PROJECT 88, *supra* note 1, at 10; *see infra* Table A1 in Appendix.

32. *See* Bohm & Russell, *supra* note 21, at 400; PROJECT 88, *supra* note 1, at 10; Fisher et al., *supra* note 28, at 406.

33. *See* OTA REPORT, *supra* note 21, at 23, 25.

34. *See* Bohm & Russell, *supra* note 21, at 400; PROJECT 88, *supra* note 1, at 10; OTA REPORT, *supra* note 21, at 23, 27.

35. *See* discussion *infra* Part IV.B.

36. *See* PROJECT 88, *supra* note 1, at 10; OTA REPORT, *supra* note 21, at 23, 26.

37. *See* Bohm & Russell, *supra* note 21, at 401; U.S. DOE, COMPENDIUM, *supra* note 21, at 2-2 (adopting "political sustainability" as a criterion for evaluating policy instruments); PROJECT 88, *supra* note 1, at 10 ("Will the policy be truly feasible in terms of . . . enactment by Congress . . . ?"); Fisher et al., *supra* note 28, at 407 (adopting "feasibility in terms of political

standability to the public,[38] *distributional issues*,[39] *fairness*,[40] and *environmental equity and justice*.[41] These are all incorporated in the cost-minimization formulation under the rubric of political constraints. Interestingly, none of the works cited in Table A1 recognized legal constraints that may limit the range of instruments available for a particular application.[42]

III. TAXONOMY OF ENVIRONMENTAL POLICY INSTRUMENTS

A. *Standard Treatment*

The environmental policy literature has produced many taxonomies of policy instruments over the past 30 years. Table A2 provides a summary of the taxonomies contained in a sample of works that were chosen to span much of the history of the environmental policy literature and to reflect both recognized academic authorities, government studies, and international agency works.[43] The degree to which the studies cited in Table A2 explicitly outline or simply imply the taxonomies varies substantially across the studies.[44]

The taxonomies may be more remarkable for their similarities than their differences. Still, there are several important patterns that emerge. First, the recognition of direct government expenditure or government investment virtually disappeared during the 1980s.[45] Sec-

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implementation" as a criterion for evaluating policy instruments).

38. *See* PROJECT 88, *supra* note 1, at 10.

39. *See* U.S. DOE, COMPENDIUM, *supra* note 21, at 2-2; PROJECT 88, *supra* note 1, at 10.

40. *See* OTA REPORT, *supra* note 21, at 23.

41. *See id.* at 23, 27.

42. *See* discussion *infra* Part IV.D (addressing legal constraints).

43. Table A2 is by no means a comprehensive survey. It is intended only to represent various formulations of the instrument taxonomy. *See infra* Table A2 in Appendix.

44. The primary purpose of some of these works was to set forth a comparative discussion of the range of instruments (*see* Bohm & Russell, *supra* note 21, at 396; U.S. DOE, COMPENDIUM, *supra* note 21, at 1-14; HAHN, ENVIRONMENTAL POLICY DESIGN, *supra* note 3, at 6, 9; OTA REPORT, *supra* note 21, at 1), while for others the taxonomy provided context and support for a more detailed discussion of a particular subset of instruments (*see* PROJECT 88, *supra* note 1, at 2), a particular environmental application (*see* U.S. DEP'T OF ENERGY, POLICIES AND MEASURES FOR REDUCING ENERGY RELATED GREENHOUSE GAS EMISSIONS: LESSONS FROM RECENT LITERATURE 1-1 (1996) [hereinafter U.S. DOE, POLICIES AND MEASURES]), or a textbook discussion of general environmental economics (*see* WILLIAM J. BAUMOL & WALLACE E. OATES, ECONOMICS, ENVIRONMENTAL POLICY, AND THE QUALITY OF LIFE 217 (1997); SCOTT J. CALLAN & JANET M. THOMAS, ENVIRONMENTAL ECONOMICS AND MANAGEMENT: THEORY, POLICY AND APPLICATIONS 105 (1996)).

45. *Compare* Elvis J. Stahr, *Antipollution Policies, Their Nature and Their Impact on Corporate Profits*, *in* ECONOMICS OF POLLUTION: THE CHARLES C. MOSKOWITZ LECTURES 83,

ond, voluntary agreements are emerging as a separate category of instruments.[46] Third, several of the taxonomies adopt categories primarily based on the comparison of command-and-control or regulatory instruments versus incentive-based or market-based instruments.[47] Fourth, it is common to include information, education, and research-oriented instruments with pollution regulation and incentive-based instruments.[48] Interestingly, information, education, and research are included more commonly in government studies than in the academic works.[49]

Finally, and perhaps most importantly, most of the studies treat the instruments in an *ad hoc* manner; they are essentially descriptive lists or menus, lacking any structure that explains the systemic differences and relationships among the instruments. The next step in

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105 (1971); Majone, *supra* note 21, at 593-94; BAUMOL & OATES, *supra* note 44, at 218, 223-25; Bohm & Russell, *supra* note 21, at 446-47, *with, e.g.*, HAHN, ENVIRONMENTAL POLICY DESIGN, *supra* note 3, at 10-12, and OTA REPORT, *supra* note 21, at 8-13. Blackman and Harrington have written the only recent study in Table A2 to recognize direct government investment. *See* ALLEN BLACKMAN & WINSTON HARRINGTON, USING ALTERNATIVE REGULATORY INSTRUMENTS TO CONTROL FIXED POINT AIR POLLUTION IN DEVELOPING COUNTRIES: LESSONS FROM INTERNATIONAL EXPERIENCE 7 (Resources for the Future Discussion Paper 98-21, 1998). *See infra* Table A2 in Appendix.

46. *See* U.S. DOE, POLICIES AND MEASURES, *supra* note 44, at 2-4; Fisher et al., *supra* note 28, at 412; BLACKMAN & HARRINGTON, *supra* note 45, at 7 ("informal regulation").

47. *See* U.S. DOE, COMPENDIUM, *supra* note 21, at 3-4, 4-5 (comparing primarily "regulation by control" with "fiscal incentives"); HAHN, ENVIRONMENTAL POLICY DESIGN, *supra* note 3, at 10-12; PROJECT 88, *supra* note 1, at 4-9; CALLAN & THOMAS, *supra* note 44, at 105, 107, 128-31; Fisher et al., *supra* note 28, at 403-05.

48. *See* Bressers & Klok, *supra* note 14, at 33-34 (1988); U.S. DOE, COMPENDIUM, *supra* note 21, at 5-1 to 6-32; SCIENCE ADVISORY BD., U.S. ENVTL. PROTECTION AGENCY, REDUCING RISK: SETTING PRIORITIES AND STRATEGIES FOR ENVIRONMENTAL PROTECTION 15 (1990) [hereinafter U.S. EPA, REDUCING RISK]; OTA REPORT, *supra* note 21, at 3, 11-13; U.S. DOE, POLICIES AND MEASURES, *supra* note 44, at 2-4.

49. *Compare* U.S. DOE, COMPENDIUM, *supra* note 21, at 5-1 to 6-32, *and* SCIENCE ADVISORY BD., U.S. ENVTL. PROTECTION AGENCY, REDUCING RISK: SETTING PRIORITIES AND STRATEGIES FOR ENVIRONMENTAL PROTECTION 15 (1990) [hereinafter U.S. EPA, REDUCING RISK], *and* OTA REPORT, *supra* note 21, at 3, 11-13, *and* U.S. DOE, POLICIES AND MEASURES, *supra* note 44, at 2-4, *with* HAHN, ENVIRONMENTAL POLICY DESIGN, note 3, at 10-12, *and* PROJECT 88, *supra* note 1, at 4-9, *and* CALLAN & THOMAS, *supra* note 44, at 105-59. The Project 88 study is included as an academic work primarily because the project coordinator, Robert Stavins of Harvard University, seems to have guided the work in that direction, notwithstanding its ties to two prominent political figures, Senators Timothy Wirth and John Heinz. In fact, many of the conclusions appear in subsequent academic publications by Stavins. *See generally* Stavins, *Harnessing the Marketplace*, *supra* note 7; STAVINS, MARKET-BASED ENVIRONMENTAL POLICIES, *supra* note 9; Hahn & Stavins, *A New Era?*, *supra* note 21; Robert W. Hahn & Robert N. Stavins, *Economic Incentives for Environmental Protection: Integrating Theory and Practice*, 82 AM. ECON. REV. 464 (1992) [hereinafter Hahn & Stavins, *Economic Incentives*].

developing a new framework for instrument choice is to create a taxonomy that provides the needed structure.

B. *Reformulation of the Taxonomy*

The discussion in the previous section illustrates several different methods for categorizing policy instruments. This section proposes a new taxonomy that will facilitate analysis of the constrained optimization formulation of the instrument choice problem.

1. Principles of a Taxonomy

A useful taxonomy reflects general principles of scientific classification, informing the user about the important similarities and differences among the various items in the classification.[50] Taxonomy is a "scheme that partitions a body of knowledge and defines the relationships among the pieces. It is used for classifying and understanding the body of knowledge."[51]

Taxonomy generally employs an organizing principle to differentiate among the elements of the classification.[52] In the taxonomy described below, the instruments are organized according to the role that the government plays in each. This approach recognizes that, across instruments, there is significant variation with respect to the type and degree of government involvement in determining the marginal cost of abatement, setting and enforcing goals, controlling how, where, and when pollution abatement will occur, and bearing the costs of pollution abatement and unabated pollution. Not only does this approach elucidate the relation among the instruments in terms of the government function, but it also provides a map that assists in the cost-minimization problem.

2. Dimension 1: Fundamental Role of Government—Entitlement Assigner vs. Regulator

Individuals or groups often make decisions to engage in activities that affect others who are not parties to those decisions. Negative environmental externalities occur when the spillover effects of the chosen actions degrade the quality of the environment, possibly

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50. *See* T. ELLIOT WEIER ET AL., BOTANY: AN INTRODUCTION TO PLANT BIOLOGY 383 (1970).

51. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, IEEE STANDARD COMPUTER DICTIONARY: A COMPILATION OF IEEE STANDARD GLOSSARIES § 610 at 198 (1990).

52. For example, in botany and zoology, taxonomies organize species according to evolutionary development. *See* WEIER ET AL. *supra* note 50, at 383.

leading to allocative inefficiency. The Coase Theorem states that if all parties have full information about their costs and benefits, if there are zero transaction costs, and if property rights are fully assigned and understood, then parties will bargain to allocatively efficient outcomes.[53] However, if property rights are incomplete or there are high transaction costs, Coasean bargaining may not occur.[54]

One efficiency-enhancing role for the government in environmental management, then, is to clarify the assignment of initial entitlements. Several of the lists in Table A2 include instruments that address the assignment or redefinition of property rights[55] or liability.[56] The government uses these instruments to address the problem of incomplete rights and responsibilities, mentioned above in the context of Coasean bargaining.

Calabresi and Melamed have provided a framework for understanding the relation between the property rights and liability approaches to controlling externalities.[57] Like Coase, Calabresi and Melamed recognize that to protect entitlements, the state must decide whom to entitle.[58] They go on to describe a second order decision that the government must make: whether to protect entitlements with property rules or liability rules.[59] Under a property rule, "someone who wishes to remove [an] entitlement from its holder must buy it from him in a voluntary transaction."[60] The current property holder has the right to refuse a sale.[61] The government role, then, is only to assign the property right and enforce it.[62] In contrast, a liability rule

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53. *See* Ronald H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1, 19 (1960).

54. *See id*. at 15-16.

55. *See* BAUMOL & OATES, *supra* note 44, at 218, 221-23; Majone, *supra* note 21, at 593, 595-598. *See infra* Table A2 in Appendix.

56. *See* Bohm & Russell, *supra* note 26, at 433-36; OTA REPORT, *supra* note 21, at 13, 123-27. *See infra* Table A2 in Appendix.

57. *See* Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules, and Inalienability: One View of the Cathedral*, 85 HARV. L. REV. 1089, 1093-1115 (1972). For more on the role and limitations of environmental liability, see TERRY L. ANDERSON & DONALD R. LEAL, FREE MARKET ENVIRONMENTALISM 135-74 (1991); Peter S. Menell, *The Limitations of Legal Institutions for Addressing Environmental Risks*, 5 J. ECON. PERSP. 93 (1991). On empirical analysis of Coasean property rights and the role of transaction costs and social norms, see Robert C. Ellickson, *Of Coase and Cattle: Dispute Resolution Among Neighbors in Shasta County*, 38 STAN. L. REV. 623 (1986).

58. *See* Calabresi & Melamed, *supra* note 57, at 1090.

59. *See id*. at 1092. Calabresi and Melamed also describe a third approach—inalienable rights—that is less germane to the topic of this article.

60. *Id.*

61. *See id*. ("[A property rule] gives the seller a veto if the buyer does not offer enough.").

62. *See id*.

allows someone to "destroy the initial entitlement if he is willing to pay an objectively determined value for it."[63] Under a liability rule, the government not only assigns the initial entitlement, but determines the value that must be paid in the case of involuntary transfer.

	ENTITLEMENT	
	POLLUTEE	**POLLUTER**
PROPERTY RULE	Pollutee may enjoin nuisance; polluter must pay pollutee's price for right to pollute	Polluter may pollute; pollutee must pay polluter's price to stop pollution
LIABILITY RULE	Polluter may pollute, but must compensate pollutee for damages	Pollutee may stop pollution, but must compensate polluter for loss

Figure 1: Calabresi and Melamed Framework on Property Rights and Liability Rules

In the context of pollution control, property and liability rules, coupled with the choice of initial entitlement, create four possible arrangements (see Figure 1).[64] The first, and perhaps best recognized, is a property right that entitles a pollutee to enjoin a pollution nuisance. To avoid an injunction, a polluter must negotiate a price directly with the pollutee. The alternative arrangement, a liability rule, wherein the pollutee is the party endowed with the entitlement, requires only that the polluter compensate the pollutee for damages in an amount determined by the state. Agreement between the polluter and pollutee is not a prerequisite as it is in the case of the property rule. Alternatively, of course, the entitlement to pollute may be vested in the polluter. Here we are most accustomed to seeing a property rule, requiring the pollutee to pay a price acceptable to the polluter to effect the cessation of the offending emission.

The three approaches above are moderately familiar to the student of law and frequently observed in practice. Calabresi and Melamed extend the range of options to include a now operatively evident, if previously overlooked, instrument based on an entitlement to pollute, protected by a liability rule.[65] They describe this design as

63. *Id.*
64. *See id.* at 1115-16.
65. *See id*. at 1116.

"a kind of partial eminent domain coupled with a benefits tax."[66]

The property rights approach is most applicable when the conditions for Coasean bargaining are approximately met, *i.e.*, when there are low transaction costs between emitters and receivers of pollution and where there is sufficient information on the marginal costs of control and environmental damage.[67] Where negotiations are not possible, either because there is a large number of parties or because the environmental injury is accidental in nature, then liability rules may be appropriate if the government is able to establish a proxy valuation of the environmental damage caused by one party against another.[68]

In many important situations, the bargaining process does entail significant transaction costs, such as coordinating parties, managing free riders, and gathering information. Additionally, the government often is not in the position to establish values to be assessed for liability by one party against another, nor to identify all parties that have been injured. So, in the real world, both approaches are often insufficient. This raises another important role for the government—that of regulator.

The first step in the instrument choice process is for the government to decide whether to adopt the "Calabresian" role of assigning property rights and liability rules, or a more involved role as an initiator of environmental protection. Figure 2 depicts the first dimension along which policy instruments are distinguished: the role of government in determining the degree of environmental protection. In one role, depicted on the left-hand-side of Figure 2, the government defines property rights and liability rules and enforces their integrity when invited to do so. Here the government plays a relatively passive role. In the case of property rights, the government relies upon Coasean bargaining among individuals to determine the efficient level of environmental protection, intervening only to protect individuals' assigned rights. For liability rules, the government not only assigns entitlements but assesses values for various environmental injuries between parties, hearing cases as they are brought for adjudication.

In its role as regulator, depicted on the right-hand side of Figure 2, the government intervenes when neither property rights nor liability rules are practical because of transaction costs, coordination costs,

66. *Id.*

67. *See id.* at 1095, 1118.

68. *See id.* at 1119.

free-riding, difficulty in setting damages values, or difficulty in identifying injured parties. In this regulatory capacity, the government sets environmental quality targets, chooses instruments to accomplish those goals, monitors compliance, and initiates actions to enforce the rules.[69] This role of government as regulator of environmental quality is the primary focus of this study.

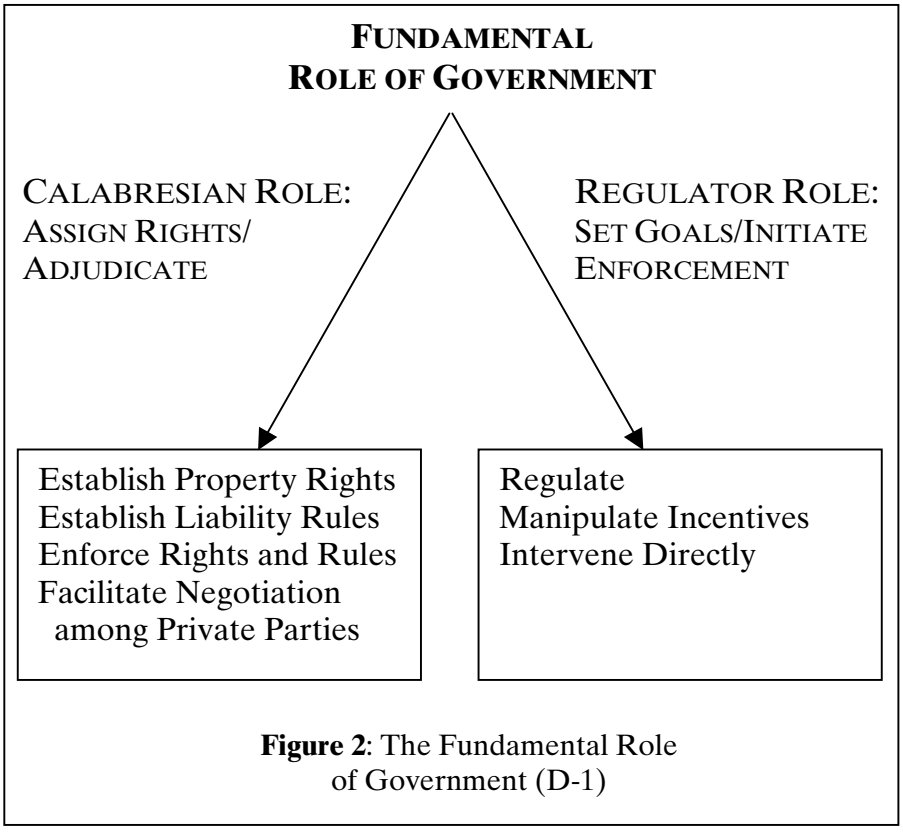

Figure 2: The Fundamental Role of Government (D-1)

3. Instruments for Implementing Environmental Goals: The Regulator Role

The remainder of this article focuses entirely on the right-hand-

69. Even in this role, the government is *de facto* assigning property rights, though they may not be legally recognized. *Cf.* RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW 53 (5th ed. 1998) ("The concept of a de facto property right . . . has broad applicability. Some economists, indeed, use the term property right to describe virtually every device—public or private, common law or regulatory, contractual or governmental, formal or informal—by which divergences between private and social costs or benefits are reduced.").

side of Figure 2, the instruments that the government uses when it directly intervenes in environmental protection decisions.

a. Dimension 2: Locus of Discretion

Abating pollution requires a decision-maker to choose which abatement technologies or practices to use. In some cases the choice is obvious; in others there are many options. The second dimension for distinguishing among policy instruments, then, is the extent to which the government controls the selection of abatement practices. If the government retains control for itself, as in the case for command-and-control regulations, it employs a hierarchical approach to decision-making. In contrast, the policy tools commonly referred to as incentive-based instruments allow the polluter or private parties themselves to identify the best ways to meet pollution abatement requirements.

b. Dimension 3: Distribution of Abatement and Environmental Damage Costs

Choosing a level of environmental protection commonly involves balancing two costs—the cost of pollution abatement versus the cost of environmental damage. Unless the government chooses an extreme option, such as no abatement or complete abatement, both of these costs will be part of any final solution. The third dimension of the taxonomy addresses which, if any, of these costs will be borne by government and society as a whole and which will be borne by the polluter.

c. A Preliminary Taxonomy

Combining the second and third dimensions, it is possible to sketch a rudimentary taxonomy of policy instruments, as shown in Figure 3. The horizontal dimension in Figure 3 represents the degree to which the government exercises control over production decisions. On the extreme right are the instruments (*government production* and *command-and-control regulation*) that, in their purest form, maximize government control. These are *hierarchical* arrangements. At the extreme left, production decisions are left entirely to private parties under *taxes*, *marketable allowances*, *subsidies* and *contracts*. The government monitors only abatement activity or pollution output.

The vertical axis in Figure 3 describes which parties bear the costs of pollution and its abatement. At the top, in the case of subsidies, contracts, or government production, society directly, or through its government agent, bears the cost of both abatement and environ-

mental damage. At the bottom, with *zero-baseline taxes* or *auctioned marketable allowances*, regulated parties bear both types of costs fully.[70] Between the two extremes, there are many different distributions of cost. One distribution denoted in Figure 3 as *grandfathered allowances* occurs at the point where the government grants each firm allowances equal to that firm's efficient level of emissions. The firm must pay for its own abatement practices, but society as a whole continues to bear the costs of unabated emissions. Figure 3 also recognizes that it is possible to reach this type of cost distribution—firms paying for abatement and society bearing environmental costs of unabated pollution—with either incentive-based or command-and-control systems.

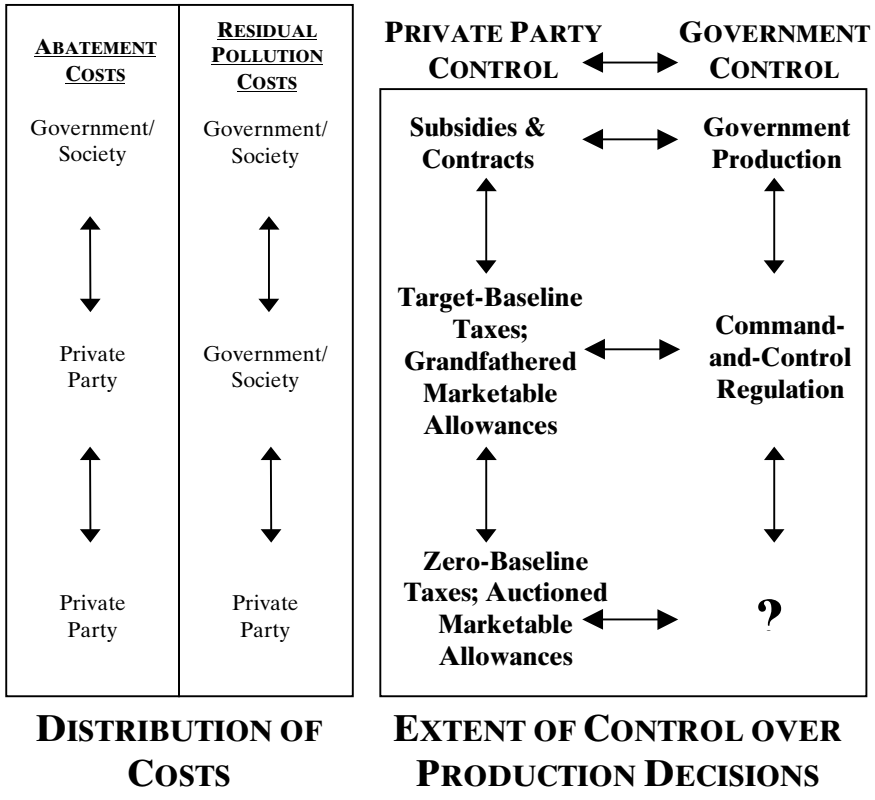

Figure 3: Locus of Discretion (D-2) and Distribution of Costs (D-3)

70. If firms' baselines for taxes are set to zero, then "the scheme reduces to a pure Pigovian pollution charge." John Pezzey, *The Symmetry Between Controlling Pollution by Price and Controlling It by Quantity,* 25 CAN. J. ECON. 983, 985 (1992) [hereinafter Pezzey, *Symmetry*].

Unlike the incentive-based instruments, the more conventional command-and-control regulation provides relatively little or no discretion to the polluting private party. In its pure form, command-and-control regulation employs a technology-based standard that specifies (*de jure* or *de facto*) the technologies that regulated firms must use to abate pollution.[71] This type of regulation controls where and how pollution abatement will occur and determines the total amount of pollution allowed.[72] In contrast, performance-based standards are less restrictive than technology-based approaches. They may specify rates of pollution removal, emissions concentration, or simply emissions quantities (in which case they are quotas). Because the performance-based standard provides more discretion to the polluting firm regarding how to abate pollution, those types of instruments fall on the interior of Figure 3, to the left of the pure command-and-control instruments, *i.e.*, technology-based instruments that leave virtually no discretion to firms.

Before proceeding further, it is important to clarify the definitions of the terms used in Figure 3. In this discussion, a pure subsidy will be narrowly defined as an offer by the government to pay a fixed price per unit of good or service to any and all takers. By contrast, when the government uses a pure contract approach to production, it sets a goal for the amount of good or service it intends to develop and searches for the least expensive suppliers through competitive bids or some other market mechanism.[73] For example, if the government wanted to increase the acres of trees in the United States, the subsidy instrument in its purest form would entail a public offering to pay any landowner a fixed price per acre of trees planted. The contract approach would involve establishing a target number of acres and negotiating agreements with enough landowners to meet the goal.[74]

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71. The Federal Water Pollution Control Act of 1972 (FWPCA), for example, mandated the use of "best practicable technology" in Phase I and "best available technology" in Phase II. *See* FWPCA §§ 304(b)(1)(A), 304(b)(2)(A), 33 U.S.C. §§ 1314(b)(1)(A), 1314(b)(2)(A) (1994).

72. The technology-based standard only controls the nature of the abating activity. It does not control the amount of underlying productive activity. So, for example, a technology-based standard may determine the emissions per car painted, but not the number of cars painted. However, the permitting process limits the amount of productive activity, for example the number of cars painted. Taken together, the permitting process and the technology-based standard limit the amount of total emissions from a given source.

73. *See* ROSEMARY O'LEARY ET AL., MANAGING FOR THE ENVIRONMENT: UNDERSTANDING THE LEGAL, ORGANIZATIONAL, AND POLICY CHALLENGES 287 (1999).

74. By this definition, the U.S. Department of Agriculture's Conservation Reserve Program was a contractual approach to reducing soil erosion. The government set a goal of establishing 45 million acres of highly erodible cropland in soil conservation practices. *See* Robert

The government production option involves carrying out environmental programs by building on existing and expanded organizational structures internal to the government.[75] For example, at the local level municipalities generally provide wastewater treatment and solid waste disposal.[76]

The lower two thirds of Figure 3 entails the more familiar environmental instruments—taxes, marketable emissions allowances, and command-and-control regulation. An environmental tax assesses a charge per unit of pollution, thus providing incentives to reduce the level of emissions.[77] Auctioned marketable permits are similar, except that the total quantity of allowances is fixed and the price is set by the market.[78] To distinguish political considerations and other

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Moulton et al., The Timberland in Conservation Reserve Program and Its Effect on Southern Rural Economies 3 (Mar. 1989) (unpublished manuscript, on file with author). The U.S. Department of Agriculture then took bids from farmers to enter into 10-year contracts to implement prescribed land-management practices. *See id*.:

> The CRP involves a ten-year agreement between the Federal government and a farmer/landowner. To enter the program a farmer agrees to place the land removed from production into an approved soil conserving cover for ten years. The government, in turn, agrees to pay the farmer an annual rental payment and half the cost of the conservation practice's establishment.

Another example of government contracting is the U.S. Environmental Protection Agency's use of private contractors to manage environmental cleanups. *See* OFFICE OF TECH. ASSESSMENT, U.S. CONGRESS, ASSESSING CONTRACTOR USE IN SUPERFUND 1-2 (1989) [hereinafter OTA, ASSESSING SUPERFUND]. During the 1980s, 80 to 90 percent of the Superfund program funds went to private contractors each year. *See* id. at 3. The government often enters into negotiated in-kind contracts such as the state of Minnesota's 1994 arrangement with Northern States Power Company, an electric utility, that the firm develop ways to generate electricity from biomass and wind in exchange for permission to expand storage of spent nuclear waste at its plant in Red Wing. *See* MINNEAPOLIS STAR TRIB., May 31, 1994, at A1.

75. *See* Kyle D. Logue, *Tax Transitions, Opportunistic Retroactivity, and the Benefits of Government Precommitment,* 94 MICH. L. REV. 1129, 1144 (1996) (referring to government production as "in-house government contracting").

76. Illustrative of federal-level production are the Federal government's activities in the realm of natural resources management, where it furnishes an extensive system of national forests through the U.S. Forest Service and of wilderness areas through the U.S. Department of the Interior.

77. For example, Sweden, Norway, Denmark, France, and Japan levy substantial taxes per unit of sulfur dioxide emissions. *See* Cansier & Krumm, *supra* note 2, at 65-66.; ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, ENVIRONMENTAL TAXES AND GREEN TAX REFORM 23-27 (1997) [hereinafter OECD, GREEN TAX REFORM]; ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, EVALUATING ECONOMIC INSTRUMENTS FOR ENVIRONMENTAL POLICY 16, 19 (1997) [hereinafter OECD, ECONOMIC INSTRUMENTS]. Norway also introduced a substantial tax on carbon dioxide emissions in 1991. S*ee* Haakon Vennemo, *Welfare and the Environment: Implications of a Recent Tax Reform in Norway*, *in* PUBLIC ECONOMICS AND THE ENVIRONMENT IN AN IMPERFECT WORLD 337, 344 (Lans Bovenberg & Sijbren Cnossen eds., 1995).

78. Title IV of the Clean Air Act Amendments of 1990 established a system of marketable allowances for sulfur dioxide emissions from power plants in the United States. *See* DALLAS

complications and constraints from the normative analysis presented here, it is assumed throughout this discussion that increased government revenue from either taxes or auctioned permits is offset by a reduction in other distortionary taxes. That is, these environmental instruments are assumed to be revenue-neutral.[79]

It is also useful to define two terms that are not explicitly included in Figure 3. An expanded notion of instrument choice also recognizes two government modes of operation: the *enterprise mode* and the *coercive mode*. Government enterprise refers to that operational mode in which the government makes direct financial commitments or investments.[80] To the extent that private firms are involved, their participation is voluntary. In contrast, the coercive mode entails mandatory participation by private firms. At the federal level the two modes operate under different powers, enumerated in Article 1, Section 8 of the United States Constitution.[81] The enterprise mode is carried out under the spending powers,[82] while the coercive mode invokes the taxing and commerce (regulatory) powers.[83] The distinction between these modes of operation helps clarify the relation among

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BURTRAW, COST SAVINGS, MARKET PERFORMANCE, AND ECONOMIC BENEFITS OF THE U.S. ACID RAIN PROGRAM 1 (Resources for the Future Discussion Paper 98-28, 1998).

79. The term "revenue-neutral" simply means that the size of the government budget does not grow with introduction of new revenue raised through environmental policy instruments. *See* discussion *infra* Part IV.C.

80. "Enterprise" is defined as a "venture or undertaking, especially one involving financial commitment." BLACK'S LAW DICTIONARY 476 (5th ed. 1979). Sax distinguishes between the government as mediator and the government as participant in economic activities. *See* Joseph L. Sax, *Takings and the Police Power*, 74 YALE L.J. 36, 61-64 (1964). "Government as enterpriser operates in a host of areas, requiring money, equipment and real estate." *Id.* at 62. Sax implicitly recognizes that even in its role as enterpriser, the government must sometimes use the coercive power of eminent domain to accomplish its goals. But when it uses that power it must pay compensation, essentially shifting it into a government production instrument.

81. Although the Sixteenth Amendment also addresses Congress' taxing power, it is specific to income tax and hence has less connection to the issues discussed in this analysis.

82. Subsidies and contracts can also be implemented under the taxing power if they take the form of tax credits. For example, the state of Washington gave $130 million tax break to Centralia Coal in exchange for reducing sulfur dioxide emissions by 90 percent. *See* SEATTLE TIMES, Mar. 17, 1997, at B2. The observation that the taxing power can be used to implement subsidies and contracts does little to change the subsequent analysis, although it does have implications for the political process.

83. The federal government generally regulates the environment under the commerce power. State and local governments regulate under the police power. Although the analysis in this study focuses primarily on federal action, many of the more general conclusions are relevant to state environmental programs as well. States also have taxing and spending powers. To serve as a reminder of the broader applicability of this analysis, the balance of this study will recognize three government powers—taxing, spending, and *regulatory* powers.

the instruments by focusing on the legal and economic implications of using each.

Returning to the taxonomy in Figure 3, this diagram of instruments supplements the standard approach to policy instrument choice. Over the last decade the environmental instrument choice literature has largely concentrated its attention on championing the merits of taxes and marketable allowances. Generally, these two instruments are compared either to each other[84] or to command-and-control regulation.[85] Some studies have mentioned alternatives to these instruments but have done little to explain the circumstances under which a regulator might choose these alternatives.[86] In particular, few recent environmental policy instrument studies have addressed the possibility of the government undertaking environmental protection directly, rather than through taxes, marketable allowances, or regulation.[87] In practice, however, governments often provide goods and services directly to the public rather than by inducing private firms to make those provisions. Although government production is most commonly associated with items such as national defense, monetary currency, and certain kinds of information gathering and dissemination, the government also provides many types of environmental amenities either directly or through its contractors. For ex-

84. *See, e.g.*, Alan Marin, Comment, *Firm Incentives to Promote Technological Change in Pollution Control: Comment*, 21 J. ENVTL. ECON. & MGMT. 297, 297 (1991); JOHN PEZZEY, CHARGE-SUBSIDIES VERSUS MARKETABLE PERMITS AS EFFICIENT AND ACCEPTABLE METHODS OF EFFLUENT CONTROL: A PROPERTY RIGHTS ANALYSIS 1-2 (Discussion Paper No. 90/271, 1990) (on file with Dep't of Econ., Univ. of Bristol) [hereinafter PEZZEY, CHARGE-SUBSIDIES]; Louis Kaplow & Steven Shavell, On the Superiority of Corrective Taxes to Quantity Regulation 1 (1996) (unpublished manuscript, on file with author); WILLIAM A. PIZER, PRICES VS. QUANTITIES REVISITED: THE CASE OF CLIMATE CHANGE 1 (Resources for the Future Discussion Paper 98-02, 1997); Marc J. Roberts & Michael Spence, *Effluent Charges and Licenses Under Uncertainty*, 5 J. PUB. ECON. 193, 194 (1976).

85. *See, e.g.*, Lawrence H. Goulder et al., *The Cost-Effectiveness of Alternative Instruments for Environmental Protection in a Second-Best Setting*, 72 J. PUB. ECON. 329 (1999); Klaus Conrad & Michael Schröder, *Choosing Environmental Policy Instruments Using General Equilibrium Models*, 15 J. POL'Y MODELING 521 (1993); JON NICOLAISEN ET AL., ECONOMICS AND THE ENVIRONMENT: A SURVEY OF ISSUES AND POLICY OPTIONS 7, 16-21 (OECD Economics Studies No. 16, 1991); Jun Jie Wu et al., *An Empirical Analysis of the Relative Efficiency of Policy Instruments to Reduce Nitrate Water Pollution in the U.S. Southern High Plains*, 43 CAN. J. AGRIC. ECON. 403, 403-420 (1995); Daniel E. Spulber, *Effluent Regulation and Long-Run Optimality*, 12 J. ENVTL. ECON. & MGMT. 103, 103-04 (1985).

86. *See, e.g.*, HAHN, ENVIRONMENTAL POLICY DESIGN, *supra* note 3, at 12; *see also* Wu et al., *supra* note 85, at 405-07.

87. For example, Fisher *et al*. mention only in passing the potential for governments making direct investments in climate change mitigation, and they did not include it in their list of instruments. *See*, Fisher et al., *supra* note 28, at 414.

ample, cleanup of hazardous waste sites, wastewater treatment, research and development on green technologies, and environmental education are all environmental services provided in the United States by state or federal agencies. The taxonomy in Figure 3 explicitly recognizes the potential for government production. Application of principles from New Institutional Economics will help explore when the government production policy instrument might be most efficient.[88]

Another result from the taxonomy in Figure 3 is that, at least in theory, there must exist an instrument under which private parties bear both environmental and abatement costs while the government retains control over abatement decisions. The fact is, however, that we have no term for such an instrument, perhaps because as a practical matter, such an instrument is virtually always politically infeasible. For now we will leave a question mark in the space corresponding to that arrangement.[89]

In contrast to the standard discussion of environmental policy instruments, Figure 3 also highlights the fact that there are many intermediate forms of the policy tools. The specified instruments at the extreme corners of the diagram refer to instruments exercised in their "pure" forms. As indicated by the arrows, for each type of cost distribution there is a continuum of instruments that combine elements of the pure instruments.[90] Thus, although the figure focuses on the "pure" instruments, the framework is broad, accommodating not only the instruments as conceptualized in theory (pure instruments), but as exercised in common practice (the intermediate instruments of the interior). As mentioned above, performance standards represent a modification of technology-based regulation—one that provides firms with discretion on *how* to make reductions, but not *where*, *when* or *how much* reductions are made. Similarly, marketable allowance programs requiring government approval of each trade or restricting who may hold and trade allowances introduce hierarchical elements that provide for sharing of discretion between the government and private parties. In another example, contracts commonly incorporate a number of different control structures to achieve hierarchy-like out-

88. This analysis is developed *infra* in Part IV.B.

89. In the stories of Harry Potter, there is a dark wizard so evil that the timid will not speak his name. They refer to him only as "You-Know-Who." J.K. ROWLING, HARRY POTTER AND THE SORCEROR'S STONE 100 (1997). Following that example, perhaps we should simply refer to the lower right corner of Figure 3 as "The-Instrument-We-Do-Not-Name."

90. For the analog in private production, see WILLIAMSON, *supra* note 29, at 16.

comes.[91] Protocols for change orders in government contracts allow the government to modify the initial agreement without vesting all control in the government. These are all examples of instruments falling in the interior of Figure 3.

In some simple applications—those involving well-behaved pollutants whose emissions are simple to measure and whose abatement requires only modest specialized investments—one instrument will minimize all three types of costs (PC, IC, and TX) simultaneously. This would probably be the case, for example, for a carbon dioxide emissions reduction program. Taxes or marketable allowances, with allowances auctioned rather than grandfathered,[92] the lower left corner of Figure 3, would likely minimize production costs, implementation costs and negative public finance impacts.

For more complex policy problems, however, the government makes tradeoffs among the categories of costs. This means moving away from a single prescriptive outcome that concentrates solely on production costs. Rather, efficiency-seeking decision-makers must seek a set of broadly applicable principles that relate the technological and institutional characteristics of specific policies to the advantages and disadvantages of each instrument. The art of instrument choice becomes a matter of assessing all three of the cost components for specific applications. The preliminary taxonomy must then be further refined to reveal the tradeoffs inherent in addressing more complex problems.

d. Dimension 4: Prices vs. Quantities

The instruments on the left-hand side of Figure 3 can be further differentiated according to whether instruments are price-based or quantity-based (see Figure 4).[93] Under perfect information either price-based or quantity-based instruments can be used to meet a specific emissions abatement goal at the same marginal production cost.[94]

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91. *See* Arthur L. Stinchcombe, *Contracts as Hierarchical Documents*, *in* ORGANIZATION THEORY AND PROJECT MANAGEMENT: ADMINISTERING UNCERTAINTY IN NORWEGIAN OFFSHORE OIL 121, 155-66 (Arthur L. Stinchcombe & Carol A. Heimer eds., 1985); *see also* discussion *infra* Part IV.B.

92. *See generally* PETER CRAMTON & SUZI KERR, TRADABLE CARBON PERMIT AUCTIONS: HOW AND WHY TO AUCTION NOT GRANDFATHER 17-18 (Resources for the Future Discussion Paper 98-34, 1998).

93. Although this article will not explore the issue, it is worth at least raising the question of whether there are both price- and quantity-based versions of the hierarchical instruments on the rights-hand side of Figure 3.

94. *See* Weitzman, *supra* note 11, at 480 ("In an environment of complete knowledge and perfect certainty there is a formal identity between the use of prices and quantities as planning

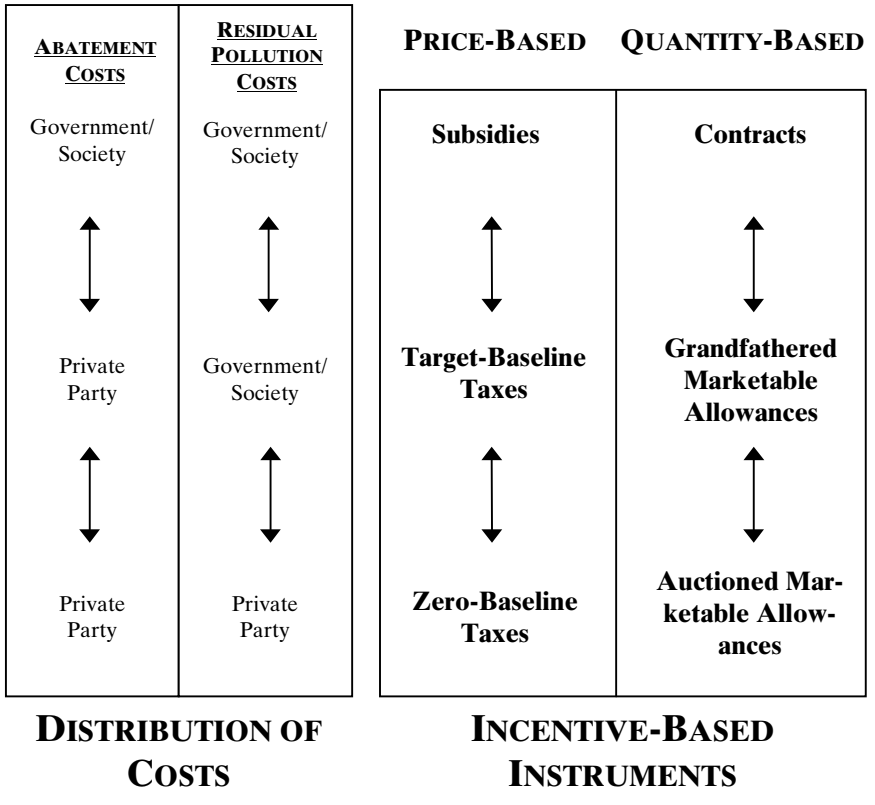

Figure 4: Taxonomy of Incentive-Based Instruments (D-4)

If a government uses a quantity-based approach as described on the right-hand side of Figure 4, say issuing a fixed number of marketable allowances, then it has automatically assured that its emissions limits will be met, assuming successful monitoring and enforcement. The government can also predict what the market clearing price of allowances will be if it knows how the marginal cost of abatement varies with the level of the emissions limit. Thus, by choosing the quantity of emissions, the government also determines the price of the allowances. Similarly, if the government uses a price-based mechanism, say a tax on emissions, and if the marginal abatement cost curve is

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instruments").

known with some certainty, then it is possible to predict the level of emissions.

However, in the presence of uncertainty, either the priced-based or quantity-based instruments may be preferred.[95] Figure 4 demonstrates that the incentive-based instruments can be distinguished by (1) whether they rely on price-based or quantity-based controls and (2) who pays for the abatement costs and the residual pollution costs. Generally, when there is uncertainty about the marginal cost of abatement, quantity-based approaches will induce abatement levels that are closer to the efficient level than will taxes, if the marginal benefits curve is steeper than the marginal cost curve.[96] All things being equal, taxes will lead to less deviation from the efficient abatement level when the uncertain marginal cost curve is steeper than the marginal benefit curve.

Intuitively, in their pure form subsidies and contracts have the same duality relation as taxes and marketable allowances. Under perfect information, the government can achieve its goals by either making price-based offers to buy or by purchasing a fixed quantity of a good or service from the lowest-cost suppliers. Pezzey started to demonstrate this symmetry in his analysis comparing charge-subsidy schemes with marketable allowances.[97] The taxonomy in Figure 4 suggests that the symmetry can be extended to include contracts.[98] The quantity-based analog to a charge-subsidy scheme is a marketable allowance-offset program. The offsets are contracts under which the government awards additional marketable allowances to firms that provide abatement services beyond those that are required. Thus, the marketable allowance-contract approach is based on the net quantity of emissions.

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95. *See, e.g.*, Gruenspecht & Lave, *supra* note 11, at 1516-19.

96. *See* Gruenspecht & Lave, *supra* note 11, at 1516.

97. *See* Pezzey, *Symmetry*, *supra* note 70, at 985-87, 989-90. Under a charge-subsidy scheme, firms are assigned a baseline effluent property right. If a firm emits effluent at a level below the baseline, the government pays it a subsidy proportionate to the amount of the over-abatement. On the other hand, if the firm's emissions exceed the baseline, the firm pays a charge in proportion to the excess.

98. The new taxonomy also suggests another extension of Pezzey's analysis by emphasizing that subsidies and contracts involve government payments while taxes and marketable allowances place abatement costs with private parties. This means that the choice of instruments has important implications for the public finance system. Pezzey asserted that the baseline effluent rights, which ultimately determine the tax burden of polluting firms in a charge-subsidy scheme, should be chosen on political grounds. *See* Pezzey, *Symmetry*, *supra* note 70, at 986 ("In a charge-subsidy scheme, baseline effluent rights . . . for each firm should be chosen entirely on political grounds . . . ."). In fact, there is a strong normative argument that auctioned marketable allowances or taxes with a zero-baseline should be preferred.

e. Dimension 5: Inputs vs. Outputs and the Degree of Correlation

The instruments described in Figures 3 and 4 can also be distinguished by the measure of performance each uses and the degree of correlation between actual emissions[99] and the measure of performance. This dimension is often cast as a choice between controlling production inputs/outputs and controlling emission outputs. For example, in Table 2A Blackman and Harrington include *direct instruments* that are based on actual emissions levels and *indirect instruments* based on either inputs or outputs of production.[100] Based on this distinction, they define environmental taxes as levies on the production of inputs or outputs and fees as charges on the actual level of emissions.[101]

A more informative construction of this issue addresses the degree of correlation between the performance indicator and the desired outcome. For example, in the case of carbon dioxide controls, the amount and type of fossil-fuel inputs to a combustion process can be used as a highly accurate predictor of carbon dioxide emissions; that is, there is a high degree of correlation between inputs and emissions.[102] In contrast, on the carbon sink side, even field measurements, often the most direct method practical for measuring carbon abatement services, leave a wide range of uncertainty.[103] Thus, the choice between using direct measurements of emissions or some proxy for those emissions depends critically upon the specific application. The choice of direct measurement or a proxy also affects the extent of discretion available to private parties. The closer regulations move to using actual emissions as the measure of performance, the further to the left in Figure 3 is the instrument, and the lower the compliance costs are likely to be.[104]

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99. In fact, actual emissions are themselves a proxy measure for environmental damage.

100. *See* BLACKMAN & HARRINGTON, *supra* note 45, at 2-3.

101. *See id*. at 1-2 ("[W]e will use the term 'fee' to refer only to charges on emissions, and the term 'tax' to refer only to charges on pollution intensive inputs and outputs").

102. *See* U.S. DEP'T OF ENERGY, REP. NO. DOE/PO-0028, 2 SECTOR-SPECIFIC ISSUES AND REPORTING METHODOLOGIES SUPPORTING THE GENERAL GUIDELINES FOR THE VOLUNTARY REPORTING OF GREENHOUSE GASES UNDER SECTION 1605(B) OF THE ENERGY POLICY ACT OF 1992, VOLUME 1: ELECTRICITY SUPPLY SECTOR 1.25 (1994) [hereinafter U.S. DOE, REPORTING METHODOLOGIES].

103. *See, e.g.*, Kenneth Richards & Krister Andersson, *The Leaky Sink: Persistent Obstacles to a Forest Carbon Sequestration Program Based on Individual Projects*, 1 CLIMATE POLICY (forthcoming 2000).

104. *See* Gloria E. Helfand, Controlling Inputs to Control Pollution 17 (Oct. 1995) (unpublished manuscript, on file with author) [hereinafter Helfand, Controlling Inputs].

f. Dimension 6: Locus of Discretion—Intertemporal Flexibility

Just as environmental policy instruments can be differentiated according to the degree of flexibility they give private parties to determine how and where emissions abatement occurs (D-2), instruments can also be differentiated according to the degree of intertemporal flexibility they give private parties. Intertemporal flexibility is generally referred to as banking, a term used here to encompass both saving and borrowing.

The flexibility derived from banking provisions is particularly important in the various incentive-based instruments. Rubin describes examples of banking provisions in marketable emissions allowances, noting the provisions in the Clean Air Act Amendments of 1990 to allow participants in the trading program to bank sulfur dioxide emissions allowances.[105] He further notes that, in the context of automobile fuel efficiency, the Corporate Average Fuel Efficiency (CAFE) system, a type of performance-based regulation, also employs banking.[106] Automobile manufacturers are allowed to bank credits for up to three years.[107] Furthermore, banking was also permitted under EPA's emission reduction credit program.[108]

The rationale for banking is that if the costs of emissions control, and hence the value of emissions allowances, change over time, intertemporal flexibility enhances allocative efficiency.[109] One of the key questions is whether the government should apply a decay function to allowances that are saved in the banking program. In California's Low-Emission Vehicle Program, vehicle manufacturers are required to meet average fleet hydrocarbon emissions for automobiles they sell in the state.[110] They are allowed to save and borrow emissions credits, but saved credits lose value "by 25, 50, 75, and 100% after 1, 2, 3, and 4 model years."[111] Such a scheme appears to discourage saving credits (*i.e.*, delaying emissions) and leads to more

105. *See* Jonathan D. Rubin, *A Model of Intertemporal Emission Trading, Banking, and Borrowing*, 31 J. ENVTL. ECON. & MGMT. 269, 269 (1996).

106. *See id.*

107. *See id.* at 270.

108. *See* Robert W. Hahn & Gordon L. Hester, *Marketable Permits: Lessons for Theory and Practice*, 16 ECOLOGY L. Q. 361, 372 (1989).

109. *See* Catherine Kling & Jonathan Rubin, *Bankable Permits for the Control of Environmental Pollution*, 64 J. PUB. ECON. 101, 108 (1997).

110. *See* California Air Resources Board, *Low-Emission Vehicle Program* (last modified May 5, 2000) <http://www.arb.ca.gov/msprog/levprog/test_proc.htm>.

111. Jonathan Rubin & Catherine Kling, *An Emission Saved Is an Emission Earned: An Empirical Study of Emission Banking for Light-Duty Vehicle Manufacturers*, 25 J. ENVTL. ECON. & MGMT. 257, 259 n.3 (1993).

emissions early in the program. Allocative efficiency would seem to be better served by paying interest on saved allowances (*i.e.*, having the size of the allowance grow as a function of the length of time it is saved in the bank) because the damages associated with the emissions are delayed. The actual accrual rate would be a function of the residence time of the pollutant, the private and social discount rates, and the path of marginal damages over time.[112]

g. Dimension 0: Information versus Abatement

The instruments depicted in Figures 3 and 4 illustrate the range of policy tools that the government can use to correct environmental

TABLE 1: DIMENSIONS FOR DIFFERENTIATING POLICY INSTRUMENTS

D-0: INFORMATION VS. ABATEMENT
Addressing Public Good vs. Externality
D-1: ROLE OF GOVERNMENT
Assigning Rights/ Selecting Rules/Judging vs. Setting Goals/Initiating Action
D-2: LOCUS OF DISCRETION (I)
Government vs. Private: How and Where will Abatement Occur?
D-3: DISTRIBUTION OF COSTS
Government vs. Private: Who Pays for Abatement and Environmental Damages?
D-4: PRICE VS. QUANTITY
D-5: INPUTS VS. OUTPUTS AND DEGREE OF CORRELATION
D-6: LOCUS OF DISCRETION (II)—INTERTEMPORAL FLEXIBILITY
Government vs. Private: When will Abatement Occur?

externalities. They accomplish this by changing the level of abatement activity, polluting activity, or restoration activity—essentially setting the level of pollution or environmental services at an optimal level.

112. *See* Paul Leiby & Jonathan Rubin, Bankable Permits for the Control of Stock and Flow Pollutants: Optimal Intertemporal Greenhouse Gas Emission Trading 24 (Mar. 10, 1998) (unpublished manuscript, on file with author) [hereinafter Leiby & Rubin, Bankable Permits]; Paul Leiby & Jonathan Rubin, Efficient Greenhouse Gas Emission Banking and Borrowing Systems, 11-12 (May 31, 1998) (unpublished manuscript, on file with author) [hereinafter Leiby & Rubin, Banking and Borrowing].

Externalities are not the only market failure that can contribute to excess pollution, however. Information-related market failures also contribute to environmental degradation when the information does not exist, is not disseminated, or cannot be used because decision-makers do not have the requisite skills.[113] When the government identifies problems related to information, it may choose to intervene in the market by, for example, developing education programs, undertaking research at government facilities, giving grants to schools, or requiring firms to inform the public about emissions.[114]

Two points are pertinent. First, when the problems are information-related, the government is addressing market failures related to either asymmetric information or information as a public good.[115] Second, when the government chooses to intervene in the market for information, it must still decide which instruments to employ and how much control to retain over the development and dissemination of the information. For these reasons the education, research, and technical assistance approaches are not explicitly included in the taxonomy described above. It is not that the taxonomy in Figures 2 to 4 does not accommodate information-based approaches but, in fact, just the opposite. The new framework highlights the fact that the government faces a parallel decision-making process of instrument choice whether it is choosing instruments to correct externalities or to provide information as a public good.

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113. *See* Kenneth Richards, Economic Measures in a Global Climate Change Policy, U.S. Concept Paper on Economic (Market) Measures 1-2 (1989) (unpublished manuscript, on file with author) (portions of this manuscript incorporated into INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE: THE IPCC RESPONSE STRATEGIES 236-237 (1991)).

114. For a discussion of the effectiveness of requiring firms to inform the public about emissions, see Christopher H. Schroeder, *Third Way Environmentalism*, 48 KAN. L. REV. 1, 14-16 (2000).

115. *See* JOSEPH E. STIGLITZ, ECONOMICS OF THE PUBLIC SECTOR 83-84 (3d ed. 2000). For a concise discussion of information and public policy, see JEAN TIROLE, THE THEORY OF INDUSTRIAL ORGANIZATION 113-14 (1988). Private contracts could, in theory, provide efficient levels of information, as suggested by the Coase Theorem. *See id*. at 113. However, given the presence of third-party externalities and transaction costs, an efficient outcome is unlikely. *See id*. The government may be able to improve welfare by, for example, subsidizing research and product testing, producing information that has a high fixed cost of development but relatively low cost of dissemination. Because, in the area of environmental protection, one person's use of information generally does not diminish another citizen's capacity to also use that information, research and testing have public good characteristics. Similarly, in the presence of asymmetric information about the risks, safety, or efficiency of a product, the government may improve social welfare by requiring labeling or some other mechanism of disseminating information.

h. Special Cases

Voluntary Programs

Table 1 summarizes the several dimensions for differentiating among policy instruments. Three of the studies included in Table A2 list voluntary programs or informal regulation as separate policy instruments, yet Figures 2 to 4 do not explicitly include this approach. While it might be tempting to insert an additional dimension into Table 1 for voluntary participation, that is not necessary. To understand how voluntary approaches fit in the new framework it is necessary first to understand the role of government in voluntary programs and informal regulation.

The recent instrument choice literature identifies two major categories of voluntary programs. The first, described by Blackman and Harrington, involves "pressure exerted on polluters by private-sector groups such as community organizations, environmental advocacy groups, and trade unions."[116] This pressure can take the form of social pressure, threats of adverse publicity, political pressure, and moral suasion. This process of private-sector negotiation is actually a form of bargaining in which private organizations threaten to exercise their speech and voting rights if the targeted polluting party does not reduce emissions. The government may have assigned, either implicitly or explicitly, the right to pollute to the polluter. Nonetheless, the polluter could find it expedient to capitulate to some private sector demands rather than bear the cost of having a community organization exercise its full range of speech and voting rights.[117] Thus, informal regulation, as defined by Blackman and Harrington, is a special case of the property rights approach on the left-hand side of Figure 2.

The second major category of voluntary programs includes government-initiated "actions which form part of government policy to meet [environmental] policy objectives, and are based on a joint undertaking between government and industry or national and local authorities."[118] The government induces cooperation through appeal to the self-interest of program participants.[119] Often, for example, the

116. BLACKMAN & HARRINGTON, *supra* note 45, at 7.

117. For a recent analysis of whether operators of facilities identified in EPA's Toxic Release Inventory undertake greater emission reductions when exposed to more politically active local citizens, see James T. Hamilton, *Exercising Property Rights to Pollute: Do Cancer Risks and Politics Affect Plant Emissions Reductions*?, 18 J. RISK & UNCERTAINTY 105 (1999).

118. INTERNATIONAL ENERGY AGENCY, VOLUNTARY ACTIONS FOR ENERGY-RELATED CO_2 ABATEMENT 27 (1997).

119. *See* Mark Storey et al., Voluntary Agreements with Industry 3 (Apr. 1997) (unpub-

government provides technical assistance to help firms improve their energy efficiency and reduce their costs, as in the case of the U.S. EPA's Green Lights Program.[120] Alternatively, companies may participate because they receive a government stamp of approval, as in the case of the EPA Energy Star Program,[121] or executive branch goodwill and political access, as in the case of the U.S. Department of Energy's (DOE) Climate Challenge program.[122] In other programs, such as the DOE 1605(b) voluntary reporting program for greenhouse gases, companies volunteer in the "shadow of regulation."[123] That is, there is an implicit threat by the government to use mandates if industry does not produce suitable environmental results voluntarily.[124]

While the motivations for firms voluntarily to undertake environmental protection measures are complex,[125] the important fact is that the government is inducing participation not with distinct voluntary program instruments, but by application of standard instruments drawn from Figure 3. The government often uses contracts or internal government production to develop and disseminate technical in-

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lished manuscript, on file with author); Jeffrey Dowd & Gale A. Boyd, A Typology of Voluntary Agreements Used in Energy and Environmental Policy 4 (Jan. 1998) (unpublished draft prepared for the Office of Pol'y & Int'l Aff., U.S. Dep't of Energy, on file with author).

120. *See* U.S. Envtl. Protection Agency, *Partnership Benefits* (last modified Aug. 1, 2000) <http://www.epa.gov/buildings/esbhome/benefits/benefits.html>.

121. *See* U.S. Envtl. Protection Agency, *Energy Star—The Symbol of Energy Efficiency* (last modified May 23. 2000) <http://www.epa.gov/energystar/>.

122. *See* Energy Efficiency and Renewable Energy Network (EREN) & U.S. Dep't of Energy, *Climate Challenge: DOE's Energy Partnerships for a Strong Economy* (last modified July 31, 2000) <http://www.eren.doe.gov/climatechallenge/>.

123. *See* U.S. Dep't of Energy, *Voluntary Reporting of Greenhouse Gases under Section 1605(b) of the Energy Policy Act of 1992: General Guidelines* (last modified Dec. 17, 1997) <http://www.eia.doe.gov/oiaf/1605/1605b.html>. It would be an informative exercise to consider the parallels among "volunteering in the shadow of regulation," as considered here, "bargaining in the shadow of the law" (Robert Mnookin & Lewis Kornhauser, *Bargaining in the Shadow of the Law: The Case of Divorce*, 88 YALE L.J. 950, 968 (1979); Robert Cooter et al., *Bargaining in the Shadow of the Law: A Testable Model of Strategic Behavior*, 11 J. LEGAL STUD. 225, 225 (1982)), and "bargaining in the shadow of power" (Robert Powell, *Bargaining in the Shadow of Power*, 15 GAMES & ECON. BEHAVIOR 255, 255 (1996)).

124. *See* Kathleen Segerson & Thomas J. Miceli, Voluntary Approaches to Environmental Protection: The Role of Legislative Threats 4 (Mar. 1997) (unpublished manuscript, on file with author).

125. *See*, *e.g.*, Seema Arora & Timothy N. Cason, *An Experiment in Voluntary Environmental Regulation: Participation in EPA's 33/50 Program*, 28 J. ENVTL. ECON. & MGMT. 271, 275-84 (1995) [hereinafter Arora & Cason, *Voluntary Environmental Regulation*]; Seema Arora & Timothy N. Cason, *Why Do Firms Volunteer to Exceed Environmental Regulations? Understanding Participation in EPA's 33/50 Program*, 72 LAND ECON. 413, 423-30 (1996) [hereinafter Arora & Cason, *Why Do Firms Voluneer?*].

formation and assistance that demonstrates the cost-effectiveness of energy efficiency investments. For example, through the USDA agricultural extension program, the government provides technical assistance and seedlings to encourage landowners to plant forest stands. This is an application of the government production instrument. The "shadow of regulation" is nothing more than the threat to exercise coercive instruments from the middle and bottom of Figure 3 if industry does not voluntarily abate pollution. Thus, voluntary programs and informal regulation are best understood not as new and separate instruments, but as specific applications of the instruments described in Figures 2 to 4.

Hybrid Systems

The new framework also suggests that some schemes that are treated as separate instruments by studies in Table A2 are actually combinations of instruments from the coercive and enterprise modes. The most obvious of these is the deposit-refund system, which combines a tax on the use or removal of potentially polluting materials, such as bottles, motor oil, and hazardous materials, with a subsidy for their return and proper disposal. Similarly, the charge-subsidy system described by Pezzey combines a tax on a firm's emissions above a certain baseline with a subsidy for reduction below that baseline, where the tax and subsidy rates per unit of emissions are equal.[126] Roberts and Spence describe a similar system of subsidies and penalties, but combine that with a system of tradable permits to address the uncertainty that may hamper the use of price-based or quantity-based instruments individually.[127] In that system the subsidy and charge rates are not equal.

Some systems, parading under the banner of one instrument, are actually hybrids of other instruments. For example, in some cases that have been described as trading, the arrangement is actually a form of direct government production. In the case of the Tar-Pamlico point-nonpoint source trading program in North Carolina, point source polluters can acquire additional emissions allowances by trading for nonpoint source offsets.[128] However, the state government is the sole supplier of the nonpoint source offsets that create the addi-

126. *See* Pezzey, *Symmetry*, *supra* note 70, at 985-986.

127. *See* Roberts & Spence, *supra* note 84, at 194.

128. *See* Esther Bartfield, *Point-Nonpoint Source Trading: Looking Beyond Potential Cost Savings*, 23 ENVTL. L. 43, 80, 86-87 (1993).

tional allowances, and those allowances are sold at a fixed price.[129] Hence, the system is actually a tax on point source emissions above a given baseline with the tax earmarked for nonpoint source controls undertaken through government production.

IV. THE CONSTRAINED COST-MINIMIZATION PROBLEM

The new taxonomy of environmental policy instruments differentiates instruments on the basis of who bears the cost of pollution abatement and environmental damage (D-3) and who controls decisions about production of abatement services (D-2). However the government chooses to distribute costs, it must decide whether it will retain control over the production of emissions abatement through direct government production and command-and-control instruments, or, alternatively, whether it should allow private firms discretion with respect to how the emissions reductions are made. The decision is analogous to a private firm's "make-or-buy" decision about whether to produce goods and services directly or to contract with other firms for production. In the environmental instrument choice literature, which concentrates primarily on minimizing production costs, the decision is generally cast as a choice between incentive-based instruments and command-and-control regulation, with a strong bias toward the former.

The preceding discussion of evaluation criteria suggests that in choosing among the various instruments, an efficiency-seeking government minimizes the sum of three costs: production costs (PC), implementation costs (IC), and public finance costs (TX), subject to various constraints.[130] The discussion in this section will proceed as follows. First, it will discuss how production costs vary among instruments, drawing primarily on the environmental policy and transaction cost economics literatures. Second, it will examine implementation costs, drawing heavily on New Institutional Economics to explain the role of intermediate instruments in the interior of Figure 3. Third, it will employ the growing literature on public finance and instrument choice (also known in the environmental policy context as the "double dividend" literature) to explore the role of public finance impacts on the relative costs of various instruments. Finally, the section finishes with a brief consideration of the constraints on the optimization problem.

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129. *See id.*

130. *See* discussion *infra* Part II.B.

A. *Abatement Production Costs: Lessons from Environmental Economics*

Production costs represent the direct costs of pollution abatement—the capital, training, operation, maintenance and private management costs. Because the choice of instruments influences which technologies are chosen for emissions control and how well those technologies are implemented, production costs will vary among the instruments. While command-and-control regulation and government production rely upon the government's ability to identify cost-effective technological options for pollution abatement, the incentive-based instruments shift that responsibility to private-sector parties.[131] The consequence is that with incentive-based instruments, private parties will search for technologies and practices that are well suited to their specific applications and will adjust the level of control of pollutants to reflect the price signals of the market. In addition, stable incentive-based instruments induce dynamic cost-effectiveness by promoting technological innovation to minimize costs over the long run.[132]

The fact that incentive-based mechanisms tend to lower production costs relative to command-and-control or hierarchical mechanisms is recognized in both the environmental instrument choice literature[133] and the transaction cost/contracting literature.[134] However, the environmental policy literature seldom acknowledges that the relative advantage of the incentive-based instruments is situation-specific, dependent in part upon the lack of a clearly identifiable best technology or practice for a given application across all abaters. Where the range of technology options is wide, or the applications are varied, vesting discretion in private parties will yield the greatest ad-

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131. This assumes the incentive-based instruments are based on actual output or some reasonable proxy for output.

132. *See* Scott R. Milliman & Raymond Prince, *Firm Incentives to Promote Technological Change in Pollution Control*, 17 J. ENVTL. ECON. & MGMT. 247, 257 (1989); Marin, *supra* note 84, at 297.

133. *See, e.g.*, Fisher at al., *supra* note 28, at 413, 415; Robert Hahn & Robert Stavins, Trading in Greenhouse Permits: A Critical Examination of Design and Implementation Issues 17 (Mar. 18, 1993) (unpublished manuscript, on file with author) [hereinafter Hahn & Stavins, Trading in Greenhouse Permits]; HAHN, ENVIRONMENTAL POLICY DESIGN, *supra* note 3, at 12-13.

134. *See, e.g.*, WILLIAMSON, *supra* note 29, at 76 (stating that outside contracting lowers production costs ("maintains high powered incentives") relative to hierarchical mechanisms ("vertical integration")); O'LEARY ET AL., *supra* note 73, at 287 ("Policymakers often find that contracts and grants are a less expensive way to deliver goods and services than providing them through government agencies").

vantages. For example, Hahn and Stavins point out that in the case of air pollution, "the cost of controlling a unit of a given pollutant may vary by a factor of 100 or more among sources."[135] Conversely, if the technology of choice is easily identified and uniform across applications, the advantage of incentive-based instruments is not as great. Similarly, if the nature of the technology is such that there are not likely to be major cost-reducing innovations, then the relative advantages of incentive-based instruments are reduced.[136] However, the incentive-based instrument will virtually always lead to lower abatement costs than the hierarchical instruments. It is only the relative advantage that declines when there is a narrow range of technology options and applications.

B. *Implementation Costs: Lessons from New Institutional Economics*

If incentive-based instruments virtually always minimize the costs of producing abatement services, why would a cost minimizing government ever select the hierarchical approaches? Perhaps because the implementation costs of incentive-based instruments can, under certain circumstances, threaten to offset their production cost advantages. The transaction cost economics literature recognizes two categories of transaction costs: measurement costs and governance costs.[137] Measurement costs refer to the resources dedicated to moni-

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135. Hahn & Stavins, Trading in Greenhouse Permits, *supra* note 133, at 5.

136. Mendelsohn addresses an issue that is similar to heterogeneous cost functions across firms, that of heterogeneous damages due to spatial variations of the pollutants. *See* Robert Mendelsohn, *Regulating Heterogeneous Emissions*, 13 J. ENVTL. ECON. & MGMT. 301 (1986).

137. *See* WILLIAMSON, *supra* note 29, at 26-29 (describing transaction cost economics as having two branches: a measurement branch and a governance branch). This article employs the language and conceptual framework of Williamsonian transaction cost economics, as opposed to the different terminology used by North and others. *Compare id*. *with* DOUGLASS C. NORTH, STRUCTURE AND CHANGE IN ECONOMIC HISTORY 39 (1981) ("The resource costs devoted to compliance differ with alternative forms of organized economic activity. These compliance costs consist of the costs of measurement in alternative organizational forms and the costs of enforcing an agreement.") [hereinafter NORTH, STRUCTURE & CHANGE], *and* DOUGLASS C. NORTH, INSTITUTIONS, INSTITUTIONAL CHANGE AND ECONOMIC PERFORMANCE 27 (1990) ("The costliness of information is the key to the costs of transacting, which consists of measuring the valuable attributes of what is being exchanged and the costs of protecting rights and policing and enforcing agreements. These measurement and enforcement costs are the sources of social, political, and economic institutions.") [hereinafter NORTH, INSTITUTIONAL CHANGE], *and* North, *Institutional Economics*, *supra* note 23, at 5 ("[T]ransaction costs are only two things: (1) the costs of measuring the dimensions of whatever it is that is being produced or exchanged and (2) the costs of enforcement."). North has referred to his brand of transaction cost economics as the "University of Washington approach" when distinguishing his approach from that of Williamson. NORTH, INSTITUTIONAL CHANGE, *supra*, at 27 n.1.

toring and evaluating performance.[138] These costs have been frequently addressed in the environmental economics literature.[139] Governance costs are the costs of establishing and maintaining mechanisms to resolve conflict and adapt to changes.[140] These are seldom mentioned in the environmental policy literature. To complete the list of implementation costs, it is necessary to include the costs of initially designing the program, gathering the needed information, and negotiating program parameters with affected parties.

One conclusion of the transaction cost literature is that developing mechanisms under which control of production decisions is shared by parties to the transaction is often more efficient than vesting all control in only one of the parties.[141] These types of discretion-sharing arrangements are frequently observed when the government acts in its enterprise mode.[142] After discussing measurement and governance costs, this section explores ways in which intermediate, discretion-sharing mechanisms might be also employed in the coercive mode.

1. Measurement Costs

The environmental instrument choice literature has largely concentrated its treatment of measurement costs on issues related to monitoring known sources of emissions and relating those sources to environmental impacts or ambient pollution concentrations.[143] Generally, where private parties have significant discretion with respect to

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138. *See* WILLIAMSON, *supra* note 29, at 29.

139. The differential cost of monitoring is an important factor driving choices among the various approaches. Blackman and Harrington observe that the information requirements associated with implementing incentive-based approaches based on emissions levels suggest that some developing countries may be better advised to use indirect approaches that sacrifice some ostensible efficiency gains in favor of lower monitoring costs. *See* BLACKMAN & HARRINGTON, *supra* note 45, at 24. For more on monitoring and enforcement of environmental regulations, see Clifford S. Russell, *Monitoring and Enforcement*, *in* PUBLIC POLICIES FOR ENVIRONMENTAL PROTECTION 243, 262-70 (Paul R. Portney ed., 1990); CLIFFORD S. RUSSELL ET AL., ENFORCING POLLUTION CONTROL LAWS 29-44, 52-62, 82-86 (1986).

140. See WILLIAMSON, *supra* note 29, at 18-32.

141. *See id*. at 129 ("The study of transaction cost economizing entails an examination of alternative ways by which to govern exchange interfaces. Firms, markets, and *mixed modes* are recognized as alternative instruments of governance." (emphasis added)).

142. *See* David E.M. Sappington & Joseph E. Stiglitz, *Privitization, Information and Incentives*, 6 J. POL'Y ANALYSIS & MGMT. 567, 579-80 (1986).

143. *See, e.g.*, Marc J. Roberts & Susan O. Farrell, *The Political Economy of Implementation: The Clean Air Act and Stationary Sources*, *in* APPROACHES TO CONTROLLING AIR POLLUTION 152, 163-174 (Ann F. Friedlaender ed., 1978); *see generally* RUSSELL ET AL., *supra* note 139; Anastasios Xepapadeas, *Enviromental Policy Under Imperfect Information: Incentives and Moral Hazard*, 20 J. ENVTL. ECON. & MGMT. 113 (1991); Pinaki Bose, *Anticipatory Compliance and Effective Regulatory Activity*, 15 INT'L REV. L. & ECON. 151 (1995).

how to abate emissions, accurate quantitative assessments of performance are particularly important to the government. That is, the amount of information the government needs to monitor performance is often positively related to the level of discretion the government vests in the private party. In some cases, such as controlling carbon dioxide from fossil fuel combustion, monitoring inputs (*i.e.*, fuel consumption) provides an inexpensive and acceptably accurate proxy for performance.[144] In many cases, however, there simply are no reliable alternatives to direct measurement of the pollutant.[145] In cases where the costs of monitoring quantities of output are high relative to the costs of observing practices, the government may choose to limit the discretion granted to private parties, thereby raising production costs but containing measurement costs. To the extent that increased discretion for private parties decreases production costs, a tradeoff arises between production and measurement costs.

2. Governance Costs

If measurement costs deal with the government's relation to the physical changes it seeks, then governance costs are associated with the government's relation with the parties whose behavior it seeks to change. Governance costs refer to those costs associated with the mechanisms that are established to resolve conflicts, provide necessary guarantees, and adapt to changes.

The instrument choice literature, concentrating on the coercive mode, has largely examined the transaction costs associated with monitoring and enforcement.[146] The emphasis on litigation-based resolution of conflict, however, means that these environmental policy studies have not adequately addressed the tension among the welfare-seeking government's goals of (1) encouraging private sector investment in the specialized assets that most cost-effectively abate pollution, (2) providing the private sector the flexibility and discretion it needs to develop specialized, high-efficiency technologies, and (3) providing the government the flexibility to adapt the program in response to changes in knowledge, technology, states of the world, and preferences. The tension among these goals is, however, addressed in

144. *See* U.S. DOE, REPORTING METHODOLOGIES, *supra* note 102, at 1.25; s*ee generally* Helfand, *supra* note 104.

145. Sulfur dioxide trading, for example, arguably had to await the availability of continuous emissions monitoring (CEM) at reasonable cost. *See* Nancy Kete, The Politics of Markets: The Acid Rain Control Policy in the 1990 Clean Air Act Amendments 242-43 (1992) (unpublished Ph.D. dissertation, Johns Hopkins University) (on file with author).

146. *See* discussion *supra* Part IV.B.1.

the treatment of governance costs by the New Institutional Economics literature.[147]

Transaction costs become important only when the parties to a

TABLE 2: ASSUMPTIONS UNDERLYING TRANSACTION COST ECONOMICS

1. ASSUMPTIONS ABOUT THE PARTIES:
- a. Bounded Rationality
- b. Opportunistic Behavior

2. ASSUMPTIONS ABOUT THE TRANSACTION:
- a. Asset Specificity
- b. Uncertainty

transaction[148] and the transaction itself both exhibit certain characteristics (see Table 2).[149] The behavioral assumptions about parties to a transaction that motivate the analysis of transaction costs are *bounded rationality* and *opportunism*.[150] Bounded rationality refers to the cognitive limits of the parties—the mind as a scarce resource.[151] If parties could identify and negotiate through every possible contingency to a transaction—a possibility assumed by classical contract doctrine,[152] then the issues addressed by transaction cost economics would disappear.[153] However, given bounded rationality, parties involved in a transaction cannot conceive of all possible contingencies

147. *See* Sappington & Stiglitz, *supra* note 142, at 576-80.

148. In the discussion that follows, the term "transaction" is used in its broadest sense—namely, to describe a transaction between parties. Not all "transactions" occur between entirely willing parties of equal power, and herein, it will be assumed only that dealings take place between parties who each exercise some influence over how the transaction is executed and its goal met. Thus, an arrangement made between a regulatory government agency and a polluting firm fits squarely within the definition established here for a "transaction."

149. *See* WILLIAMSON, *supra* note 29, at 44-61.

150. *See id*. at 45-49; Oliver E. Williamson, *Economic Institutions and Development: A View from the Bottom*, *in* A NOT-SO-DISMAL SCIENCE: A BROADER VIEW OF ECONOMIES AND SOCIETIES 92, 96 (Mancur Olsen & Satu Kähkönen eds., 2000) [hereinafter Williamson, *A View from the Bottom*].

151. *See* WILLIAMSON, *supra* note 29, at 45, 46 n.6.

152. *See id*. at 69.

153. *See id*. at 50 ("Of special importance is that transaction cost economics pairs a semi-strong form of cognitive competence (bounded rationality) with a strong motivational assumption (opportunism). Without *both*, the major problems of economic organization [addressed by transaction cost economics] would vanish or be vastly transformed.").

and address them in a comprehensive agreement.[154] The more complex is the transaction, the more important is the role of bounded rationality. This assumption does not imply that parties are irrational or nonrational. Rather they intend to act with rationality but are limited in cognitive capacity.[155] Thus, bounded rationality does not question parties' rationality, but rather their omniscience.

The second behavioral assumption relates to what Williamson refers to as the parties' "self-interest orientation."[156] The strongest form of self-interest, opportunism (defined as self-interest coupled with guile), underlies transaction cost analysis.[157] Opportunism goes beyond simple self-interest seeking, which is the assumption that parties will attempt to gather the wealth and advantages that their skills and assets afford them but will always act openly and honestly.[158] Opportunism suggests that parties will also "mislead, distort, disguise, obfuscate, or otherwise confuse"[159] where it is to their advantage to do so.[160]

The choice of optimal governance structure also depends upon the nature of the transaction itself. Two important characteristics of transactions are the degree of *asset specificity* and the level of *uncertainty*.[161] Asset specificity refers to the extent to which the resources used to produce the object of the transaction are idiosyncratic to the transaction.[162] In Williamson's words,

[A]sset specificity refers to durable investments that are under-

154. *See id*. at 46 ("Comprehensive contracting is not a realistic organizational alternative when provision for bounded rationality is made.").

155. *See id.* at 45 ("[A]ctors are assumed to be '*intendedly* rational, but only *limitedly* so.'" (quoting Herbert Simon, *Human Nature in Politics: The Dialogue of Psychology with Political Science*, 79 AM. POL. SCI. REV. 293, 303 (1985))); Williamson, *A View from the Bottom*, *supra* note 150, at 96 (quoting same passage).

156. WILLIAMSON, *supra* note 29, at 47.

157. *See id*. ("By opportunism I mean self-interest seeking with guile. This includes but is scarcely limited to more blatant forms, such as lying, stealing, and cheating. Opportunism more often involves subtle forms of deceit."). *See also* POSNER, *supra* note 69, at 103 (describing opportunism as "trying to take advantage of the vulnerabilities created by the sequential character of contractual performance."); NORTH, STRUCTURE & CHANGE, *supra* note 137, at 36 (describing opportunism as "the ability of one party to an exchange to benefit at the expense of the other party by violating the agreement in his or her post-contractual behavior").

158. *See* WILLIAMSON, *supra* note 29, at 49.

159. *Id*. at 47.

160. Adverse selection and moral hazard are two specific manifestations of the presence of opportunistic behavior. *See id*.

161. *See id.* at 52, 56.

162. Williamson identifies four categories of asset specificity: site specificity, physical asset specificity, human asset specificity, and dedicated assets. *See id.* at 55.

> taken in support of particular transactions, the opportunity cost of which investments is much lower in best alternative uses or by alternative users should the original transaction be prematurely terminated . . . .[163]

While asset specificity is the most important characteristic of the transaction for this type of analysis, uncertainty is also important.[164] When a transaction involves uncertainty and the parties are subject to bounded rationality, adaptability of the transaction is crucial.[165] If there is no uncertainty in the future, or uncertainty exists but all possible outcomes can be anticipated, a detailed agreement or set of rules could cover all contingencies.[166] Or, if there is no opportunism, a general rule stating how sharing arrangements for joint gains from new opportunities could lead to efficient actions. However, the combination of bounded rationality and opportunism in the presence of uncertainty means that it is unlikely that parties will easily adapt to, and exploit opportunities arising from unexpected changes in the world.

Uncertainty contributes a central explanation for the imprecise nature of the transaction agreement. Williamson recognizes both state-contingent uncertainty and behavioral uncertainty.[167] While the former arises from changes in the state of the world, the latter relates to either the limits of communication (non-strategic) or the potential for parties to a transaction to use information to their advantage (strategic).[168] Williamson is primarily concerned with uncertainty arising from strategic behavior.[169] For transaction cost analysis to be of interest, it is not necessary that parties actually behave strategically, but only that they might.[170] Note, however, that behavioral uncertainty is only of interest in the case where there is also the potential for exogenous disturbances requiring adaptation, *i.e.*, state-contingent uncertainty.[171]

The factors that are key to the analysis of transaction costs—bounded rationality and opportunism on the part of the parties and asset specificity and uncertainty in the transaction—are equally

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163. *Id*.
164. *See id.* at 56-57.
165. *See id*. at 57.
166. *See id*. at 59.
167. *See id*. at 57-58.
168. *See id*.
169. *See id.* at 58.
170. *See id* at 58-59.
171. *See id.* at 59.

relevant to pollution abatement programs.[172] If the regulator and regulated industries fully shared information, including information regarding uncertainty about the knowledge, technology, state of the world and regulatory preferences, they could ascertain efficient investments in emissions-reducing technology and agree to share risks in a scheme to maximize net social benefits. This arrangement would not only lead to the choice of the most cost-effective technologies given current emission targets, but also would provide private parties appropriate incentives to modify investment strategies to account for the potential for efficiency-enhancing changes in targets.

However, there are two problems with this scenario. First, of course, it assumes a level of information exchange inconsistent with bounded rationality. Second, the scenario ignores the role of opportunistic behavior. The fact that industry withholds information in the regulatory process is well documented.[173] More pernicious, perhaps, is the potential for government opportunistic behavior once private firms have invested in specialized assets. Private firms can and should incorporate legitimate regulatory uncertainty in their investment decisions. This lowers the cost of efficiency-enhancing adaptive changes in the goals of government programs. However, social welfare decreases when investors alter their investments for fear of opportunistic behavior by the regulator. Changes in the direction of the regulation should be based on reasonably well-defined economic and scientific criteria, not government opportunism. In EPA's emission trading program, for example, fear of expropriation likely impeded trading and, by implication, cost-effective investment.[174] Private firms may have recognized that they were revealing new cost information when they undertook inter-firm trades of emissions credits.[175] This invited confiscation by state regulators who were required to meet regional air quality standards.[176] The ambiguity about the treatment of

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172. *See* Williamson, *A View from the Bottom*, *supra* note 150, at 96 (emphasis added):

> The two behavioral assumptions out of which transaction cost economics works are (1) bounded rationality (on which account all complex contracts are unavoidably incomplete) and (2) opportunism (on which account mere promise unsupported by credible commitments poses contractual hazards). These behavioral assumptions apply systematically to *all* forms of organization, which is to say that economic actors in the private sector and public sector are described as being alike.

173. *See*, *e.g.*, Dennis A. Yao, *Strategic Responses to Automobile Emissions Control: A Game-Theoretic Analysis*, 15 J. ENVTL. ECON. & MGMT. 419, 420-421 (1988).

174. *See* Hahn & Hester, *supra* note 108, at 378-79 (referring to the fear of confiscation as a transaction cost).

175. *See id.* at 379.

176. *Id*.

tradable allowances in the regulatory process simply aggravated investor fears.[177]

How can the government address the firms' concerns about opportunistic behavior that might prevent them from investing in cost-effective, specialized pollution abatement activities? First, the government could seek mechanisms to make credible commitments against opportunistic behavior.[178] But effective commitments can be costly and at times infeasible.[179] Alternatively, the government may adopt one of the hierarchical modes on the right-hand side of Figure 2 that do not provide private firms with discretion over the investment decisions. In the context of private transactions involving both idiosyncratic (specialized) investments and uncertainty, Williamson notes the advantages of hierarchical arrangements:

> Incentives for trading weaken as transactions become progressively more idiosyncratic . . . . The choice of mode then turns entirely on which mode has superior adaptive properties . . . . The advantage of vertical integration is that adaptations can be made in a sequential way without the need to consult, complete, or revise interfirm agreements.[180]

Just as private transactions may rely on hierarchical arrangements to provide adaptability in the presence of uncertainty, the government may want to employ government production or direct regulation if it anticipates the need to adapt its environmental programs to changes in information or changes in goals. This adaptability comes at a price, however. The hierarchical governance approach sacrifices the "high-powered incentives" present in the other governance structures to gain the adaptability of internal control.

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177. In a morphologically similar setting related to command-and-control regulation of automobiles, Yao observes that when EPA announces a new standard to take effect at a future date, industry may under-invest in developing new technology, hoping to convince the government agency that the regulation is more costly than expected. *See* Yao, *supra* note 173, at 433-435. Yao observes in this setting that "[i]f EPA could be persuasive in demonstrating its inability to learn . . . society would benefit." *Id*. at 433.

178. *See* Sappington & Stiglitz, *supra* note 142, at 574; WILLIAMSON, *supra* note 29, at 168.

179. *See* discussion *infra* Part IV.D.3 (concerning prohibitions on legislative entrenchment and alternative mechanisms for credible commitment). On difficulties related to government precommitment to transition relief in the case of changes in the tax law, see also Logue, *supra* note 75, at 1153-63.

180. WILLIAMSON, *supra* note 29, at 78. When Williamson refers to "organizing mode," he is distinguishing between "bilateral structures where the autonomy of the parties is maintained and unified structures, where the transaction is removed from the market and organized with . . . an authority relation (vertical integration)." *Id.* at 75-76. Hence, Williamson differentiates between decentralized discretion and hierarchical control. Do not confuse this with the way the term "mode" is used in this article—namely, as a means to distinguish between the "enterprise mode" and the "coercive mode."

The choice of governance structure may also have a dynamic element if the level of uncertainty can be reduced through experience. As Williamson notes,

> To the extent that uncertainty decreases as an industry matures, which is the usual case, the benefits that accrue to internal organization (vertical integration) presumably decline. Accordingly, greater reliance on market procurement is commonly feasible for transactions of recurrent trading in mature industries.[181]

Similarly, if the government pursues a new environmental strategy, such as carbon sequestration in forests,[182] it may be that in the early stages of implementation, uncertainty and the inability to provide credible commitments against opportunistic behavior will favor hierarchical arrangements. With experience and decreased uncertainty, it may be possible to shift toward the incentive-based instruments.

Sappington and Stiglitz argue that the most important difference between private and public provision of goods and services is the transaction costs associated with intervention by the government in the production activities.[183] Unlike private production, public provision leaves the government with residual rights to intervene.[184] In situations of high uncertainty this is an important option.[185]

In choosing between public and private control, it is important to consider both the expected benefits and costs of intervention, and the probability that intervention will occur. Two important elements of this calculation are the complexity of the task under consideration and the need for rapid adaptation to unforeseen contingencies. When the task is particularly novel and complex, unforeseen contingencies are more likely to arise. And if rapid adaptation to these events is

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181. *Id*. at 80.

182. Carbon sequestration refers to the strategy of reducing atmospheric carbon dioxide levels by adopting programs to increase biomass cover, particularly forests. *See generally* ROBERT J. MOULTON & KENNETH R. RICHARDS, FOREST SERV., U.S. DEP'T OF AGRIC., GEN. TECHNICAL REP. NO. WO-58, COSTS OF SEQUESTERING CARBON THROUGH TREE PLANTING AND FOREST MANAGEMENT IN THE UNITED STATES (1990).

183. *See* Sappington & Stiglitz, *supra* note 142, at 568, 580-81.

184. *See id*. at 568.

185. *Cf.* O'LEARY ET AL., *supra* note 73, at 288-89 (suggesting that government may adopt a contract or privatization approach to *enhance* flexibility because "[i]n some circumstances, starting up new programs is easier for a contractor or grantee than for a government bureaucracy encumbered by mandated standard operating procedures, demanding interest groups, and bureaucratic red tape.") The Superfund program, for example, was established with heavy reliance on contractors, because Congress and EPA assumed contracting would enable EPA to get the program started faster than if the agency had to first develop internal structure and expertise. *See* OTA, ASSESSING SUPERFUND, *supra* note 74, at 1-4.

crucial (as in the case of national defense, for example), ease of intervention to redirect activities and limit the duration of renegotiation may be relatively important; under such circumstances, government provision is more likely to be the preferred method.

Neither De Alessi nor Sappington and Stiglitz consider the use of government enterprise as a tool to control opportunistic behavior by a government,[186] although this may be as important as the government's ease of intervention.

The normative conclusion based on the transaction cost economics literature is that allocating more discretion to private parties in the environmental protection process should be favored when innovation is important, the goal is well defined, specialized investments are minimal, and outputs can be measured or inputs are good proxies for output. Government production should be favored when asset specificity is high, the government is unable to credibly commit not to behave opportunistically, uncertainty is high, goals are ill-defined or changeable, and measurement is particularly costly.

3. Intermediate Instruments

As demonstrated by the lists of tools in Table A2, the policy literature commonly depicts the instrument choice problem as discrete—*i.e.*, "choose this or that." New Institutional Economics, however, does not necessarily lead to a choice of one or the other—pure output-based contract or pure internal production.[187] The transaction cost economics literature recognizes the existence of a range of instruments between classical contracts/subsidies and pure government production. In the interior of that range the government and private firms share control over production decisions (Figure 3). Several structures can be built into a contract or subsidy to create hierarchical elements while avoiding the need for the government to undertake the production activity directly. The elements include:

> (a) command structures and authority systems, (b) incentive systems, supporting authority systems and also guiding the use of a contractor's discretion by a structure of differential rewards partially isolated from the market, (c) standard operating procedures, which describe routines that involve actions by both contractors

186. *See* De Alessi, *supra* note 30; Sappington & Stiglitz, *supra* note 142. De Alessi does discuss the use of government enterprise as a means of escaping problems related to private contractors appropriating assets. He states that "[a]s the cost of reducing the range for such opportunistic behavior increases, more of these activities will be vertically integrated within government." De Alessi, *supra* note 30, at 202.

187. *See* WILLIAMSON, *supra* note 29, at 129.

> and clients, (d) dispute resolution procedures, partially isolated from the court system and the market, and (e) pricing of variations in performance partially isolated from the market, including especially pricing based on contractor costs.[188]

Authority systems primarily establish the means for legitimating directions for changes and for clarifying the distribution of costs and risks associated with the changes.[189] In the extreme, however, authority systems become approval systems, slipping into supervisory/monitoring functions. When government supervision of contract execution becomes too cumbersome, there is the serious possibility of losing the "high-powered" incentives that constitute the primary advantage of contract or subsidy arrangements with private parties.[190] "Aside from the extra work involved in creating a document for approval for each intermediate decision, such a fine net of approvals strains out any discretion or originality that the contractors' engineers might have been afflicted with."[191]

While the authority system recognizes that contractual changes may be required, the incentive systems and standard operating procedures built into contracts serve to clarify how performance will be evaluated and the specific expectations of the parties. The dispute resolution procedure, often involving an arbitrator, allows performance to continue even as disagreements are settled. Thus, performance can be more rapidly redirected. Finally, the pricing of variations (change orders in the language of construction contracting) clarifies for the client the cost of changing specifications, allowing efficient adaptation and reducing the potential for conflict.

These mechanisms allow contractual adaptation to uncertainty. They develop governance mechanisms that lie somewhere between classical contracts and pure hierarchy. For example, Stinchcombe estimates that in large construction projects, typically 20 percent of the work is done under hierarchical change orders.[192] Eighty percent of the work done in R&D contracts for weapons is done in a hierarchical mode.[193]

These specialized governance mechanisms are costly, however, and may be less attractive than either incentive-based contracts,

188. Stinchcombe, *supra* note 91, at 156.
189. *See id*. at 156-157.
190. WILLIAMSON, *supra* note 29, at 140.
191. Stinchcombe, *supra* note 91, at 157-158.
192. *See id*. at 167.
193. *See id*.

which are unable to induce investment in highly specialized assets, or government production, which sacrifices desirable incentive characteristics. The art of choosing and designing a governance mechanism for transactions is to recognize when the production cost benefits associated with incentive-based governance are so seriously eroded that the considerable costs of developing nonstandard mechanisms are no longer justified. The goal is to find the arrangement that minimizes the sum of production and implementation costs. These intermediate mechanisms can be designed to overcome potential difficulties related to measurement, asset specificity, and uncertainty/adaptability, but their benefits must be weighed against their considerable costs.[194]

The same opportunities and same caveats can be applied to the coercive instruments, such as taxes, marketable allowances, and command-and-control regulation. In some applications, performance-based standards provide private firms with more discretion (lower production costs) than technology-based command-and-control standards, without introducing unreasonable monitoring, measurement and governance (implementation) costs. Arguably, requirements of government approval of individual trades in the case of marketable allowances for air emissions and nonpoint source water pollution programs have been intended to reduce monitoring and measurement costs while retaining the attractive attributes of an incentive-based system. The results may have been perverse, however, nearly eliminating the incentive to trade while introducing greater monitoring costs.

C. *Revenue-Raising Costs: Lessons from Public Economics*

The previous section explored the tradeoff between production costs and implementation costs in environmental policy instrument choice. For many standard applications, incentive-based instruments minimize both types of costs. However, for some more complex applications, such as carbon sequestration and nonpoint source pollu-

194. A related issue arises when the government is implementing a complex program such as Superfund. The government has attempted to contract out the actual testing and physical cleanup work while retaining many of the decisions that require government authority or value judgements. *See* OTA, ASSESSING SUPERFUND, *supra* note 74, at 4, 5. However, these two roles cannot be clearly delineated in a highly technical, complex, and socially volatile program. The matter is made more complex by the high attrition rate among government employees that manage the contractors. The salary differential between government managers and private contractors induces civil servants with even modest experience to migrate to the private sector. *See id*. at 6. Thus, there is a "lack of development of internal EPA expertise, which results in poor contract management and oversight." *Id*.

tion abatement, the decision is not as clear. While production costs may be minimized by an incentive-based system, the implementation costs might not. This section examines the third cost component listed in the cost-minimization function—public finance costs.

Taxes on labor, capital, consumption, and production drive a wedge between the market price of resources and the marginal cost of their production.[195] This tends to distort production and consumption decisions.[196] The extent of the distortion depends upon the precise nature of the tax and the characteristics of consumer preferences.[197] Understanding the general equilibrium effects of distortionary taxes is an important element of the study of public economics.[198]

Imposing a tax on pollutants will reduce the level of pollution, assuming that the demand for emissions is not perfectly inelastic.[199] It has been further suggested that the efficiency of the tax system could be improved by shifting part of the tax burden from productive factors, such as labor and capital, toward "public bads" such as pollution.[200] While shifting taxes toward environmental charges may be good public policy, it is unlikely to reduce distortions from public revenue raising.[201] This is because the burden of an environmental tax ultimately rests on labor, even if it is imposed via a tax on pollution or polluting goods. Imposing the tax indirectly, via an emissions charge, actually introduces additional distortions into the labor-leisure tradeoff decision and reduces social welfare.[202] This is not to say that envi-

195. *See, e.g.*, STIGLITZ, *supra* note 115, at 536 (labor), 649 (capital), 531-32 (consumption and production).

196. *See id*. at 532.

197. *See id*. at 531-32.

198. *See* Robert A. Musgrave, *A Brief History of Fiscal Doctrine*, *in* 1 HANDBOOK OF PUBLIC ECONOMICS 1, 42 (Alan J. Auerbach & Martin Feldstein eds., 1985).

199. *See* STIGLITZ, *supra* note 115, at 224-27.

200. *See* ROBERT REPETTO ET AL., GREEN FEES: HOW A TAX SHIFT CAN WORK FOR THE ENVIRONMENT AND THE ECONOMY 1-12 (1992). For an early discussion of the use of effluent charges, see Allen V. Kneese & Blair T. Bower, MANAGING WATER QUALITY: ECONOMICS, TECHNOLOGY, INSTITUTIONS 237, 245-53 (1968).

201. *See* A. Lans Bovenberg & Ruud A. de Mooij, *Environmental Levies and Distortionary Taxation*, 94 AM. ECON. REV. 1085, 1085 (1994) ("[E]nvironmental taxes typically exacerbate, rather than alleviate, preexisting tax distortions—even if revenues are employed to cut preexisting distortionary taxes."); LAWRENCE H. GOULDER, ENVIRONMENTAL TAXATION AND THE "DOUBLE DIVIDEND:" A READER'S GUIDE 31 (Nat'l Bureau of Econ. Res. Working Paper No. 4896, 1994); A. Lans Bovenberg & Lawrence H. Goulder, *Optimal Environmental Taxation in the Presence of Other Taxes: General Equilibrium Analyses*, 86 AM. ECON. REV. 985, 994-95 (1996) [hereinafter Bovenberg & Goulder, *Optional Environmental Taxation*].

202. For a complete demonstration of how distortions are introduced into the labor-leisure tradeoff by environmental taxes and how social welfare is reduced, see Bovenberg & de Mooij, *supra* note 201, at 1087.

ronmental taxes are poor public policy. Rather, if taxes improve social welfare, it will likely be due to the value of the improved environmental services, despite their impact on the public revenue-raising system.

That said, if public policy mandates pollution abatement, how should the requirement be implemented? To answer this, it is important to recognize that the distorting effect of the pollution reduction on consumer demand and labor supply may be felt regardless of whether the chosen instrument raises revenue or not. The question then shifts to one of comparing instruments for both distortionary effects on consumer demand and the potential to raise revenue and thereby offset other distortionary taxes.

Terkla examined the "efficiency value" of taxes versus regulations as environmental policy instruments.[203] Because taxes on labor, capital, consumption, and production all have distortionary effects on prices, the act of government revenue raising has a significant social cost.[204] The extent of the distortion depends upon the effective tax wedge and the demand and supply elasticities of the taxed commodity (*e.g.*, labor or capital).[205] The range of estimates of the marginal welfare cost of taxes runs from 10 to 300 percent,[206] with the most common estimates in the 15 to 50 percent range.[207] The high marginal cost of public funds has serious implications for the choice of environmental policy instruments. For example, drawing on estimates available at the time of his study, Terkla found that in the United States the marginal social cost of raising another dollar of revenue via the labor income tax was 0.16 to 0.66 dollars.[208] Thus, the marginal social cost of government expenditures is 1.16 to 1.66 dollars per dollar spent. The marginal cost of raising revenue with a tax on corporate income was estimated at 0.56 dollars per dollar of revenue.[209] Terkla found that the relative cost of reducing particulate and sulfur dioxide

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203. *See* David Terkla, *The Efficiency Value of Effluent Tax Revenues*, 11 J. ENVTL. ECON. & MGMT. 107, 108 (1984).

204. *See* STIGLITZ, *supra* note 115, at 531-32, 536, 649.

205. *See id*. at 531-32.

206. *See* Edgar K. Browning, *On the Marginal Welfare Cost of Taxation*, 77 AM. ECON. REV. 11, 21 (1987).

207. *See* Charles L. Ballard et al., *General Equilibrium Computations of the Marginal Welfare Costs of Taxes in the United States*, 75 AM. ECON. REV. 128, 128 (1985); Charles Stuart, *Welfare Costs Per Dollar of Additional Tax Revenue in the United States*, 74 AM. ECON. REV. 352, 358-60 (1984).

208. *See* Terkla, *supra* note 203, at 114.

209. *See id*.

air pollutants in the United State via regulation rather than taxes bore an additional social cost of up to $4.87 billion per year.[210]

Parry developed a general equilibrium analysis suggesting that while regulation has all of the undesirable "tax interaction effects" of an environmental tax, it provides none of the desirable "revenue-recycling effects."[211] Thus, from a public finance point of view alone, if emissions abatement is imposed, it should be done through one of the revenue-raising mechanisms (taxes or auctioned allowances). [212] Bovenberg and Goulder developed a more formal general equilibrium model that incorporated both capital and labor to demonstrate that the value of the revenue-raising contribution of an environmental tax depends upon the extent to which there are taxes that are even more distortionary than the labor tax.[213]

The new instrument choice framework (Figure 3 and 4) suggests that the existing general equilibrium models can be usefully expanded to analyze instruments that involve different types of government spending. Starting from a framework similar to that described in Figure 3, Richards examined the relative public finance impacts of taxes (or auctioned marketable allowances), quotas, and subsidies in the context of an analytical general equilibrium model similar to that of Bovenberg and de Mooij.[214] The study asked a somewhat different, and arguably more policy-relevant, question than previous studies. Rather than compare welfare before and after an environmental tax, Richards took environmental regulation, in the form of a quota on a polluting good, as given.[215] The study then addressed two questions.

The first question was whether in the presence of a preexisting

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210. It would be interesting to know what percentage of total costs under the regulatory regime could be recouped by shifting to a tax approach. Unfortunately, Terkla only provides absolute and not relative potential cost savings. *See id*. at 115.

211. *See* Ian W.H. Parry & Roberton C. Williams III, *A Second Best Evaluation of Eight Policy Instruments to Reduce Carbon Emissions*, 21 RESOURCE & ENERGY ECONOMICS 347, 350 (1999).

212. *See* Kenneth Richards, Rethinking Environmental Instrument Choice 40 (unpublished manuscript, on file with author) [hereinafter Richards, Rethinking Instrument Choice].

213. *See* A. Lans Bovenberg & Lawrence H. Goulder, *Costs of Environmentally Motivated Taxes in the Presence of Other Taxes: General Equilibrium Analyses* 50 NAT'L TAX J. 59, 64 (1997).

214. *Compare* Richards, Rethinking Instrument Choice, *supra* note 212, *and* Kenneth Richards, Integrating Science, Economics and Law into Policy: The Case of Carbon Sequestration in Climate Change Policy 203-21 (1997) (unpublished Ph.D. dissertation, Univ. of Pennsylvania) (on file with author)[hereinafter Richards, Integrating Science], *with* Bovenberg & de Mooij, *supra* note 201.

215. *See* Richards, Rethinking Instrument Choice, *supra* note 212, at 31; Richards, Integrating Science, *supra* note 214, at 206.

quota, imposing a tax on the polluting good unambiguously improves welfare when revenues are recycled to decrease the labor tax.[216] The answer is yes; imposing a tax on the polluting good up to the point where the quota constraint is no longer binding will improve welfare.[217] This is because using the tax on the polluting good replaces a distortionary labor tax with a nondistortionary pollution tax.[218]

The second question was whether, given that the quota is going to be tightened, an abatement subsidy would unambiguously lower welfare relative to simply tightening the quota.[219] Again, the answer is yes, because providing the subsidy, which does nothing to lessen the economic impact of the tightening regulation, requires the government to raise additional revenue, increasing the distortionary effect of the labor tax.[220]

Three primary points emerge from this brief discussion. First, in general the public finance impacts of environmental taxes will be more positive than quotas that achieve the same result.[221] Similarly, the public finance impacts of either taxes or quotas will be more positive than environmental subsidies.[222] Second, the costs of environmental policies, such as tightening sulfur dioxide emissions or increasing carbon sinks, cannot be meaningfully analyzed without specifying which policy instruments will be used to implement the policies. For example, a bottom-up analysis of a carbon sequestration program is likely to understate the costs of carbon sinks relative to

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216. *See* Richards, Integrating Science, *supra* note 214, at 213.

217. This is the same as the finding in Terkla. *See* Terkla, *supra* note 203, at 115.

218. Because there is an existing binding quota on the polluting good, adding a tax does not change production and consumption decisions. Therefore, applying a tax to the polluting good is akin to a lump-sum tax. *See* Ian Parry, *Reducing Carbon Emissions: Interactions with the Tax System Raise the Cost*, RESOURCES (Resources for the Future), Summer 1997, at 9, 10-11 (comparing the relative welfare effects of taxes and quotas in the presence of preexisting distortionary taxes); Goulder et al., *supra* note 85, at 338 (comparing the public welfare effects of taxes, quotas, performance standards, and technology standards in a second-best setting).

219. See Richards, Rethinking Instrument Choice, *supra* note 212, at 39-40.

220. For further discussion of the public finance effects of environmental subsidies, see DON FULLERTON & ANN WOLVERTON, THE CASE FOR A TWO-PART INSTRUMENT: PRESUMPTIVE TAX AND ENVIRONMENTAL SUBSIDY (Nat'l Bureau of Econ. Res. Working Paper No. 5993, 1997); DON FULLERTON & GILBERT METCALF, ENVIRONMENTAL CONTROLS, SCARCITY RENTS, AND PRE-EXISTING DISTORTIONS (Nat'l Bureau of Econ. Res. Working Paper No. 6091, 1997); Ian W.H. Parry, *A Second-Best Analysis of Environmental Subsidies*, 5 INT'L TAX & PUB. FIN. 153 (1998). Interestingly, no environmental policy studies have yet looked at the public finance implications of using government production instruments relative to the alternatives.

221. *See* Richards, Rethinking Instrument Choice, *supra* note 212, at 214-15.

222. *See id*. at 218.

energy emissions reductions if it does not account for the fact that emissions can be controlled with taxes or quotas but sinks will probably require subsidies or government production.

Third, it is unlikely that the trading ratios in hybrid systems that use multiple instruments (*e.g.*, deposit-refund systems, subsidy-charge systems, auctioned marketable allowances with offsets, the Tar-Pamlico point-nonpoint source "trading" program) should be one-to-one. Malik *et al*. discuss several reasons that a point-nonpoint source trading program might require more than one unit of nonpoint source reductions in exchange for an increase of one unit of point source emissions allowances.[223] These include the greater administration costs and the greater uncertainty associated with measurement of nonpoint source emissions.[224] The current discussion suggests that the differential public finance impacts may serve to complicate further the derivation of a trading ratio where different instruments are used.

D. *Legal Constraints*

Three types of legal constraints that affect instrument choice are addressed below. This section does not give an exhaustive analysis of how legal constraints limit the government's access to potentially efficient environmental policy tools, but rather simply highlights the issue as an important consideration in instrument choice analysis.[225] The clear message, however, is that the most efficient instruments as evaluated on the basis of production, implementation, and public finance costs may not lie in the feasible set.

1. Regulatory Takings

Where transaction costs are high because of asset specificity, uncertainty, and obstacles to measurement, the government may choose to use one of the instruments under which it retains discretion (government production or direct regulation on the right-hand side of Figure 3). The discussion above demonstrated that, on the basis of public finance considerations, the regulatory approach may be preferred to that of government production. However, there are constitutional limitations on the types of activities that the United States federal and state governments can mandate under regulation. In par-

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223. *See* Arun S. Malik et al., *Point/Nonpoint Source Trading of Pollution Abatement: Choosing the Right Ratio*, 75 AM. J. AGRIC. ECON. 959, 963-66 (1993).

224. *See id*. at 966.

225. For a more complete treatment of legal constraints on instrument choice, see Richards, Integrating Science, *supra* note 214, at 222-62.

ticular, constraints imposed by regulatory takings law may prevent the government from employing the regulatory option.

The United States federal government employs the enterprise and coercive modes under different constitutional powers. The enterprise mode is carried out under the spending powers, while the coercive mode invokes the taxing and commerce (regulatory) powers. Despite the fact that they are both considered coercive powers, the regulatory and taxing powers face different legal constraints. The federal regulatory power is constrained by the Fifth and Fourteenth Amendments of the U.S. Constitution from taking private property without compensation. Regulatory takings law defines, albeit imperfectly, the circumstances under which a regulation acts as if to take private property, thus requiring compensation for the loss.

Until recently the "harm-benefit" rule-of-thumb has been a remarkably reliable predictor of court decisions in takings cases. Under this test, if a regulation acts to prevent a "harm" it is a legitimate exercise of the regulatory power.[226] But if a regulation requires the creation of a public "benefit," compensation is required, raising the activity to a public enterprise.[227] This rule of thumb still leaves ample room for dispute about what constitutes a harm or benefit, but it does serve as a starting point for determining which of the two modes, coercive or enterprise, the government would use to implement a program.

In the past decade, however, the Supreme Court's decisions on regulatory takings have taken a different direction, broadening the circumstances under which the Court will find a taking to have occurred.[228] Recent Congresses have considered widening those circumstances further still.[229] Where governments are aware that their new regulations will be regarded as a takings, they may choose to employ the government production instrument, paying property owners to acquire their property, or *de facto* be moved into government production by the litigation process as in the case of *Lucas v. South Carolina*

226. *See, e.g.*, Nollan v. California Coastal Comm'n, 483 U.S. 825, 834-837 (1987).

227. *See, e.g.,* Penn Cent. Transp. Co. v. New York City, 438 U.S. 104, 124 (1978).

228. *See, e.g.,* Dolan v. City of Tigard, 512 U.S. 374 (1994) (requiring a municipal government to pay compensation because development exactions sought from the property owner were not in "rough proportionality" to the impacts of the proposed development).

229. For instance, the House of Representatives passed the Private Property Protection Act of 1995, H.R. 925, 104th Cong. (1995), which, if enacted into law, would have significantly expanded the circumstances under which compensation would be required for reductions in private property values caused by new regulations.

Coastal Council.[230]

In contrast to the limits on the regulatory powers, there is relatively little constitutional limit to the federal government's use of the taxing power. Even where the motivation of an excise tax is clearly regulatory and the effect of the tax is to render a business or property completely unprofitable, the Court will not find that the tax works a taking, provided that the tax raises revenue.[231]

The differential treatment of actions under the taxing power and the regulatory power suggests that one instrument may be applied in circumstances where the other cannot. It also raises the interesting question of how the court would treat auctioned marketable allowances.[232] Since allowance programs involve direct limitations on emissions, and air pollution has always been controlled under the regulatory powers, a marketable allowance program may be subject to review as regulation. At the same time, if allowances are auctioned, they clearly have revenue-raising properties and may be controlled under the taxing powers. A new marketable allowance program therefore might enjoy unfettered freedom reviewed under the taxing power, but might also run into the regulatory takings net, particularly if Congress refined it to screen out further intrusions on private property.

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230. 505 U.S. 1003 (1992), *remanded to* 309 S.C. 424 (1992)(finding that South Carolina's statutory provision restricting use could be a "taking" if it eviscerated "all economically beneficial uses of the land," provided that the landowner *possessed* by right of title the usage rights purported to be taken, according to the state common law; thus, remanding for determination of the extent of this owner's property interests).

For a discussion of this seminal case, see WILLIAM A. FISCHEL, REGULATORY TAKINGS: LAW, ECONOMICS, AND POLITICS 59-61 (1995). Not only did the state legislature amend the law that regulated Lucas' beachfront property, but the state also purchased the lots from Lucas in a settlement agreement. *See id*. at 61.

231. In a reversal of a lower court opinion finding a local tax on parking facilities unconstitutional because of the combination of an "unreasonably high" tax and the competition from the city's own, untaxed facilities, the United States Supreme Court acknowledged broad taxing powers, observing, "[T]he Court has consistently refused either to undertake the task of passing on the 'reasonableness' of a tax that otherwise is within the power of the Congress or of state legislative authorities, or to hold that a tax is unconstitutional because it renders a business unprofitable." City of Pittsburgh v. Alco Parking Corp., 417 U.S. 369, 373 (1974).

232. The issue is not limited simply to judicial review of takings. In developing rules to implement the Montreal Protocol, EPA debated whether it would have the legal authority to auction the allowances. "The EPA questioned whether such a regulatory auction would constitute a delegation by Congress of its Constitutional powers to tax or to regulate commerce and whether Congress had, in fact, delegated such authority to the EPA." Hahn & McGartland, *supra* note 4, at 609 n.64.

2. Federal versus State Regulation of Land Use

In some cases, such as carbon sequestration and nonpoint source water pollution control, emissions abatement involves changing land-use practices. These changes tend to be complex and may invite information-economizing regulation rather than incentive-based approaches. However, land-use control has traditionally rested at the state and local level, not with the federal government.[233] Vesting control in states may limit the capacity of the federal government to address those land-use issues that transcend state boundaries. In the case of carbon sequestration, for example, the regulatory option for increasing carbon sinks may be foreclosed if the federal government cannot control forestland management.

However, the federal government is not without influence over land-use regulation.[234] Federal programs have had significant effects on land-use issues such as nonpoint source water pollution control, wetlands preservation, and coastal zone management, acting through the Federal Water Pollution Control Act and the Coastal Zone Management Act (CZMA).[235] These three cases suggest some of the boundaries of, and strategies for, federal influence over land-use issues. In none of the cases did the federal government directly regulate the land use in question. Rather in all three cases, legislation required states to undertake a two-stage process: (1) develop assessment reports and management plans, and (2) implement the state-designed plans. While state and local governments are able to retain primary responsibility for land-use planning under this approach, the federal government exercises control through its provision of ground rules for the plans, its retention of veto power, and its guidance of state governments. In both the nonpoint source pollution control program and the coastal zone management program, the federal government provided substantial funding to assist states in developing their management plans and subsequently implementing those plans. The CZMA demonstrated that the federal government may be able to induce states to agree to share influence in one area by increasing state control in another, *e.g.*, control over federal lands.

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233. *See* Daniel R. Mandelker, *Controlling Nonpoint Source Water Pollution: Can It Be Done?*, 65 CHI.-KENT L. REV. 479, 489 (1989) ("With few exceptions, land use controls are a local responsibility . . . .").

234. *See* Robert H. Nelson, *Federal Zoning: The New Era in Environmental Policy*, *in* LAND RIGHTS: THE 1990'S PROPERTY RIGHTS REBELLION 295, 295-97 (Bruce Yandle ed., 1995) (arguing that the enactment of much of federal environmental laws has resulted in "the rise of a new system of federal land-use regulation").

235. *See id.*

Ultimately state acceptance will be a political issue, resolved by states' views of the balance between the benefits of federal assistance and cooperation and the cost of partially surrendering local control over land-use decisions.

3. The Rule Against Legislative Entrenchment

The analysis of instruments above suggests that incentive-based instruments can induce the private sector to efficiently invest in pollution abatement. However, if those investments involve specialized assets, private firms may look to the government to provide credible commitments against opportunistic rent-seeking behavior such as revoking subsidies or changing the tax code after investments have been made. The government's ability to provide commitments against opportunism may be limited by prohibitions on legislative entrenchment.

A general principle of legislative authority provides that one legislature cannot bind the actions of its successors.[236] Thus, "a legislature has only limited capacity to provide stability and reassurance."[237] This restriction has serious implications for the government's ability to make credible long-term commitments.[238] With respect to instrument choice, it may limit the range of candidate instruments. For example, in the case of carbon sequestration, since it takes several decades for most of the carbon removal to occur, it may be difficult for the government to provide a meaningful promise to make subsidy payments on an "as removed" basis. Instead, the government may have to offer subsidies structured to provide larger initial payments. The disadvantage of this approach is that it requires the government to pay for services before they have been delivered.

While the prohibition on legislative entrenchment affects all

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236. *See* Julian N. Eule, *Temporal Limits on the Legislation Mandate: Entrenchment and Retroactivity*, 1987 AM. BAR FOUND. RES. J. 379, 381 (1987); Paul W. Kahn, *Gramm-Rudman and the Capacity of Congress to Control the Future*, 13 HASTINGS CONST. L.Q. 185, 219-28 (1986).

237. Stewart E. Sterk, *The Continuity of Legislatures: Of Contracts and the Contracts Clause*, 88 COLUM. L. REV. 647, 647 (1988).

238. *See* Kenneth A. Shepsle, *Discretion, Institutions, and the Problem of Government Commitment*, *in* SOCIAL THEORY FOR A CHANGING SOCIETY 245, 250 (Pierre Boundieu & James S. Coleman eds., 1991). In the game theory and industrial economics literature this is referred to as time inconsistency. When expectations are rational, policymakers retain discretion, and the game is against economic agents rather than nature, the social objective function cannot be maximized. *See, e.g.*, Finn E. Kydland & Edward C. Prescott, *Rules Rather Than Discretion: The Inconsistency of Optimal Plans*, 85 J. POL. ECON. 473, 487 (1977). Consequently, a government agent that follows rules limiting future options may be better able to advance social welfare than an agent that retains discretion. *See id*. at 474, 487.

three of the general categories of instruments aimed at influencing private sector behavior,[239] the effect is not uniform. In the absence of legally binding commitments, private parties will look for government commitment as demonstrated through past government actions and trends. The instruments based most directly on the taxing and spending powers (taxes and subsidies) will likely appear the least durable, while those based on the regulatory powers (command-and-control regulation and marketable allowances) may be deemed more reliable. Not only are the taxing instruments generally transitory, but the rate of change among those instruments appears to be increasing, with the greatest change among subsidies granted in the form of tax credits.[240]

The government's ability to credibly commit is most important where private-party investment in specialized assets is critical to low-cost delivery of environmental services.[241] Further research should shed light on mechanisms by which government can make credible commitments. For example, although government contracts are

239. Subsidies and contracts are payments to induce changes in private-party actions. Environmental taxes and marketable allowances are also intended to change private-sector behavior. Command-and-control regulation uses the legal threat of fines or criminal sanctions to control private parties. In the context of Figure 3, only pure government production is carried out in the absence of direct private-sector involvement. For a discussion of the importance of government precommitment in the case of contracts and subsidies, see Logue, *supra* note 75. For the role of precommitment in the case of automobile regulations, see Yao, *supra* note 173; and for precommitment related to prohibitions on seawalls in the face of rising sea levels, see Joseph L. Sax, *The Fate of Wetlands in the Face of Rising Sea Levels: A Strategic Proposal*, 9 UCLA. J. ENVTL. L. & POL'Y 143 (1991).

240. *See* Richard L. Doernberg & Fred S. McChesney, *On the Accelerating Rate and Decreasing Durability of Tax Reform*, 71 MINN. L. REV. 913, 922-23 (1987).

241. For example, states are finding that to attract investment they must make credible commitments to developers of brownfields not to sue either current or future owners of the sites. *See* Jim Nichols, *Companies Getting Green Light to Oversee Own 'Brownfields,'* THE PLAIN DEALER, June 27, 1996, at 4B (metro section). This issue extends well beyond the provision of environmental services, of course. Electric utilities that made investments as regulated monopolies now face enormous stranded costs as the federal and state governments move toward competition in electricity generation. *See* Timothy J. Brennan & James Boyd, *Stranded Costs, Takings, and the Law and Economics of Implicit Contracts*, 11 J. REG. ECON. 41, 42 (1997) ("[T]he amounts at stake are enormous . . . . [C]redible estimates of [utilities' stranded costs] range as high as $200 billion . . . ."); Leigh H. Martin, Note, *Deregulatory Takings: Stranded Investments and the Regulatory Compact in a Deregulated Electric Utility Industry*, 31 GA. L. REV. 1183, 1183-84 (1997) ("[T]he estimated value of these stranded investments ranges from $10 billion to greater than $200 billion."). This is essentially opportunistic behavior on the part of the government following the utilities' investment in specialized assets. For a discussion of similar issues in the telecommunications industry, see J. Gregory Sidak & Daniel F. Spulber, *Deregulatory Takings and Breach of the Regulatory Contract*, 71 N.Y.U. L. REV. 851 (1996); William J. Baumol & Thomas W. Merrill, *Deregulatory Takings, Breach of the Regulatory Contract, and the Telecommunications Act of 1996*, 72 N.Y.U. L. REV. 1037 (1997).

based on the spending power and are subject to a different body of law than private contracts, private parties may view them as providing more reliable promises than a general subsidy provision.

V. HEURISTIC PRINCIPLES FOR ENVIRONMENTAL APPLICATIONS

The analysis in the previous sections provides some insight into the three components of costs on which this study focuses—production costs (PC), implementation costs (IC) and welfare losses associated with negative impacts on the public finance system (TX). The incentive-based instruments tend to encourage lower production costs, though the level of savings depends upon the extent to which the private sector is better able than the government to identify appropriate technologies and innovations. Where there are diverse options and applications for abatement, incentives are especially important. The coercive instruments in general, and the zero-baseline taxes and auctioned marketable permits in particular, have superior public finance characteristics. The fact that taxes and marketable allowances tend to minimize both PC and TX would seem to make them the instruments of choice for environmental protection. However, these advantages might be overridden in some cases where the implementation costs associated with incentive-based instruments are sufficiently high due to information requirements, specialized assets, and uncertainty. Thus, no instrument dominates the others in all cases.

Table 3 provides a summary of the relation between several programmatic and technological characteristics and the relative attractiveness of selected individual instruments. A plus sign indicates that an increase in that factor increases the applicability of the instrument, while a minus sign indicates lower applicability.

Taxes and auctioned marketable allowances generally involve lower production costs and less negative impacts on the public finance system than the other instruments. Thus, a higher marginal cost of public funds would tend to make the coercive mode more attractive, and taxes or auctioned allowances particularly so. Taxes and marketable allowances are also favored when there is a wide range of

technological options from which to choose, and technological innovation is apt to be important in reducing the cost of abatement over time.

In contrast, where abatement involves highly specialized assets, the program goals and rules are subject to high uncertainty, the government's credible commitments against opportunistic behavior are costly, and the cost of measuring or modeling the accomplishments of private parties is high, the government may need to retain more discretion for itself by directly producing the abatement service or using command-and-control regulation. Generally command-and-control regulation should be preferred to the enterprise mode instruments on the basis of public finance considerations. However, in some cases, particularly those where the abatement activity is not directly linked to the emission itself, the government may be constrained by takings law from requiring private parties to provide the abatement service.

Moreover, where the abatement activity involves changes in private land use, the federal government, generally excluded from direct land-use regulation, may have to rely on a combination of subsidies to landowners, government production, and incentives for states and local governments to adopt the needed regulations.

In general, where there is uncertainty around the marginal cost of abatement, either price-based or quantity-based instruments might be preferred. The steeper the marginal abatement cost curve, the more beneficial is a price-based system, such as taxes or subsidies. The flatter the marginal abatement curve, *ceteris paribus*, the more preferable become the quantity-based approaches, such as marketable allowances and contracts.[242]

242. Because this article does not address the quantity versus price issue in the context of the hierarchical instruments, Table 3 will simply register question marks and leave that question for future discussion.

TABLE 3: SUMMARY OF FACTORS AFFECTING INSTRUMENT CHOICE

	INSTRUMENT					
	Subsidies	Contracts	Government Production	Zero-Baseline Taxes	Auctioned Marketable Allowances	Command-and-Control Regulation
MARGINAL COST OF PUBLIC FUNDS	–	–	–	++	++	+
IMPLEMENTATION COST FACTORS						
Asset Specificity	–	–	+	–	–	+
Program Uncertainty	–	–	+	–	–	+
Cost of Output Measurement	–	–	+	–	–	+
Relative Steepness of (Uncertain) Marginal Abatement Curve	+	–	?	+	–	?
PRODUCTION COST FACTORS						
Diversity of Applications	+	+	–	+	+	–
Innovation Potential	+	+	–	+	+	–
LEGAL FACTORS						
Benefit Providing	+	+	+	+	?	–
Land Use Changing	+	+	+	–	–	–

A plus sign indicates a positive correlation between that factor and the attractiveness of the corresponding instrument. For example, command-and-control regulations are more attractive relative to the enterprise mode instruments (subsidies, contracts, and government production), if the marginal cost of public funds is believed to be high. Revenue-raising zero-baseline taxes and auctioned marketable allowances, designated with a double plus, would be even more attractive.

VI. CONCLUSIONS

This article endeavors to advance understanding of the relation among instruments by providing a conceptual framework. First, it expands the scope of instrument choice beyond the common narrow focus on market-based instruments and command-and-control regulation. In particular, it incorporates the government production and contracting instruments.

Second, by delineating the two most important characteristics of instruments (*i.e.*, who pays and who controls abatement generation decisions), it places the instruments in their proper relation to each other. Most noticeably, subsidies, which are generally lumped in with other incentive-based tools in the instrument choice literature, are grouped under this taxonomy with contracts, which are generally excluded entirely from those studies. Subsidies and contracts as defined in this article are simply price-based and quantity-based mechanisms for achieving the same goals.

Third, by reorganizing the evaluation criteria as a constrained optimization problem, this approach helps frame the analysis of the public finance impacts of choosing one instrument over another. The choice among instruments along the vertical axis of Figures 3 and 4 have profound implications for the government's revenue-raising requirements.

Fourth, the taxonomy identifies the constitutional powers under which each instrument is exercised. This is a necessary first step in analyzing the legal constraints on the use of the instruments.

Fifth, it applies lessons developed in the New Institutional Economics and the contract governance literatures to the instruments addressed in the more traditional environmental policy literature. It preserves the useful distinction between regulation and incentive-based controls without succumbing to the false dichotomy.

Sixth, it differentiates between the provision of abatement services and the provision of information about abatement. Identifying which type of market failure the agency is attempting to correct, externality or public good, clarifies the instrument choice process.

Seventh, this framework raises issues of trading ratios for linked programs, such as deposit-refund, tax-subsidy, or market allowance-offset programs. For example, if the government is taxing carbon emissions and subsidizing carbon sinks, the two approaches have different impacts on the public finance system. If the differences are

substantial, as they may well be, it is possible that the optimal ratio of tax to subsidy could be substantially greater than one.

Finally, the distinction between abatement costs and residual environmental damages emphasizes the issues of equity and fairness inherent in deciding who bears these two types of costs. These issues quickly translate into political constraints that may render many environmental policy strategies (such as carbon sequestration) infeasible if decision-makers consider only the coercive instruments.

APPENDIX

TABLE A1: EVALUATION CRITERIA FROM ENVIRONMENTAL POLICY INSTRUMENT CHOICE LITERATURE

MAJONE (1976)
1. Environmental Effectiveness
2. Economic Efficiency
3 Political and Administrative Feasibility
4. Compatibility with Existing Institutions
5. Polluter Pays Principle

BOHM & RUSSELL (1985)
1. Static Efficiency
2. Information Intensity
3. Ease of Monitoring and Enforcement
4. Flexibility in the Face of Economic Change
5. Dynamic Incentives
6. Political Considerations

DEPARTMENT OF ENERGY (1989)
1. Efficiency
2. Informational Requirements
3. Distributional Effects
4. Political Sustainability
5. Applicability

PROJECT 88—ROUND II (1991)*
1. Efficacy with Respect to Environmental Goals
2. Cost-Effectiveness
3. Information Requirements
4. Monitoring and Enforcement Costs
5. Flexibility in Face of Changes in Tastes, Technology, Resource Use
6. Dynamic Incentives for Innovation and Adoption of New Technology
7. Resolvability of Distributional Equity Issues
8. Understandability to Public
9. Political Feasibility

* See also Hahn & Stavins (1993)

OFFICE OF TECHNOLOGY ASSESSMENT (1995)
1. Cost-Effectiveness
2. Fairness
3. Demand on Government Resources
4. Assurance Goals Will be Met
5. Prevention vs. Cleanup
6. Environmental Equity and Justice
7. Adaptability
8. Technology Innovation and Diffusion

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (1996)
1. Environmental Considerations
   a. Target pollutants
   b. Other environmental impacts
2. Economic and Social Considerations
   a. Cost-effectiveness
   b. Project level considerations
   c. Macro-economic considerations
   d. Equity considerations
3. Administrative, Institutional, and Political Considerations
   a. Administrative burden
   b. Political considerations
   c. Replicability

TABLE A2: SUMMARY OF INSTRUMENT CATEGORIES FROM SAMPLE OF ENVIRONMENTAL POLICY LITERATURE

Stahr (1971)
1. Product Standards
2. Production Process Standards
3. Taxes on Emissions
4. Subsidies for Pollution Control
5. Government Expenditure on Abatement Projects

Majone (1976)
1. Regulation, Direct Public Action, and Subsidies
2. Effluent Charges
3. Contract and Redefinition of Property Rights
4. Organization

Baumol and Oates (1979)
1. Moral Suasion
2. Direct Controls
   a. Regulation of levels of emissions
   b. Specification of processes or equipment
3. Market Processes
   a. Tax on environmental damage
      i. Rates based on damage
      ii. Rates designed to achieve preset environmental quality standard
   b. Subsidies
      i. Payments per unit of pollution reduction
      ii. Subsidies to defray equipment costs
   c. Marketable pollution licences
      i. Sale of licenses to highest bidder
      ii. Equal distribution of licenses
   d. Refundable deposits against environmental damage
   e. Allocation of property rights
4. Government Investment Facilities
   a. Regenerative facilities
   b. Dissemination of information
   c. Research
   d. Education

Bohm and Russell (1985)
1. Prices and Taxes
2. Tradeable Rights
3. Deposit-Refund Systems and Performance Bonds
4. Liability
5. Regulation
   a. Forcing private negotiation
   b. Performance standards
   c. Regulating decision variables correlated to emissions
   d. Design standards
   e. Bans on products or processes
6. Government Investment in Protection and Restoration
7. Moral Suasion

Bressers and Klok (1988)
1. Creating Alternatives (Technological Development)
2. Alternatives Reduction (Physical Intervention)
3. Changing Pros and Cons of Alternatives
4. Changing Valuation of Outcomes
5. Information Provision

Department of Energy (1989)
1. Regulation
   a. Regulation by controls
      i. Bans
      ii. Emissions controls
      iii. Input controls
      iv. Consumption controls
      v. Price controls
      vi. Rate of return regulation
   b. Standards
      i. Technology standards
      ii. Licensing and certification
2. Fiscal Incentives
   a. Emission fees
   b. Tradeable emission rights
   c. Deposit-refund systems
   d. Taxes
      i. Excise taxes
      ii. Taxes on firms
      iii. Personal income tax
      iv. Property taxes
      v. Tariffs
   e. Subsidies
   f. Direct government expenditure
      i. R&D support
      ii. Direct government purchases
3. Information
   a. Advertising and labeling
   b. Education
   c. Moral suasion
   d. Signaling
4. Research, Development, and Demonstration
   a. Public invention support programs
   b. Commercialization education
   c. Provision of specialized information
   d. Demonstrations

Hahn (1989)
1. Standards
   a. Ambient standards controlling environmental quality
   b. Emissions standards
      i. Technology-based standards
      ii. Performance standards
2. Subsidies
3. Taxes and Emissions Fees
4. Tradeable Permits

Environmental Protection Agency (1990)
1. Conventional Regulations
   a. Standards
   b. Use restrictions
   c. Product design
2. Market Incentives
   a. Pollution charges
   b. Permit systems
3. Scientific/Technical Measures (R&D)
4. Provision of Information
5. Enforcement
6. Cooperation with Other Government Agencies and Nations

Project 88C Round II (1991)*
1. Command-and-Control
   a. Technology-based standards
   b. Uniform performance standards
2. Market-Based Instruments
   a. Pollution charges
   b. Tradeable permits
   c. Deposit-refund systems
   d. Market barrier reductions
   e. Government-subsidy elimination

* Also similar: Project 88 (1988), Stavins (1992), Hahn and Stavins (1991, 1992), Stavins (1998)

Office of Technology Assessment (1995)
1. Direct Limitations
   a. Single-source tools
      i. Harm-based standards
      ii. Design standards
      iii. Technology specifications
      iv. Product bans and limits
   b. Multisource tools
      i. Integrated permitting
      ii. Tradeable emissions
      iii. Challenge regulations
2. Indirect Limitations
   a. Pollution charges
   b. Liability
   c. Information reporting
   d. Subsidies
   e. Technical assistance

Department of Energy (1996)
1. Information and Education
2. Voluntary Programs
3. Research, Development and Demonstration
4. Regulation
5. Market-Based Incentives

Callan and Thomas (1996)
1. Command-and-Control
   a. Technology-based standards
   b. Performance-based standards
2. Market-Based
   a. Pollution Charge
      i. Effluent charge
      ii. Product charge
      iii. User charge
      iv. Service charge
   b. Subsidy
   c. Deposit/Refund
   d. Pollution permit market
      i. Credit system
      ii. Allowance system

Intergovernmental Panel on Climate Change (1996)
1. Market-Based Programs
   a. Taxes
   b. Full-cost pricing
   c. Subsidies
   d. Phaseout of subsidies
   e. Tradeable emissions quotas
2. Voluntary Agreements
   a. Energy use and emissions standards
   b. Government procurement
   c. Promotional programs
3. Regulatory Measures
   a. Mandatory building or equipment standards
   b. Product and practices bans
   c. Nontradeable emissions quotas
4. Research, Development and Demonstration

Fisher et al. (1996)
1. Conventional Regulation
2. Market-Based Instruments
   a. Taxes and subsidies
   b. Tradeable permits
3. Other Complementary Policies
   a. Education and provision of information
   b. Family planning
   c. Modification of trade policy and subsidies

Blackman and Harrington (1998)
1. Economic Incentives
   a. Direct (emissions fees, marketable permits)
   b. Indirect (environmental taxes)
2. Command-and-Control
   a. Direct (emissions standards)
   b. Indirect (technology standards)
3. Government Investment
   a. Direct (road paving, waste disposal plants)
   b. Indirect (R&D in clean technology)
4. Informal Regulation

Table A2 (Continued): Summary of Instrument Categories from Sample of Environmental Policy Literature