The Role of Public-Private Partnerships - *in* - U.S. Environmental Policy:

Case of the EPA and the U.S. Semiconductor Industry

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Introduction

Until a few decades ago, management of environmental problems in the United States was predominantly under the purview of the federal government. Through direct regulation with key statutes such as the Clean Air Act (1970), the Clean Water Act (1972), the Resource Conservation and Recovery Act (1976), and the Toxic Substances Control Act (1976), the U.S. Environmental Protection Agency (EPA) effectively regulated what is often termed as a first generation of environmental problems, point-source environmental problems that rose to prominence in the early 1960s. Despite the growing appeal of market-based approaches to management of environmental problems in the 1980s, the command-and-control strategies of direct regulation were still the dominant instrument.[1] However, this top-down approach has fallen short in addressing what have become second- and third-generation environmental problems, such as climate change, biodiversity, and toxic and hazardous waste.[2]

The complexity and uncertainty of environmental problems has prompted the redefinition of the traditional roles of the government, the private sector, and non-governmental actors.[3] This redefinition process has given rise to a combination of innovative approaches including voluntary agreements, cross-sector collaborations, and information-based approaches in an attempt to address the second- and third-generation environmental problems. Unlike the command-

1 Jordan Andrew, Wurzel Rudiger and Zito Anthony. "'New' Instruments of Environmental Governance: Patterns and Pathways of Change," *Environmental Politics* 12, no. 1 (2003): 1–24.

2 In his seminal book on *Environmental Policy and Politics* (2004), Michael Kraft categorized environmental problems in three generations depending upon their nature, complexity, and severity. This categorization is widely used by environmental policy scholars, especially while describing climate change as a "third generation" environmental problem.

3 Coglianese Cary and Allen Laurie. "Building Sector Based Consensus: A Review of US EPA's Common Sense Initiative," in *Industrial Transformation: Environmental Policy Innovation in the United States and Europe*, ed. Theo de Bruijn and Vicki Norberg-Bohm (Cambridge, Massachusetts: The MIT Press, 2005).

and-control strategies that dominated the environmental regulation landscape in the 1970s and 1980s, these collaborative approaches are performance-based and allow for flexibility, stakeholder engagement, and consensus building. With appeal across all three sectors, the innovative approaches are becoming commonplace in the U.S. environmental policy-making arena.

The aim of this paper is to investigate a special type of cross-sector collaboration called public-private partnerships (PPPs) that are gaining currency in policy making in the United States and around the world. Using case studies of three noteworthy partnerships between the EPA and the U.S. semiconductor industry, this paper evaluates their performance, outlines a few pitfalls and challenges, and offers lessons for scholars and practitioners interested in such collaborative partnerships. Results show that the three partnerships experienced mixed success; however, they have created some long-lasting policy changes in U.S. environmental policy making and prompted more private sector participation.

This paper builds on to the existing knowledge of public-private partnerships by placing the research in U.S. institutional settings. Traditionally, the public sector has strictly provided public goods due to inherent market failures in the private sector, including negative externalities (e.g., pollution), profit motive and the fact that the scope and urgency of environmental problems typically exceeds the capacity of markets and individuals. According to some scholars, the provision of public goods though the government also has been fraught with difficulties such as failure of downstream implementation, lack of accountability, and inefficiency.[4] In describing the weakness of existing environmental regulations and influential theories of agency-capture, Robert Kagan's adversarial legalism and Max Weber's bureaucratic rationality may lend themselves to sources of government failures in the regulation of environmental problems.[5, 6] Despite these government and market realties, both the public and private sector are partnering to collectively address complicated policy problems. The value-add of this paper is to evaluate to what extent these public-private partnerships help reconcile and balance market failure with government failure to address complex environmental problems.

The paper is divided into seven sections. The first section is an overview of the data and methods used to evaluate public-private partnerships. The second section is a background on the role and origin of public-private partnerships in U.S. environmental policy making. The third section is a literature review of the existing research on public-private partnerships. The fourth section offers a brief overview of the three case studies. The fifth section is an analysis of the three case studies. The sixth section offers key lessons learned. Finally, the last section provides conclusions and policy implications and discusses future areas of research.

4 Ansell, Chris and Gash Alison. "Collaborative Governance in Theory and Practice," *Journal of Public Administration Research and Theory* 18, no. 4 (2008): 543–571.

5 Weber, Max, Hans Heinrich Gerth, and Charles Wright Mills. From *Max Weber: Essays in Sociology: Essays in Sociology* (Oxford university press, 1946).

6 Kagan, Robert A. "Adversarial Legalism and American Government," *Journal of Policy Analysis and Management* 10, no. 3 (1991): 369.

Data and Methods

This paper is based on a qualitative analysis of three public-private partnerships between the EPA and the U.S. semiconductor industry from 1994 to the present, namely, The Common Sense Initiative, Project XL, and PFC Partnership/ Climate Reduction Partnership. I rely on primary and secondary data to inform my knowledge of these partnerships from a researcher, as well as practitioner, perspective. The primary data sources are semi-structured interviews with a former EPA official who directed the Common Sense Initiative project and directed the global and environmental policy of a large U.S. semiconductor company. I also rely on the *Policy Dialogue Report*, which draws on twenty-two interviews with business, legal, and technology experts from semiconductor companies, industry and trade organizations, and law firms, among others.

The secondary data is obtained from various EPA project evaluation reports; memorandums (MOUs) between the EPA and U.S. semiconductor industry; project manuals from the EPA; individual semiconductor company reports; third-party consultancy reports; and existing literature reviews of networks, cross-sector collaboration, and environmental governance.

Background: Role of Public-private Partnerships in U.S. Environmental Policy

In the context of U.S. environmental policy, public-private partnerships are not a recent phenomenon. The earliest version of such a partnership appears two decades ago, when the private sector provided state and local wastewater treatment services in collaboration with the U.S. EPA.[7] However, sustained and increasing enthusiasm for public-private partnerships around the world is built on the premise that public policy problems—addressed exclusively by the public sector in the past—are becoming more complex and need to be solved using a collaborative endeavor that takes advantage of the specialization and professional expertise offered by the private, semi-private, and nonprofit sectors.[8] Further, the current trend toward globalization and the need for devolution of government service delivery has stoked interest in the research and practice of public-private partnerships.[9]

Historically, the failure to launch an effective welfare state in the 1960s and 1970s showed the limitation of the government as a sole problem-solving

7 This partnership is more of the nature of privatization of government delivery of public goods and services. The wastewater treatment was one of the first collaborations recognized by the US EPA as form of a 'public-private partnership.' (Source: http://water.epa.gov/grants_funding/cwf/privatization.cfm)

8 Rhys, Andrews and Tom Entwistle. "Does Cross-Sectoral Partnership Deliver? An Empirical Exploration of Public Service Effectiveness, Efficiency, and Equity." *Journal of Public Administration Research and Theory* 20 (2010): 679–701.

9 Johnston, Jocelyn and Barbara Romzek. "Traditional Contracts as Partnerships: Effective Accountability in Social Service Contracts in the American States," in *The Challenge of Public Private Partnerships: Learning from International Experience,* ed. Graeme Hodge and Carsten Greve (Cambridge, Massachusetts: Edward Elgar Publishing, Inc, 2005).

entity.[10] In the context of U.S. environmental policy, the command-and-control approaches have not been without their limitations. By the mid-1980s, discontent rose from the industry and environmentalists for the government's top-down, technology-forcing, compliance-based approach. The government was criticized on the grounds of inflexibility, administrative complexity, high compliance and transaction cost, lack of stakeholder and public participation, and multiple enforcement challenges.[11, 12, 13]

Fortunately, the private sector's parallel movement toward corporate environmentalism has created new opportunities for collaborative environmental management.[14, 15] Berry and Rondinelli also recognize another reason for an increased interest in public-private partnerships: the EPA is not inherently designed to address or incentivize companies that go above compliance. The movement by the private sector toward self-regulation and exceeding minimum compliance standards was harnessed in the mid-1990s, during a time termed the Reinvention Era in the Clinton administration. Some political scientists suggest that the environmental instruments experimented with in the Reinvention Era were partly in response to the growing discontent with top-down regulation. Thereby, collaborations and partnerships increased during the Reinvention Era in an effort to streamline regulation and to respond to the trends in the private sector.[16]

Literature Review

For more than two decades, literature on policy networks, contracting, and environmental governance has explored different types of initiatives wherein the government has collaborated with non-state actors such as the private and nonprofit sectors to provide delivery of public goods and services. The popularity of such initiatives has given rise to various formats for collaboration in management of environmental problems. These are documented in the literature under the various headings of cross-sector collaborations, co-regulation, and public-private partnerships.

10 Kickert, Walter J. M., Erik-Hans Klijn and Joop Koppenjan. *Managing Complex Policy Networks* (London: Sage, 1997).

11 Fiorino, Daniel J. "Rethinking Environmental Regulation," *Harvard Environmental Law Review* 23, no. 467 (1999): 1–26.

12 Durant, Robert F. "Reconceptualizing Purpose," in *Environmental Governance Reconsidered: Challenges, Choices, and Opportunities*, ed. Robert F. Durant, Daniel J. Fiorino and Rosemary O'Leary (Cambridge, Massachusetts: The MIT Press, 2004), 29–34.

13 Coglianese, Cary and Laurie Allen. "Building Sector Based Consensus: A Review of US EPA's Common Sense Initiative," in *Industrial Transformation: Environmental Policy Innovation in the United States and Europe*, ed. Theo de Bruijn and Vicki Norberg-Bohm (Cambridge, Massachusetts: The MIT Press, 2005).

14 Durant, Robert F. "Reconceptualizing Purpose," in *Environmental Governance Reconsidered: Challenges, Choices, and Opportunities*, ed. Robert F. Durant, Daniel J. Fiorino and Rosemary O'Leary (Cambridge, Massachusetts: The MIT Press, 2004), 29–34.

15 Rondinelli, Dennis A. and Michael Berry. "Corporate Environmental Management and Public Policy: Bridging the Gap." *The American Behavioral Scientist* 44, no. 2 (2000): 1–32.

16 Fiorino, Daniel J. *The New Environmental Regulation* (Cambridge, Massachusetts: The MIT Press, 2006).

Due to the multiple terminologies and interchangeable usage, the exact scope and definition of public-private partnerships in the existing literature is highly contested. Some scholars define public-private partnerships as normal contracts or as privatization of public service delivery, while others argue that they are a new governance tool with joint decision-making in the absence of a hierarchical principal-agent relationship.[17, 18] Integrating the different perspectives, Hodge and Greve offer a broad definition of the concept of public-private partnerships. According to these two scholars, public-private partnerships are "loosely defined as cooperative institutional arrangements between public and private sector actors."[19]

According to the characterization in the public policy literature, third-generation policy problems—such as climate change and sustainability—are classic examples of what Rittel and Webber call a wicked problem. Originally coined by the two, the term wicked problems refers to those policy problems that involve risks and uncertainty but have no consensual solution.[20]

Extending the concept of wicked problems to public policy research, one of the earlier works on collaboration by O'Toole suggests that cooperation of this form sometimes is deemed technically necessary due to increasing complexity and intricate circumstances.[21]

Scholars such as O'Leary and Bingham, Weber and Khademian, and Rhys and Entwistle argue that wicked problems cannot be solely managed by a single entity.[22, 23] They suggest that for long-term problem solving, organizations must look beyond their own four walls to tap into unique skills, strategies, and tools offered by the public, private, and nonprofit sector actors.

Rhys and Entwistle analyzed primary and secondary data from 46 local government service departments in United Kingdom and found that the prospects of public service improvement may depend on the sector choice that organizations make in terms of tapping into the distinct advantages of the private sector and/or nonprofit organizations.[24]

17 Savas, E. S. (2000). *Privatisation and Public-Private Partnerships* (New York: Chatham House Publishers, Seven Bridges Press, 2000).

18 Klijn, Erik-Hans and Geert R. Teisman "Governing Public-private Partnerships: Analyzing and Managing the Process and Institutional Characteristics of Public Private Partnerships, in *Public Private Partnerships: Theory and Practice in International Perspective*, ed. Stephen Osborne (London: Routledge, 2000), 84–102.

19 Hodge, Graeme and Carsten Greve. *The Challenge of Public Private Partnerships: Learning From International Experience* (Massachusetts: Edward Elgar Publishing Inc., 2005).

20 Rittel, Horst W.J. and Melvin M. Webber (1973). "Dilemmas in a General Theory of Planning," *Policy Sciences* 4, no. 2, 155–169.

21 O'Toole, Laurence J. "Implementing Public Innovations in Network Settings," *Public Administration & Society* 29, no. 2 (1997): 115–138.

22 Weber, Edward P. and Anne. M. Khademian "Wicked Problems, Knowledge Challenges, and Collaborative Capacity Builders in Network Settings," *Public Administration Review*, 68, no. 2 (2008): 334–349.

23 O'Leary, Rosemary and Lisa Blomgren Bingham. "Managing Conflict in Networks." *International Public Management Journal* 10, no. 1, (2007):103–111.

24 Rhys, Andrews and Tom Entwistle. "Does Cross-Sectoral Partnership Deliver? An Empirical Exploration of Public Service Effectiveness, Efficiency, and Equity." *Journal of Public Administration Research and Theory* 20 (2010): 679–701.

Emerson et al. assert that the uncertainty of wicked societal problems cannot be managed by a single entity.[25] Hence, organizations collaborate in order to reduce, diffuse, and share risk. The authors state that leadership, interdependence, and consequential incentives are other preconditions for collaborative action.

To give a specific example, van Bueren et al. used a policy network framework to analyze the collaborative process in a Dutch zinc case. They found that risks and uncertainties were associated with the emissions from zinc products. Solving this issue required collaboration among multiple policy actors to balance continued zinc production with reduced pollution.[26]

In the same vein, Bryson et al.; Agranoff and McGuire; and Kickert, et al., argue that the growing importance of cross-sector partnerships is necessary and desirable to tackle tough social problems for beneficial community outcomes.[27, 28, 29] Many policy scholars offer conditions that led to the creation of public-private partnerships and have identified characteristics that constitute a successful and sustained partnership. For instance, Ansell and Gash and Rhys and Entwistle provide a contingency theory of the conditions that led to creating and maintaining successful cross-sector collaborations.[30, 31] They performed a meta-analytical study of 137 different policy cases and identified crucial variables that determine collaboration. They found that conditions that led to collaboration include past government failures and positive policy experiences. The variables under government failure consist of downstream implementation failure, high cost of traditional regulation, adversarial policy making, and accountability failures of managerialism. In their analysis, positive policy experiences include policy-learning, need for specialized knowledge, increase in institutional capacity, and prevention of stagnancy.

The work of Klijn and Koppenjan suggests that successful cross-collaboration is essentially an interaction of strategies of various actors or policy games that public managers play. According to the two scholars, some of the strategies include external mutual dependencies, learning processes, converging perceptions, and incentives to improve cooperation and limit interaction risks.

25 Emerson, Kirk, Tina Nabatchi and Stephen Balogh. "An Integrative Framework for Collaborative Governance," *Journal of Public Administration Research and Theory* 22, no. 1 (2011) : 1–29.

26 van Bueren, Ellen, Erik-Hans Klijn and Joop Koppenjan. "Dealing with Wicked Problems in Networks: Analyzing an Environmental Debate from a Network Perspective," *Journal of Public Administration Research and Theory* 13, no. 2 (2003) : 193–212.

27 Agranoff, Robert and Michael McGuire. "Another Look at Bargaining and Negotiating in Intergovernmental Management," *Journal of Public Administration Research and Theory* 14, no. 4 (2004): 495–512.

28 Bryson, John, Barbara Crosby and Melissa Middleton Stone, "The Design and Implementation of Cross-Sector Collaborations: Propositions from the Literature," *Public Administration Review* 66, no. 1 (2006) : 44–55.

29 Kickert,Walter J. M., Erik-Hans Klijn, and Joop Koppenjan. *Managing Complex Policy Networks* (London: Sage, 1997).

30 Ansell, Chris and Alison Gash. "Collaborative Governance in Theory and Practice," *Journal of Public Administration Research and Theory* 18, no. 4 (2008): 543–571.

31 Rhys, Andrews and Tom Entwistle. "Does Cross-Sectoral Partnership Deliver? An Empirical Exploration of Public Service Effectiveness, Efficiency, and Equity." *Journal of Public Administration Research and Theory* 20 (2010): 679–701.

Balleisen and Eisner lay out the prerequisites of successful co-regulation between public and private sector actors.[32] They assert that private regulatory actors must possess a genuine commitment to regulatory purposes and sufficient degree of institutional autonomy, while receiving adequate resources to do their jobs. The public sector actors must be responsible for having clear missions, flexibility in regulatory detail, sufficient expertise to access performance and oversight, and transparency about the actions of private regulators that third parties can evaluate.

Stiglitz and Wallsten study public-private technology partnerships and assert that for a partnership to be successful it is important for both public and private policy actors to have common shared objectives.[33] They suggest that even when interests are not aligned for both public and private sector actors, such partnerships can still be effective as long as they constitute formal incentive-accountability structures.

Agranoff and McGuire's study of high-stakes grants and contractual programs shows that two-way managerial games of bargaining and negotiating are important in collaborative partnerships.[34] They refer to Helen Ingram's study of environmental programs, suggesting that collaborative programs are more of an opportunity to bargain by different sector actors and less an instrument of federal control.

Having provided a background of the role of public-private partnerships in the U.S. environmental policy context and an overview of the existing literature on collaborative partnerships, this paper now proceeds to examine the three comparative case studies of the public-private partnerships with the U.S. EPA and the U.S. semiconductor industry.

Public-private Partnerships: EPA and the U.S. Semiconductor Industry

In recent decades, the U.S. regulatory and institutional landscape has undergone a variety of changes in the environmental policy arena. The private sector has helped lead the environmental agenda by engaging in self-regulation, voluntary initiatives, and exceeding the minimum compliance to improve environmental performance. The U.S. semiconductor industry in particular is a good example of this leadership.

The semiconductor industry is relatively a clean industry when measured against traditional manufacturing. Compared to other pollution-intensive manufacturing processes for products such as chemicals, paint, petroleum and automobiles, and coal the semiconductor industry was responsible for less than 0.08 percent of the

32 Balleisen, Edward and Marc Eisner. "The Promise and Pitfalls of Co-regulation: How Governments Can Draw on Private Governance for Public Purpose," in *New Perspectives on Regulation*, ed. David Moss and John Cisternino (Cambridge, Massachusetts: Library of Congress, 2009), 127–150.

33 Stiglitz, Joseph E. and Scott J Wallsten. "Public-Private Technology Partnerships: Promises and Pitfalls," *American Behavioral Scientist* 43, no. 1 (1999) : 52–73.

34 Agranoff, Robert and Michael McGuire. "Another Look at Bargaining and Negotiating in Intergovernmental Management," *Journal of Public Administration Research and Theory* 14, no. 4 (2004): 495–512.

total U.S. greenhouse gas emissions in 2010.[35] However, according to Moore's law,[36] the semiconductor industry may require continued reliance on critical chemicals that may have harmful environmental, safety, and health concerns. In the past, the industry has come under scrutiny for worker safety concerns, occupational hazards, water and energy use, and release of toxic chemicals.[37]

The report by the Center for Environmental Policy identified some key challenges for the semiconductor industry in the coming years.[38] These included having regulatory certainty and consistency; maintaining high levels of environmental performance, while remaining globally competitive; having continued access to critical chemicals; and sustaining the technology innovation needed to deliver economic benefits, while maintaining regulator and public confidence. The report also concluded that the semiconductor industry has the opportunity to tackle its challenges through its continued voluntary initiatives; self-regulation; and work toward a regulatory reform of related environmental statutes such as the U.S. Toxic Substances Control Act (TSCA), the Resource Conservation and Recovery Act (RCRA), and Federal Insecticide Fungicide and Rodenticide Act (FIFRA).

In order to address its environmental challenges while remaining competitive in the global marketplace, the semiconductor industry has positioned itself as a proactive player in shaping the U.S. regulatory framework. One of the ways the industry has worked with the government is through public-private partnerships. Over the past two decades, the semiconductor industry has partnered with the EPA to improve the industry's environmental performance with respect to greenhouse gas emissions, phase-out of harmful chemicals such as lead, reach energy efficiency, and reduce its water use. Some of these collaborative efforts culminated in prominent public-private partnerships, namely, The Common Sense Initiative, Project XL, The Climate Partnership program. Table 1 below provides basic information on the three partnerships.

35 US Environmental Protection Agency. Greenhouse Gas Inventory Report (2011).

36 Intel's co-founder, Gordon-Moore's bold prediction, popularly known as Moore's Law, states that the number of transistors on a chip will double approximately every two years.

37 Mazurek, Jan. *Making microchips: Policy, Globalization, and Economic Restructuring in the Semiconductor Industry* (Cambridge, Massachusetts: MIT Press, 1999).

38 The Center for Environmental Policy. *Regulation, Innovation, and the Semiconductor Industry: Policy and Management Options for Chemical Issues* (2011).

Table 1: General information on the EPA-U.S. semiconductor industry public-private partnerships

Project	*Objective(s)*	*Members/Participants*
Common Sense Initiative (CSI) (1994–1998)	i. Comprehensive and consistent environmental strategies ii. Permitting and enforcement iii. Pollution prevention iv. Stakeholder participation	Computers and electronics, auto, iron and steel, metal, printing, and petroleum industries
Project XL (1995–2002)	i. Cost-effective regulatory approaches ii. Innovative regulatory approaches iii. Economic gains for business and environment iv. Effective public engagement	Businesses, communities, state and local government, federal facilities
PFC Reduction / Climate Partnership (1996–Present)	Kyoto Target: 10 percent absolute reductions in perfluorinated chemicals (PFCs) of the 1990 baseline by 2000	US semiconductor manufacturers, World Semiconductor Council (WSC), Semiconductor Industry Associations of US, Europe, Korea, Japan, and China

The Common Sense Initiative (1994–1998)

The Common Sense Initiative (CSI) was the first major reinvention step taken by the Clinton administration in 1994. It was seen partly as a reaction to the long-held criticism of the EPA's command-and-control strategies.[39] Under CSI, the EPA took a novel sector-to-sector approach and worked with stakeholders across six different industry sectors, including computers and electronics, automobile, iron and steel, printing, metal, and petroleum to achieve cleaner, cheaper, and smarter approaches to environmental pollution control.

CSI's main objectives were to create comprehensive and consistent environmental strategies, develop an efficient permitting process and enforcement mechanisms, provide participating industries the incentives to develop pollution-prevention technologies, invite stakeholder participation, encourage companies to exceed minimal requirements, and motivate participating industries toward clear and transparent reporting and record-keeping.

For each of the six participating sectors, the EPA brought together multiple stakeholders, including the industry, local and state agencies, and representatives from environmental NGOs (eNGOs) and labor groups to identify and eliminate conflicting or contradictory regulations.[40] The rationale for this action was that if

39 Coglianese, Cary and Laurie Allen. "Building Sector Based Consensus: A Review of US EPA's Common Sense Initiative," in *Industrial Transformation: Environmental Policy Innovation in the United States and Europe*, ed. Theo de Bruijn and Vicki Norberg-Bohm (Cambridge, Massachusetts: The MIT Press, 2005).

40 Mazurek, Jan. *Making microchips: Policy, Globalization, and Economic Restructuring in the Semiconductor Industry* (Cambridge, Massachusetts: MIT Press, 1999).

the stakeholders developed the standards themselves, they could avert any future costs and time consuming adversarial processes.[41]

According to some industry experts, CSI was a modest success in terms of attaining tangible results. Yet, a former EPA official labeled the partnership as an "outright failure." According to an official and other experts, CSI was a lofty endeavor,[42] but one of the major reasons the partnership failed is because the EPA "tried to do too much."[43] The official further explained that getting all stakeholders together from the six different industries was a novel idea in theory; however, in practice, they did not follow through with implementation. The official also attributed the unsatisfactory performance to goals that were vague and procedural rules that were open-ended.[44] For instance, one of the projects aimed at the computers and electronics sector focused on promoting the creation of zero wastewater discharge systems, but the project was hindered by a lack of clarity on how these systems fit into the existing legal framework.[45]

Carol Browner, the EPA administrator at the time of the partnership, labeled CSI as a "bold experiment." The sector-by-sector, pollutant-specific strategy was an unprecedented approach, which brought traditionally adversarial stakeholders to the same table.[46] And despite its shortcomings, some policy and industry experts viewed CSI to be a significant effort of the EPA to reinvent regulation and provide good policy learning. For instance, the use of stakeholder dialogues reflected the effort to capture diverse interests in a collaborative process. The project led to some transparency in industry recordkeeping and reporting.[47] As per the stated goals, large firms started voluntarily reporting their environmental performance, while smaller firms maintained compliance manuals.[48] CSI also helped streamline proper disposal and recovery of lead-heavy semiconductor devices, such as cathode ray tubes (CRTs). Through this partnership, the industry worked with the EPA to make recycling and re-use of some of the semiconductor devices more efficient and the process easier to comply with under the EPA Resource Conservation and Recovery Act (RCRA), federal hazardous waste laws.

41 "What is Project XL?" last modified January 12, 2011. http://www.epa.gov/projectxl/file2.htm

42 Coglianese, Cary and Laurie Allen. "Building Sector Based Consensus: A Review of US EPA's Common Sense Initiative," in *Industrial Transformation: Environmental Policy Innovation in the United States and Europe*, ed. Theo de Bruijn and Vicki Norberg-Bohm (Cambridge, Massachusetts: The MIT Press, 2005).

43 Personal communication with author, November 19, 2011.

44 Fiorino, Daniel J. *The New Environmental Regulation* (Cambridge, Massachusetts: The MIT Press, 2006).

45 Coglianese, Cary and Laurie Allen. "Building Sector Based Consensus: A Review of US EPA's Common Sense Initiative," in *Industrial Transformation: Environmental Policy Innovation in the United States and Europe*, ed. Theo de Bruijn and Vicki Norberg-Bohm (Cambridge, Massachusetts: The MIT Press, 2005).

46 U.S. Environmental Protection Agency. *The Common Sense Initiative: Lessons Learned About Protecting the Environment in Common Sense, Cost Effective Ways* (Washington, DC: U.S. EPA, 1998).

47 Fiorino, Daniel J. *The New Environmental Regulation* (Cambridge, Massachusetts: The MIT Press, 2006).

48 Coglianese Cary and Laurie Allen. "Building Sector Based Consensus: A Review of US EPA's Common Sense Initiative," in *Industrial Transformation: Environmental Policy Innovation in the United States and Europe*, ed. Theo de Bruijn and Vicki Norberg-Bohm (Cambridge, Massachusetts: The MIT Press, 2005).

Project XL (1995–2002)

In 1995, as a part of reinventing environmental regulation, the EPA's Office of Policy, Economics, and Innovation introduced Project XL ('eXcellence and Leadership'). Project XL was a national pilot program that allowed state and local governments, federal facilities, businesses, and communities to develop innovative regulatory approaches with the EPA to test better or more cost-effective ways of achieving environmental and public health protection.[49] In return, the EPA issued regulatory or procedural flexibilities to industries.

The basic tenet of Project XL can be explained in terms of its three elements. Through prudent experimentation and regulatory flexibility, the EPA and its partners can find economic gains for businesses and government, more effectively engage the public in decisions that affect local environments, and achieve a cleaner environment.[50]

Unlike command-and-control strategies, Project XL truly adopted a performance-based approach. The participating actors were given the flexibility to adopt alternative strategies to replace or modify existing regulatory requirements in return for producing better environmental performance. The project convened stakeholder dialogues that represented community interests and provided citizen participation. Once the EPA approved an initial proposal, the applicant, usually a company, worked with federal, state, and local authorities and citizen groups on a final project agreement. The EPA ultimately developed more than fifty environmental innovation pilot projects under Project XL.

However, Project XL was a not without its problems. With an initial enthusiasm of a dozen companies such as Intel, Union Carbide, 3M, and Merck that applied in the initial round of the project, the participation levels dramatically reduced due to several issues that cropped up within the first year of the project. One major criticism was that Project XL low-balled expected performance at the facility level and did not quite "push the envelope" in terms of partnership outputs.[51] Project XL was also regarded as lacking statutory basis for providing certain flexibilities to the industries. For instance, facilities explored a type of flexible air permits that, at the time, was not explicitly allowed under the EPA Clean Air Act. A lack of clearly defined goals, a questionable partnership design, and legitimacy of the stakeholder process were some of the other criticisms of the project.[52]

Despite some of its pitfalls, the partnership was successful in providing companies an opportunity to develop innovative environmental improvements and reduce compliance and transaction costs. For instance, according to the EPA's *Comprehensive Report* on Project XL, seventy innovations came out of the fifty successfully completed projects.[53] The average transaction costs of coordinating

49 "What is Project XL?" last modified January 12, 2011. http://www.epa.gov/projectxl/file2.htm

50 "Easier Recycling of Cathode Ray Tubes," last modified November 15, 2012. http://www.epa.gov/osw/hazard/recycling/electron/crt-fs06.htm

51 Former EPA official, personal communication with author, November 19, 2011.

52 Fiorino, Daniel J. *The New Environmental Regulation* (Cambridge, Massachusetts: The MIT Press, 2006).

53 U.S. Environmental Protection Agency. *Project XL: Directory of Regulatory, Policy, and Technological Innovations 2000 Comprehensive Report* (Washington, D.C.: U.S. EPA, 2000).

among different stakeholders fell from $600,000 to $100,000 in less than five years.[54] In terms of environmental gains, companies such as Crompton Sisterville, Intel, Molex, Vandenberg AFB, and Weyerhaeuser achieved substantial reductions in their emissions, while increasing water reuse and recycling.[55]

Project XL is also recognized for creating innovative techniques to reduce air pollution. For instance, Intel developed flexible air permits known as plant-wide applicability (PAL) limits that were tested at a plant in Chandler, Arizona. The PAL limits later became a model for developing the EPA's new system for flexible air permits.[56]

PFC Reduction / Climate Partnership (1996–Present)

With support from the U.S. semiconductor industry, the EPA's Climate Protection division created the PFC Reduction/Climate Partnership in 1996. Perfluorinated compounds (PFC) is a collective name for potent and persistent greenhouse gases (GHG), which are potentially released in certain amounts during the wafer manufacturing process. The original PFC Reduction/Climate Partnership consisted of twenty-two U.S. semiconductor manufacturers, which were responsible for 70 percent of PFC emissions from the sector; the Semiconductor Industry Association (SIA); the World Semiconductor Council (WSC);[57] the European Commission; and global semiconductor trade associations.

In 1998, PFC emission reduction was recognized as the semiconductor industry's top environmental priority. Following this recognition, in April 1999 the World Semiconductor Council pledged to reduce the industry's PFC emissions by the Kyoto Protocol target of at least 10 percent below the 1995 baseline level by year-end 2010.[58] During the course of the partnership, the semiconductor manufacturers worked alongside the EPA to develop a cost-effective pollution prevention strategy, identify and implement PFC-reducing process changes, and make tool improvements for integrated circuits. At present, the partnership continues, but without any specific reduction target.

Overall, the partnership is recognized as a success. By 2003, the U.S. semiconductor industry achieved its 10 percent reduction goal. The industry then

54 Fiorino, Daniel J. *The New Environmental Regulation* (Cambridge, Massachusetts: The MIT Press, 2006).

55 U.S. Environmental Protection Agency. *Project XL: Directory of Regulatory, Policy, and Technological Innovations 2000 Comprehensive Report* (Washington, D.C.: U.S. EPA, 2000).

56 Former EPA official, personal communication with author, November 19, 2011.

57 The WSC was formed in 1996 to address market access issues and promote industry cooperation on economic, trade and environmental issues facing the global semiconductor industry, includes semiconductor industry associations of US, Europe, Korea, Japan, and China. The WCS members represent 90% of world semiconductors (Source: http://www.epa.gov/semiconductor-pfc/international.html)

58 U.S. Environmental Protection Agency. *Energy Star and Other Climate Protection Partnerships 2007 Annual Report* (Washington, D.C. : U.S. EPA, 2007).

surpassed the goal in 2004, despite an increased wafer demand over time.[59] A positive outcome was that the participating companies including Intel, IBM, Applied Materials, Motorola, Hewlett Packard, Advanced Micro Devices, and others started publicly reporting their energy use.[60] One of the biggest wins of the partnership that a former EPA official identified was that in 1994 the growing Chinese semiconductor industry—with high projected PFC emissions—agreed to join the World Semiconductor Council to set absolute PFC reduction targets.[61] According to the United Nations Framework Convention on Climate Change, the tracking and reporting scheme implemented under this partnership enabled participants to document early contributions to the prevention of global climate change.[62]

One of the challenges recognized by the EPA was the sustained effort required to maintain flexibility and leadership when aligning the U.S. semiconductor industry efforts with its semiconductor manufacturing units that operated in developing economies with varying government rules and regulations.[63] A subtle yet important challenge pointed out by the former EPA official was that the EPA implicitly expected that the industry would continue to reduce its PFC emissions even after meeting the original PFC reduction target in 2003. Those expectations were not quite fulfilled by the semiconductor industry. The official further noted that this incident somewhat strained the already delicate relationship between the EPA and the U.S. Semiconductor Industry Association and may have acted as a stumbling block for future partnerships and negotiations.[64]

Despite the shortcomings of the partnership, it had some positive impacts. The involvement of the U.S. semiconductor industry in the PFC reduction partnership was well-received by the global environmental and regulatory community. Notably, the semiconductor industry became one of the first industries to have globally coordinated a voluntary reduction in its greenhouse gas emissions. Additionally, the partnership served as a catalyst for the semiconductor industry in Europe and Asia to commit to absolute reductions in their emissions.[65] Acknowledging the efforts of the semiconductor industry in the partnership, the EPA regarded it as "demonstrating a true commitment to protecting the environment."[66]

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59 Beu, Laurie. *Reduction of Perfluorocompound (PFC) Emissions: 2005 State-of-the-Technology Report* (Austin, Texas: International SEMATECH Manufacturing Initiative, 2005).

60 Intel Corporation. *Our Climate Change Commitment* (2009).

61 Former EPA official, personal communication with author, November 19, 2011.

62 "U.S. Voluntary PFC Emission Reduction Partnership for Semiconductors," last modified 2013. http://unfccc.int/2860.php

63 U.S. Environmental Protection Agency. *Energy Star and Other Climate Protection Partnerships 2007 Annual Report* (Washington, D.C. : U.S. EPA, 2007).

64 Former EPA official, personal communication with author, November 19, 2011.

65 Beu, Laurie. Reduction of Perfluorocompound (PFC) Emissions: 2005 State-of-the-Technology Report (Austin, Texas: International SEMATECH Manufacturing Initiative, 2005).

66 U.S. Environmental Protection Agency. *Energy Star and Other Climate Protection Partnerships 2007 Annual Report* (Washington, D.C. : U.S. EPA, 2007).

Analysis of the Three Public-private Partnerships

Given the background of the three public-private partnerships above, this section is an assessment on the basis of cost-effectiveness, environmental performance, and long-lasting policy impacts of the three partnerships. Long-lasting policy impacts are divided into policy learning by government officials and industry impacts. Table 2 below summarizes the results of the three partnerships.

Table 2: Performance of the EPA-U.S. Semiconductor Industry Public-private Partnerships

Project	Environmental Performance	Cost-Effectiveness	Policy Learning Industry Impacts
Common Sense Initiative (CSI)	Increased proper recycling of cathode ray tubes (CRTs)	Only cost effective for private sector; eNGOs dropped out due to lack of funds and no financial support by the EPA	i. Collaboration ii. Voluntary reporting iii. Compliance manuals iii. EPA Record keeping
Project XL	i. 52 percent emission reductions ii. Increased solid waste recycling iii. 70 percent increase water reuse in 2000 (1997 levels)	Average transaction costs fell from $600,000 to $100,000 in less than 5 years	i. Flexible air permits introduced under EPA's Clean Air Act ii. Revised EPA RCRA for proper labeling and recycling of cathode ray tubes
PFC Reduction / Climate Partnership	i. Met and surpassed perfluorinated chemical reduction goal by 2004 ii. By 2000, a 56 percent per reduction of perfluorinated chemicals by Intel	Developed innovative technologies that could mitigate perfluorinated chemical emissions	i. Public reporting of annual energy use ii. China commit to PFC reductions iii. Forestalled Europe's perfluorinated chemicals ban

Cost-Effectiveness

One of the stated objectives common across all three collaborations was to achieve, in a cost-effective manner, high environmental performance. A 2007 McKinsey report noted that the EPA climate protection partnerships with the private sector had been highly cost-effective mechanisms for reducing GHG emissions.[67] This statement however, may only be valid for the PFC Reduction/ Climate Partnership and to a certain extent for Project XL. Despite the fact that

67 McKinsey and Company. *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?* (2007).

PFC reduction requires substantial investment in technology and infrastructure, the PFC Reduction/Climate Partnership resulted in developing innovative technologies, which helped meet the targets at reduced costs. Further, the coordination efforts of the members with global partners, chemical suppliers, and equipment manufacturers helped distribute cost and reach economies of scale.[68] As a result of meeting the PFC target, the semiconductor industry avoided the cost of emission damages, in the form of fees and liability. Under Project XL, the average transaction costs between the government and semiconductor industry fell by 80 percent in less than five years.[69] Also, once the plant-wide applicability limits (PALs) was made a federal standard, the industry benefitted from scaling up its existing infrastructure in Arizona to facilities in Oregon and New Mexico.

With regard to CSI, the partnership was cost-effective only from the industry's perspective. It was noted that some eNGOs that were originally a part of the partnership had to drop out due to lack of financial resources and EPA financial assistance.[70]

Environmental Performance

In the area of environmental performance, the PFC Reduction/Climate Partnership stands apart from the three partnerships studied. Under the partnership, the U.S. semiconductor industry achieved the 10 percent reduction goal in 2003 and surpassed its 2010 target in 2004.[71] By 2000, Intel Corporation—one of the largest semiconductor companies and the partnership leader—had reduced its PFC emissions by 56 percent in absolute terms.[72]

Through the project's lifetime, Project XL experienced some cumulative environmental benefits from large chemicals, water, and energy intensive companies. Participating companies achieved 52 percent emission reductions in the six air pollutants under the U.S. Clean Air Act, namely lead, ozone, particulate matter, carbon monoxide, sulphur dioxide, and nitrogen oxide. The companies increased their solid waste recycling by 8,700 tons and achieved a 70 percent increase in water reuse from their 1997 levels.

Even though the CSI partnership did not achieve substantial environmental gains, the semiconductor industry started the safe recycling and reuse of certain mercury- and lead-heavy manufacturing devices. This step led to some environmental and health benefits including energy savings, conservation of resources, and the diversion of harmful substances from reaching landfills.[73]

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68 "U.S. Voluntary PFC Emission Reduction Partnership for Semiconductors," last modified 2013. http://unfccc.int/2860.php

69 Fiorino, Daniel J. *The New Environmental Regulation* (Cambridge, Massachusetts: The MIT Press, 2006).

70 Former EPA official, personal communication with author, November 19, 2011.

71 Beu, Laurie. *Reduction of Perfluorocompound (PFC) Emissions: 2005 State-of-the-Technology Report* (Austin, Texas: International SEMATECH Manufacturing Initiative, 2005).

72 Little, T. (2000). Intel PFC Report: Intel Corporation.

73 The National Center for Environmental Economics. *The United States Experience with Economic Incentives for Protecting the Environment* (Washington, D.C: U.S. EPA, 2001).

Long-Lasting Policy Impact

One of the positive outcomes of the three partnerships was the lasting impact on policy. For instance, the CSI partnership opened the door for future collaborations between traditionally adversarial actors. In his evaluation of CSI, Fiorino notes that most of the participants were satisfied with the engagement process and good working relationships were forged between the industry, environmentalists, and government officials. The EPA report recognized CSI in promoting 'unprecedented levels' of cooperation among stakeholders.[74, 75]

Some successful projects piloted by the industry ultimately became federal standards. For instance, Intel's facility-level PALs project was scaled up to become a nation-wide standard under the U.S. Clean Air Act. In 2007, through the CSI partnership, the semiconductor industry was able to reform the EPA RCRA rule to label glass tubes as universal waste instead of hazardous waste. This ruling was a win-win for the industry as well as the government. The industry was able to effectively manage its waste and consistently comply with the EPA RCRA, and the EPA was able to avert dangerous exposures and dangerous impacts on human health. According to the EPA, this ruling improved the implementation and compliance to the federal hazardous waste program.[76] It also advanced environmental goals of energy savings and resource conservation.

Policy Lessons Learned

Policy learning is often considered a desirable goal for policy analysis and debate. As May rightly pointed out in his analysis of a set of U.S. policies, "policy failures present opportunities for policy learning." A diverse set of scholars including Charles Lindblom highlight the importance of learning as a foundation for improving policy making.[77, 78] As pointed out in the previous section, one of most significant outcomes of these partnerships is the policy learning, evolution, and the new industry initiatives. While some new partnerships have been built on the past experiences, the following policy lessons are critical for public as well as private sector actors in the nature, design, and implementation of future public-private partnerships.

Importance of Strong Implementation Enforcement

The partnerships' experiences underscore the importance of a strong design, clearly pre-stated goals, and effective enforcement mechanisms. With CSI, for

74 Fiorino, Daniel J. *The New Environmental Regulation* (Cambridge, Massachusetts: The MIT Press, 2006).

75 U.S. Environmental Protection Agency. *The Common Sense Initiative: Lessons Learned About Protecting the Environment in Common Sense, Cost Effective Ways* (Washington, DC: U.S. EPA, 1998).

76 "Easier Recycling of Cathode Ray Tubes," last modified November 15, 2012. http://www.epa.gov/osw/hazard/recycling/electron/crt-fs06.htm

77 May, Peter J. "Policy Learning and Failure." *Journal of Public Policy* 12, no. 4 (1992): 331–354.

78 Lindblom, Charles. *Inquiry and Change* (New Haven: Yale University Press, 1990).

instance, it was noted that the EPA tried to take on a large project of coordinating among multiple industry sectors, which was beyond the agency's institutional capacity.[79] Further, owing to a failure in downstream implementation, the CSI's grand goals were not fulfilled. Another reason given to explain the failure was that the goals were ambiguous and open-ended.[80] This experience highlights that open-ended goals leave room for potential misinterpretation and may lead to a case of what Bohte and Meier refer to as goal displacement by policy actors.[81]

In the PFC Reduction/Climate Partnership case, the EPA's lack of strong enforcement and unclear expectations played a large role in the waning interest and commitment of the semiconductor industry. The EPA had assumed that after the targets had been met, the industry would continue to work toward further reducing its emissions. And hence, the EPA did not declare any enforceable targets. Due to a lack of clear enforcement and expectations, the industry was neither legally liable nor incentivized to invest its time and resources into PFC reductions. Thus, the EPA's goal ambiguity as well as the semiconductor industry's lack of accountability led to erosion of mutual trust between the two parties and created an obstacle for potential partnerships in the future. These instances highlight the importance of strong implementation and enforcement, which can ensure accountability and help strengthen mutual trust to a certain extent.

Flexibility Can Be a Double-Edged Sword

One common criticism of the EPA regulations—especially command-and-control—has been that they are often too prescriptive. Hence, the built-in flexibility offered by the public-private partnerships often helps provide companies an opportunity to develop innovative ways to achieve a set target. The architects of CSI and Project XL hoped that by providing greater regulatory flexibility and less oversight, high-performing firms would simultaneously improve environmental quality and U.S. competitiveness.[82] However, especially in the case of Project XL, a lack of a legal authorization and weakened implementation did not make members accountable for decision-making at the plant level.

According to Fiorino, flexibility can also be viewed as a strength.[83] These partnerships enabled the EPA to try innovative policy instruments and technologies to respond to issues without cumbersome legal prescriptions. In general, it is important to note that because participation to these partnerships is voluntary, firms decide to take part because they see some derived value in the form of better interactions with the government, legitimacy of actions, sharing of best practices, or other incentives.

79 Former EPA official, personal communication with author, November 19, 2011.

80 Fiorino, Daniel J. *The New Environmental Regulation* (Cambridge, Massachusetts: The MIT Press, 2006).

81 Bohte, John and Kenneth J. Meier. "Goal Displacement: Assessing the Motivation for Organizational Cheating," *Public Administration Review* 60, no. 2 (2000) : 173–182.

82 Mazurek, Jan. *Making microchips: Policy, Globalization, and Economic Restructuring in the Semiconductor Industry* (Cambridge, Massachusetts: MIT Press, 1999).

83 Fiorino, Daniel J. *The New Environmental Regulation* (Cambridge, Massachusetts: The MIT Press, 2006).

Outputs May Not Beget Outcomes

The objectives of a partnership either are direct, often short-term, tangible outputs, e.g., percentage of emissions reductions, or long-term outcomes of a policy, e.g., clean air. Often a partnership or a policy success is solely evaluated on the basis of direct measurable outputs, without considering its long-term outcomes. The PFC Reduction/Climate Partnership is a good example. Once the goal or direct output of PFC reduction was met and exceeded, no effort was made to renew the goal. Since 2004, the partnership exists but without a clear standard. The program was in general labeled as a success based on meeting immediate outputs and making gains for the semiconductor industry on forestalling future PFC bans from Europe. However, in general, the project is seen as losing steam. For CSI, regulatory reform targets may have been achieved in the form of more reporting, compliance manuals, and recordkeeping, but these did not necessarily lead to any substantial environmental improvements.

Public-private Partnerships Are Not a Panacea

Despite some success of these public-private partnerships, it should be noted that when private and public sector actors are involved in the provision of public goods, both government and market failure is possible. And, even though the immediate outputs are met efficiently, these partnerships may not always result in long-term, socially desirable outcomes.

The PFC Reduction/Climate Partnership is a classic example of a bureaucratic and market failure. The bureaucratic failure stemmed from the fact that the EPA did not have strict enforceable mechanism and clear expectations of further reductions in PFC emissions after initial targets were met. The market failure stemmed from the fact that, in the absence of a binding agreement and a regulation, the private sector was not incentivized to invest time and resources into PFC reductions. Further, too many actors led to dispersion of responsibility, in which one expected the other to reduce its emissions and potentially gave room to free ride. Hence, public-private partnerships may not be the solution for solving all complex policy problems. And sometimes they are better serving as complements, than substitutes, to regulation.

One must not completely disregard the achievements and potential of these partnerships. Public-private partnerships, to a certain extent, were cost-effective, met the stated environmental targets, aided in policy learning, and spurred voluntary industry reporting. All this was done in the absence of any direct regulation. So, one must also note that in the absence of regulation, these partnerships may be a viable solution, and may serve as a precursor to future regulations.

Summary and Conclusions

Given the complex nature of our present environmental problems, the institutional landscape for environmental policy has changed over the recent decades. The top down command-and-control approach to regulating the industry no longer works to address the second- and third-generation environmental problems. Public-private partnerships have emerged in the environmental policy arena as a way to address these complex policy issues.

This paper evaluates the evolving role of public-private partnerships in U.S. environmental policy making. Using case studies of three noteworthy public-private partnerships between the EPA and the U.S. semiconductor industry, this paper analyzed their performance on basis of environmental goals, cost-effectiveness, and long-lasting policy impact. Results show that the three partnerships achieved mixed success over environmental goals and cost-effectiveness; however, all three contributed substantially to long-term policy impact. Further, partnerships like Project XL and CSI struck a chord among actors who were traditionally at odds and opened the doors to many such future collaborations. Additionally, these partnerships contributed important lessons learned.

Policy Implications

The lessons highlight the importance of the implementation, enforcement, and goal clarity for the success of public-private partnerships. Also, one must note that flexibility can be both a strength, e.g., technological innovations, as well as have some unintended consequences, e.g., lack of accountability. Keeping in context the realities of government and market failure in the provision of public goods, one must note that public-private partnerships may be a potential solution, but not a panacea. Their success is contextual and dependent on many factors internal and external to the sectors involved. And, depending on the public good in question, these partnerships may work better as a complement than a substitute to regulation. Therefore, one should be cautiously accepting of Hodge and Greve's label of public-private partnerships as the "policy for all seasons."

Given the government realties, current institutional settings, and the inherent market failure in managing a public good such as the environment, the results and experiences of these three partnerships are valuable both for public policy and private sector actors. These lessons also pave the way for other forms of cross-sector collaborations, such private sector collaboration with NGOs or the government working with the NGOs. As global environmental issues like sustainability and climate change become more pressing, the lessons learned will be important for the careful design and implementation of future successful public-private partnerships and other creative policy solutions.

Future Directions of Research

The challenges that emerged from the study of these partnerships are also the challenges with which the field of public management continues to contend. One of the unanswered questions is how to measure and effectively evaluate the success and failure of these partnerships. Given the challenge of government and market failure, should specific policy problems and the provision of certain public goods be solely managed by the government, the market, or both? My future research aims to answer these questions.

In terms of methodology, these cases hold some internal validity, i.e., the results of are relevant to the specific study in question. Thus, one can evaluate the performance and policy implications for a specific partnership. Cross-case comparison helps extend this internal validity beyond a single case to other cases that deal with the EPA and the U.S. semiconductor industry. However, in order to earn some external validity and offer some general conclusions about public-private partnerships, research is needed on longitudinal case studies of public-private partnerships of multiple industries across different countries. For instance, the U.S. semiconductor industry may look very different from the industry in Europe and Asia. Also, the U.S. semiconductor industry may have different conditions under which it partners with the EPA and has a successful partnership versus, for example, the U.S. automobile sector. The study also warrants some quantitative analysis to provide the basis for success or failure of partnerships on quantifiable parameters, such as cost-effectiveness and environmental performance. These answers may help resolve some of the dilemmas faced by policy-makers today while dealing with wicked problems like climate change and sustainability. These theoretical as well as methodological challenges open up some interesting areas of future research.