SHAPING CODE

Jay P. Kesan* & Rajiv C. Shah**

* Associate Professor, College of Law and Institute of Government and Public Affairs, University of Illinois at Urbana-Champaign.
** Doctoral Candidate, Institute of Communications Research, University of Illinois at Urbana-Champaign.
This material is based upon work supported by the National Science Foundation under Grant No. ITR-0081426. Any opinions, findings, and conclusions or

recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

I. INTRODUCTION

One of the most significant theoretical advancements in the legal academy is the recognition that law is not the only method of social regulation. Other methods of social control include social norms and architecture.[1] This has led researchers in a variety of disciplines to document how the architecture of information technologies or code affects our online experiences and activities.[2] The term "code" refers to the hardware and software components of information technologies. This has also led to policymakers to consider code-based as well as legal solutions to societal problems.[3] The problems addressed include preventing crime,[4] fostering competition,[5] limiting free speech,[6] protecting privacy,[7] increasing

---

[1] *See* LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE 95 (1999) (noting the role of architecture and social norms). Among the most influential works on social norms are Amitai Etzioni, *Social Norms: Internalization, Persuasion, and History*, 34 L. & SOC'Y REV. 157 (2000); ROBERT ELLICKSON, ORDER WITHOUT LAW (1991); Richard H. McAdams, *The Origin, Development, and Regulation of Norms*, 96 MICH. L. REV. 338 (1997); ERIC A. POSNER, LAW AND SOCIAL NORMS (2000).

[2] *See* Paul DiMaggio et al., *Social Implications of the Internet*, 27 ANN. REV. OF SOC. 307 (2001) (discussing the need for sociologists to attend to the architecture of information technologies); CARL L. SHAPIRO & HAL R. VARIAN, INFORMATION RULES (1998) (discussing how the architecture of information technologies can affect informational economics); François Bar, *The Construction of Marketplace Architecture*, *in* TRACKING A TRANSFORMATION: E-COMMERCE AND THE TERMS OF COMPETITION IN INDUSTRIES (2001) (discussing how consumer choice and market outcomes can be affected by the architecture of information technologies); Andrew J. Flannigan et al., *The Technical Code of the Internet/World Wide Web*, 17 CRITICAL STUD. MASS COMM. 409 (2000) (discussing the role of the architecture of information technologies for communication scholars).

[3] Neal Kumar Katyal, *Architecture as Crime Control*, 111 YALE L.J. 1039 (2002); TIMOTHY D. CROWE, CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN (2d ed. 2000).

[4] Neal Kumar Katyal, *Criminal Law in Cyberspace*, 149 U. PA. L. REV. 1003 (2001).

[5] The open access movement is based upon the principle that the architecture can support competition as well as providing a platform to support innovative applications. Mark A. Lemley & Lawrence Lessig, *The End of End-To-End: Preserving the Architecture of the Internet in the Broadband Era*, 48 UCLA L. REV. 925 (2001).

[6] This Article discusses the use of architectural solutions for addressing the problem of minors viewing inappropriate content. A number of commentators have addressed this issue. Lawrence Lessig & Paul Resnick, *Zoning Speech On The Internet: A Legal And Technical Model*, 98 MICH. L. REV. 395 (1999); Jonathan Weinberg, *Rating the Net*, 19 HASTINGS COMM. & ENT. L.J. 453 (1997). *See also* David E. Sorkin, *Technical and Legal Approaches to Unsolicited*

security,[8] ensuring fair use in copyright,[9] and revitalizing democratic discourse.[10]

In choosing architectural solutions, policymakers have had to rely on their own insights and experiences. There is no comprehensive analysis of the various methods government can use to reshape code. This article addresses this lacuna by building upon previous work by Reidenberg and others in discussing how government can influence the development of code.[11] The resulting

---

Electronic Mail, 35 U.S.F. L. REV. 325 (2001) (discussing approaches to limit unsolicited bulk email); CASS SUNSTEIN, REPUBLIC.COM 182-89 (2001) (proposing the redesign of web sites to incorporate links of different viewpoints to provide exposure to differing viewpoints).

[7] An example of an architectural solution for privacy is the Preferences for Privacy Project (P3P). *See* William McGeveran, *Programmed Privacy Promises: P3P and Web Privacy Law*, 76 N.Y.U. L. REV. 1813 (2001) (arguing for P3P as a solution to privacy problems. *See also* Malla Pollack, *Opt-In Government: Using the Internet to Empower Choice—Privacy Application*, 50 CATH. U. L. REV. 653 (2001) (proposing the creation of a government search engine that only links to web sites that protect a user's privacy); Shawn H. Helms, *Translating Privacy Values With Technology*, 7 B.U. J. SCI. & TECH. L. 288 (2001) (arguing the government, privacy advocacy groups, and users should support the adoption of privacy enhancing technologies).

[8] President's Critical Infrastructure Protection Board, *The National Strategy to Secure Cyberspace*¸ *available at* http://www.whitehouse.gov/pcipb/ (Sep. 2002) (suggesting a number of architectural solutions for improving security).

[9] Dan L. Burk & Julie E. Cohen, *Fair Use Infrastructure for Rights Management Systems*, 15 HARV. J.L. & TECH 41 (2001) (providing an example of an architectural solution to allow fair use in digital based intellectual property). The media industry has been very vocal in supporting architectural solutions to protection their intellectual property. Amy Harmon, *Hearings on Digital Movies and Privacy*, N.Y. TIMES, Mar. 2, 2002, *available at* http://www.nytimes.com/2002/03/01/technology/01DIGI.html. *See also*, Michael J. Madison, *Complexity and Copyright in Contradiction*, 18 CARDOZO ARTS & ENT. L.J. 125 (2000) (using the architectural metaphor to examine copyright law).

[10] *See* ANTHONY G. WILHELM, DEMOCRACY IN THE DIGITAL AGE 44-47 (2000); Cathy Bryan et al., *Electronic Democracy and the Civic Networking Movement in Context, in* CYBERDEMOCRACY 1 (Roza Tsagarousianou et al. eds., 1998).

[11] Reidenberg explicitly addresses how public policy can change code. Joel Reidenberg, *Lex Informatica: The Formulation of Information Policy Rules Through Technology*, 76 TEX. L. REV. 553, 588-92 (1998). *See also* STUART BIEGEL, BEYOND OUR CONTROL? CONFRONTING THE LIMITS OF OUR LEGAL SYSTEM IN THE AGE OF CYBERSPACE (2001) (providing a broad framework for regulating cyberspace). *See generally* David M. Hart, *U.S. Technology Policy: New Tools for New Times*, NIRA REV., (1998), *available at* http://www.nira.go.jp/publ/review/98summer/hart.html (providing a good summary of the various methods the government can use to shape the development of technologies); OFFICE OF TECHNOLOGY ASSESSMENT, GOVERNMENT

categorization defines various methods policymakers can use, while also providing an analyzing the possibilities and limitations of each approach. The resulting framework allows policymakers to encourage and proactively shape the development of code to meet a variety of societal concerns, such as privacy, security, and competition through the use of government's regulatory and fiscal powers.

While, this Article may seem unnecessary given the current rhetoric that government must keeps its hands off the internet, U.S. Department of Commerce General Counsel Andrew Pincus argues that "the needs and dynamics of the marketplace, and not governments, must guide standard development and implementation activities. Governments should refrain from issuing technical regulations and instead should rely, to the maximum extent possible, on the private sector to self-regulate."[12] The reality is that government has, is, and will be heavily involved in shaping the development of code. For example, consider recent legislation on unsolicited e-mail and regulations requiring cell phone number portability.[13] In addition to the proposals mentioned above, the government is also involved in shaping the development of code for reasons of antitrust,[14] national security,[15] protection of intellectual

---

INVOLVEMENT IN THE INNOVATION PROCESS (1978) (discussing various methods for government to shape technologies).

[12] Andre Pincus, General Counsel of the Department of Commerce, *The Role of Standards in Growth of the Global Electronic Commerce*, Oct. 28, 1999, *available at* http://www.useu.be/ISSUES/ecom1028.html.

[13] Controlling the Assault of Non-Solicited Pornography and Marketing Act of 2003, Pub. L. No. 108-127 (2004); Telephone Number Portability, CC Docket No. 95-116, *Memorandum Opinion and Order and Further Notice of Proposed Rulemaking*, FCC 03-284 (Nov. 10, 2003).

[14] For example, in the Microsoft antitrust trial the government is attempting to restrain Microsoft from using its code for illegal competitive advantages. Microsoft has "commingled" the code of its Internet Explorer browser and the Windows operating system to protect its monopoly power in violation of antitrust laws. While the remedy is still unclear, the government is influencing the design of code for the benefit of competition and ultimately consumers. The illegal commingling was upheld by the U.S. Court of Appeals for the District of Columbia. *See Appeals court rejects Microsoft, government requests*, ZDNET, Aug. 2, 2001, *available at* http://www.zdnet.com/eweek/stories/general/0,11011,2801117,00.html. *See also* Jay P. Kesan & Rajiv C. Shah, *Fool Us Once Shame on You – Fool Us Twice Shame On Us: What We Can Learn From the Privatizations of the Internet Backbone Network and the Domain Name System*, 79 WASH. U. L.Q. 89, 195 (2001) (noting how government modified code for competition during the privatization of the backbone network).

property rights,[16] accessibility,[17] safety,[18] and the labeling content.[19] Since government regulation generally seeks to prevent harm and

---

[15] For national security reasons, the government has restricted the sale of code. *See* Steven B. Winters & John A. Blomgren, *How the US Government Controls Technology*, 19 COMPUTER & INTERNET LAW. 1 (2002). The U.S. Government restricted the export of code containing strong encryption until 2000. This law led to companies, such as Netscape, having to market a weaker encryption version of their browser for download outside of the United States. In January 2000, a new encryption policy allowed the export of strong encryption in programs to most of the world. David E. Sanger & Jeri Clausing, *U.S. Removes More Limits on Encryption Technology*, N.Y. TIMES, Jan. 13, 2000, *available at* http://www.nytimes.com/library/tech/00/01/biztech/articles/13export.html.
Relatedly, the government eased export restrictions on the fastest computers. John Markoff, *White House Eases Exports*, N.Y. TIMES, Jan. 11, 2001, *available at* http://www.nytimes.com/2001/01/11/technology/11EXPO.html. Despite the terrorist attacks, the U.S. Government is not planning to require "backdoors" that would allow government access to encrypted communications. Declan McCullagh, *Senator Backs Off Backdoors*, WIRED NEWS, Oct. 17, 2001, *available at* http://www.wired.com/news/conflict/0,2100,47635,00.html.

[16] To protect intellectual property rights, the government uses both civil and criminal penalties. The government effectively shut down the music-trading program Napster for copyright violations. John Borland, *Database "upgrades" keep Napster down*, CNET NEWS.COM, July 6, 2001, *available at* http://news.cnet.com/news/0-1005-200-6443598.html. The government attempted prosecuting a programmer who wrote a program that circumvented Adobe's E-book format. Amy Harmon & Jennifer Lee, *Arrest Raises Stakes in Battle Over Copyright*, N.Y. TIMES, July 23, 2001; Roger Parloff, *Free Dmitry? Spare Me: Why the FBI Was Right to Arrest the Internet's Latest Martyr*, INSIDE.COM, Aug. 01, 2001, *available at* http://www.inside.com/product/Product.asp?pf_id=%7BE8EECFA3-CBD1-447E-952C-CC16283D266C%7D (providing an excellent review of the facts and circumstances around Dmitry Sklyarov's arrest).

[17] The government regulates the design of code for accessibility as a form of public welfare. For example, the government has required television manufacturers to incorporate closed captioning for the hearing impaired. Closed Caption Decoder Requirements for Television Receivers, 47 C.F.R. § 15.119 (2002); The FCC page on closed captioning is *at* http://www.fcc.gov/cib/dro/caption.html. Similarly, regulations require that federal agencies must become disability friendly. This has created demand for code that allows the development of accessible web sites. Carrie Johnson, *A More Accessible Web*, WASH. POST, Aug. 21, 2000, at E01.

[18] The FAA and the FDA regulate the development of code for the safety of society. *See* Leslie A. (Schad) Johnson, *DO-178B, Software Considerations in Airborne Systems and Equipment Certification*, CROSSTALK, Oct. 1998, *available at* http://www.stsc.hill.af.mil/crosstalk/1998/oct/schad.asp (focusing on DO-17B rules); George Romanski, The *Challenges of Software Certification*, CROSSTALK, Sep. 2001, *available at* http://www.stsc.hill.af.mil/crosstalk/2001/sep/romanski.asp (discussing how to ensure safe air transportation while using computer controlled systems). Similarly, the FDA also regulates medical device software for the benefit of public safety. These regulations require developers to use accepted software engineering practices during the development process to ensure the

promote benefits such as innovation, regulating with code is analogous to the architectural regulation found in buildings and cities,[20] transportation,[21] the environment,[22]and biotechnology.[23]

Discussed herein are various measures government can use to shape the development of code. For each measure, we identify and discuss regulatory and technological issues that affect its effectiveness. The result is a more informed approach in weighing the alterative approaches to shaping code. We do not attempt to determine the comparative efficiency of different approaches to shaping code, because, in part, that analysis is a factually laden inquiry depending on the specific characteristics and issues related to the particular type of code in question. Generally, government becomes involved when societal concerns are not being addressed in the marketplace and often uses a combination of these approaches to shape code.

This article contributes to three different literatures. First, it provides the regulatory literature with a work that is tailored to information technologies. It does this by largely building upon Justice Breyer's seminal work on regulatory theory.[24] The result is a framework that provides a comprehensive approach for regulating the Internet. Second, this article contributes to the emerging

---

software will operate properly. Quality System Regulation, 21 C.F.R. § 820 (1999); FDA, *Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices, available at* http://www.fda.gov/cdrh/ode/57.html (May 29, 1998); John K. Suzuki, *Documenting the Software Validation of Computer-Controlled Devices and Manufacturing Processes: A Guide for Small Manufacturers*, MED. DEVICE & DIAGNOSTIC INDUSTRY MAG., (Jan. 1996), *available at* http://www.devicelink.com/mddi/archive/96/01/023.html (providing an overview of the process).

[19]. The government has required television manufacturers to incorporate the "V-chip" which allows parents to block inappropriate television programs. Requirement for Manufacture of Televisions that Block Programs, 47 U.S.C. § 303(x) (2001); The FCC page on the V-Chip is *at* http://www.fcc.gov/vchip/legislation.html. Similarly, legislation requires public libraries funded by federal funds to install software to block obscene or pornographic images. *See* United States v. American Library Association, 539 U.S. 194 (2003).

[20] This literature encompasses urban planning through zoning and architecture through building codes. *See* JOHN LEVY, CONTEMPORARY URBAN PLANNING (1999); INTERNATIONAL BUILDING CODE (2000).

[21] ROBERT W. CRANDALL ET AL., REGULATING THE AUTOMOBILE 155-56 (1986).

[22] PETER S. MENELL & RICHARD B. STEWART, ENVIRONMENTAL LAW AND POLICY (1994).

[23] MICHAEL J. MALINOWSKI, BIOTECHNOLOGY: LAW, BUSINESS, AND REGULATION (1999).

[24] STEPHEN G. BREYER, REGULATION AND ITS REFORM (1982).

literature on using code as a regulatory mechanism. With this approach, code is used to modify or limit behavior, instead of relying upon users to limit their behavior because of legal sanctions. In the process of developing our framework, we highlight numerous ways in which code is or can be used by government as a regulatory mechanism. Third, this article contributes to the communications literature by highlighting how government shapes the medium of cyberspace. While communications scholars have focused on how code is developed, little attention has been focused on the myriad of ways government has traditionally shaped communications technologies to address societal concerns. [25]

This Article is organized in four parts. Part II discusses how government can use its regulatory power to shape code; specifically, prohibitions on code, using standards or market-based incentives, modifying liability, and requiring disclosure. We also argue that government needs to develop a comprehensive regulatory strategy for code. Part III discusses fiscal measures government can utilize, including government funding of research and development, the use of the government's procurement power, tax expenditures, and funding of education and training. In Part IV, we analyze how government can shape code through intellectual property rights. We discuss this in a general sense and then focus on compulsory licensing and technology transfer issues.

II. SHAPING CODE THROUGH REGULATORY METHODS

It is well established that government can and should shape code with its regulatory power.[26] This section provides a framework

[25] Much of the communication literature focuses on how corporations shape the medium. VINCENT MOSCO, THE POLITICAL ECONOMY OF COMMUNICATION: RETHINKING AND RENEWAL (1996); Robert McChesney, *The Political Economy of Global Communication*, *in* CAPITALISM AND THE INFORMATION AGE 1 (Robert McChesney et al. eds., 1998). But newer work recognizes other institutions, such as the open source movement, in the development of communication technologies. Rajiv C. Shah & Jay P. Kesan, *Deconstructing Code*, 6 YALE J. L. & TECH. (forthcoming 2004).

[26] Considerable support has amassed for the principle that government has a role in regulating the Internet. LESSIG, *supra* note 1, at 201-02; Neil Weinstock Netanel, *Cyberspace Self-Governance: A Skeptical View from Liberal Democratic Theory*, 88 CAL. L. REV. 395 (2000); Reidenberg, *supra* note 11; Jay P. Kesan & Rajiv C. Shah, *Fool Us Once Shame on You – Fool Us Twice Shame On Us: What We Can Learn From the Privatizations of the Internet Backbone Network and the Domain Name System*, 79 WASH. U. L.Q. 89 (2001); Jay P. Kesan & Andres A. Gallo, *Neither Bottom-Up Nor Top-Down: A Tacit Public Private Cooperative Solution*

of various regulatory tools and analyzes how they may be used to shape code. We do not attempt to formulate a simplistic model for how government should shape code. Instead, we attempt to provide a framework to highlight some of the critical issues that must be addressed when using any specific regulatory approach. This approach is preferable to a simplistic formulistic approach that is bound to fail due to numerous and varied factors prevalent in any attempted government regulation.[27]

Government may employ its regulatory power in five different ways to influence the development of code; all of which regulate harmful technology. Table 1, below, lists a brief synopsis of each regulatory method.

Method	**One word summation**	**Rationale**	**Examples of code-based regulation**
Prohibit Code	Ban	Harm is unacceptable at any level	Digital Millennium Copyright Action ban on anti-circumvention code Transmitting obscene content to minors across the Internet
Set standards	Stick	Require the use of technologies to reduce the harm	Closed captioning and V-Chip Requiring filtering software Digital broadcasting
Market-based regulation	Carrot	Limit the harm by making it more costly (taxes) or by limiting its quantity (property rights)	Creation of property, e.g., domain names and IP addresses

for Internet Regulation (forthcoming); Paul Schiff Berman, *Cyberspace and the State Action Debate: The Cultural Value of Applying Constitutional Norms to "Private Regulation"*, 71 COLO. L. REV. 1263 (2000); Henry H. Peritt, *Towards a Hybrid Regulatory Scheme for the Internet*, 2001 U. CHI. LEGAL F. 215 (2001); Margaret Jane Radin & R. Polk Wagner, *The Myth of Private Ordering: Rediscovering Legal Realism in Cyberspace*, 73 CHI.-KENT L. REV. 1295 (1998). Even libertarians agree that the government may have a role in regulating the Internet. *See* David Post, *What Larry Doesn't Get: Code, Law, and Liberty in Cyberspace*, 52 STAN. L. REV. 1439 (2000).

[27] *See* STEPHEN G. BREYER, REGULATION AND ITS REFORM 4-11 (1982) (discussing the rationale for using a framework approach in his work on government regulation).

Method	One word summation	Rationale	Examples of code-based regulation
Modify liability	Lawsuits	Encourage development of safer products	Advocated for increasing security, and part of the concern with UTICA
Disclosure	Warnings	Inform society about the harm	Labeling requirements for commercial email Disclosure security violations in computer systems in California CERT coordination center for informing users about security issues

Table 1. Regulatory methods for addressing harms

A. Prohibiting Code

Unlike regulation, which allows a certain level of a technology or activity, a prohibition holds there is no acceptable level within society.[28] Prohibited technologies and activities can involve national security, public safety, and environmental concerns,[29] e.g., the Communications Decency Act of 1996 attempted to prohibit the transmission of indecent and obscene material to minors.[30] In this section, we first present the chief criticisms of the government's use of prohibition as a regulatory mechanism. The remainder of the section addresses these criticisms and shows how prohibitions can shape code.

---

[28] We are focusing on prohibitions that actively shape code and not prohibitions that are focused on competition. In telecommunications, the government has long prohibited certain firms from engaging in certain activities to foster competition. For example, not allowing the baby Bells into the long distance market until they allow for competition in the local market. *See* Steve Bickerstaff, *Shackles on the Giant: How the Federal Government Created Microsoft, Personal Computers, and the Internet*, 78 TEX. L. REV. 1 (1999) (describing how competitive restrictions on AT&T shaped code).

[29] For example, banning of predatory fish, such as the snakehead fish. Here the government is saying, that it is in the interest of society that people do not have access to these fish. The potential costs to society are too great. *See* Anita Huslin, *At Last, U.S. Hopes, Snakehead is History*, WASH POST, Aug. 21, 2002, at B4 (discussing a forthcoming ban on snakehead fish).

[30] Communications Decency Act, 47 U.S.C. § 223 (1997).

The use of government prohibition has three major criticisms. First, since a prohibition does not allow for potentially beneficial uses, it is not an economically efficient means of regulation because its cost is much higher than its benefit.[31] Critics suggest that a less costly approach would be to use regulation with standards or require the use of product warnings. A second criticism, high cost, arises because the easy reproduction and transmission of code in a software format makes enforcement difficult. As an example, in the DeCSS case, members of the hacker community distributed a program that deciphered the encryption used to protect DVDs.[32] In a short time, this code spread across the world and is still readily available despite the efforts of the movie industry to stifle its distribution. The final criticism results from the negative effect of prohibition on innovation. By not allowing the development or sale of a technology, the government closes off a path for future research and development. This is especially pertinent to emerging areas of technological development and has been used widely in the recent debate over the use of stem cells. Proponents of stem cell research argue that limiting research could stifle the development of lifesaving medical breakthroughs.[33]

Despite these criticisms, prohibitions can be an efficient means of regulation. A prohibition is efficient when the cost of no prohibition to society greatly outweighs the needs of some citizens.[34] In these cases, society cannot permit the needs of a select few to outweigh those of the entire society.[35] Because regulations serve to provide an acceptable level of a technology or activity within society, when no such a balance is acceptable, prohibition becomes necessary. For example, the standard for banning a product by the

---

[31] James M. Buchanan, *In Defense of Caveat Emptor*, 38 U. CHI. L. REV. 64 (1970).

[32] David M. Ewalt, *DeCSS Case Could Change Your IT Shop*, INFORMATIONWEEK, July 16, 2001, *available at* http://www.informationweek.com/story/IWK20010711S0010.

[33] Office of the Director, National Institutes of Health, *Stem Cells: A Primer*, *available at* http://www.nih.gov/news/stemcell/primer.htm (last visited Aug. 3, 2002).

[34] The cost here is not purely economic cost, but social cost. There are many prohibitions based on moral grounds, such as human cloning. Many technologies associated with reproduction are prohibited or heavily regulated, for example stem cell research and cloning. *See* Vernon J. Ehlers, *The Case Against Human Cloning*, 27 HOFSTRA. L. REV. 523 (1999).

[35] *See* DAVID W. PEARCE & R. KERRY TURNER, ECONOMICS OF NATURAL RESOURCES AND THE ENVIRONMENT 44 (1990) (arguing that product bans are useful when the social costs clearly exceeds the social benefits).

Consumer Product Safety Commission is if "no feasible consumer product safety standard . . . would adequately protect the public from the unreasonable risk of injury."[36] Society has banned each of the following technologies: polychlorinated biphenyls (PCBs),[37] chlorofluorocarbons (CFCs),[38] and, without suggesting an equivalence amongst these examples, anti-circumvention code.[39]

A prohibition's enforcement costs are generally much lower than other regulatory actions. It is much simpler to enforce a ban on all uses of a technology rather than limiting a single product or activity. Since it is much more difficult to ensure a product is only being used or sold for its "permitted" use, once government allows such use, enforcement costs rise. Availability of substitutes is another factor that can lower the cost of enforcement. Substitutes that impose lower social costs can reduce demand for the prohibited product, thus easing enforcement of the prohibition. However, the lack of substitutes and continuing high demand for the prohibited product risk the creation of an illegal market. Looking at the ongoing drug war, the lack of substitutes for narcotics and the high demand has led to the formation of a vast illegal market. Thus, our analysis suggests that prohibitions are most efficient when enforced broadly across society and when users have access to substitute products.

Prohibitions on code can lead to high enforcement costs because of the ease of reproduction and transmission of code. Nonetheless, prohibitions on code are not useless. Rather, prohibition can still drastically limit the use of a technology through its effect on law-abiding individuals and firms. While there may be elements of society that bypass the prohibition, prohibitions can substantially reduce the social costs of undesired technology. This is true of intellectual property rights, which the government has protected by making it illegal to develop anti-circumvention code.[40] As a result, there are no legitimate firms selling such code.[41] While

---

[36] 15 U.S.C. § 2057 (1976). *See also* Richard A. Merrill, *CPSC Regulation of Cancer Risks in Consumer Products*, 67 VA. L. REV. 1261 (1981) (examining the Consumer Product Safety Commission's regulation of carcinogens).

[37] Toxic Substances Control Act, 15 U.S.C. § 2605 (e).

[38] Consumer Products Safety Commission, Regulations for Self-Pressurized Consumer Products Containing Chlorofluorocarbons, 16 C.F.R. § 1401.

[39] Digital Millennium Copyright Act, 17 U.S.C. § 1201(a)(1) (2001).

[40] *Id.*

[41] In the earlier days of personal computing, a popular genre was copy programs that circumvented copy protection. For example, *LockSmith* was a commercially available program that allowed its users to copy programs that were copy

this has not stopped the development of anti-circumvention code, the prohibition has severely limited distribution of this code out of concern for the potential liability exposure.[42] Similarly, prohibiting unsolicited email is not expected to solve the problem, but rather provide another means of reducing unsolicited email.[43]

We find it difficult to apply enforcement cost analysis to the government's restriction on the export of encryption technology. While the government historically restricted the export of encryption technology,[44] it has recently relaxed its export regulations and allowed the export of encryption technology.[45] The major exception to this policy is the prohibition against exports to Cuba, Iran, Iraq, Libya, North Korea, Sudan, and Syria.[46] Enforcement costs increase both because this prohibition is a limited one,[47] and because prohibited encryption technologies are readily available. We see an example of this is in export regulations which allow firms to publicly post their code on the web for download. According to the regulations, this is not considered a knowing export and is thus permissible, even though anyone, including people in the prohibited countries, can download the code.[48] Additionally, the lack of substitutes drives up enforcement costs. In fact, there are no substitutes or alternatives to alleviate the social costs arising from encryption technology which allow terrorists and criminal

---

protected. This was a legitimate need, as many software publishers would not provide a backup or replacement copy of the software if the disk became unreadable. *See* Donald W. Larson, User Land Discussion Archive, *Tales of Woz's Genius*, (July 7, 2000), *available at* http://static.userland.com/userLandDiscussArchive/msg018908.html.

[42] This can be seen in the efforts to place alternative programs and operating systems on Microsoft's Xbox gaming console. While individuals have circumvented the Xbox's security systems, this code has not been publicly distributed. *See* David Becker, *MIT Student Hacks into Xbox*, CNET NEWS.COM, (June 3, 2002), *available at* http://news.com.com/2100-1040-931296.html; David Becker, *"Mod Chip" for Hacking Xbox Discontinued*, CNET NEWS.COM, (June 26, 2002), *available at* http://news.com.com/2100-1040-939591.html.

[43] Jonathan Krim, *Anti-Spam Act Signed But Some Are Skeptical*, WASH POST, Dec. 17, 2003, at A18.

[44] Peter H. Lewis, *Privacy For Computers? Clinton Sets the Stage For a Debate on Data Encryption*, N.Y. TIMES, Sep. 11, 1995, at D7.

[45] *See supra* note 15.

[46] Revisions and Clarifications to Encryption Controls in the Export Administration Regulations, 67 Fed. Reg. 38, 855 (June 6, 2002).

[47] For example, this provision is found in the license of the Netscape browser. Netscape, *Netscape Browser Distribution Program License Agreement*, available at http://wp.netscape.com/bisdev/distribution/start.html (last visited Aug. 3, 2002).

[48] Export Administration Regulations, 15 C.F.R. § 15.740.13(e)(6).

organizations to conceal their communications.[49] The government did attempt to solve this problem with the Clipper chip, but the effort failed.[50] All of the aforementioned factors combine to create high enforcement costs, suggesting that current policy is not practical.[51]

Prohibitions can also provoke innovation and provide an impetus for research and development.[52] Conversely, prohibiting technologies in emerging industries can reduce innovation.[53] Research has shown that prohibitions have varying effects upon the development of substitutes by the existing "insider" firms within an industry. However, prohibitions can lead to new "outsider" firms developing technologically innovative substitutes.[54] One method of minimizing the impact of prohibitions upon innovation and encouraging the creation of substitutes is a gradual phasing out of the technology. The government implemented just such a policy by phasing out the production of CFCs thereby allowing the development of alternatives materials.[55]

An example of a code-based prohibition that could have provoked technological change is the now unconstitutional part of the CDA, which banned the transmission of indecent content to minors over the Internet. Without challenging the holding, based

---

[49] While lesser strength encryption products are not prohibited, they are not adequate substitutes for terrorist or criminal organizations. This is because the government is able to decrypt communications protected by these weaker products. *See* Daniel Verton, *DOD: Encryption Export Troubling*, FED. COMPUTER WK., (July 12, 1999).

[50] The Clipper chip was an encryption technology that left a "back door" for the government to eavesdrop on communications. However, it met with opposition and was never adopted. *See* LAURA J. GURAK, PERSUASION AND PRIVACY IN CYBERSPACE: THE ONLINE PROTESTS OVER LOTUS MARKETPLACE AND THE CLIPPER CHIP (1997); A. Michael Froomkin, *The Metaphor is the Key: Cryptography, the Clipper Chip, and the Constitution*, 143 U. PA. L. REV. 709, 752-59 (1995).

[51] While this policy is ineffectual from the standpoint of enforcement costs, there are other reasons why it may still be necessary. In this case, this policy is part of the Wassenaar Arrangement, which seeks to regulate dual-use technologies. *See* Revisions and Clarifications to Encryption Controls in the Export Administration Regulations, *supra* note 46.

[52] Nicholas Ashford et al., *Using Regulation to Change the Market for Innovation*, 9 HARV. ENVIRON. L. REV. 419 (1985).

[53] OFFICE OF TECHNOLOGY ASSESSMENT, ENVIRONMENTAL POLICY TOOLS: A USER'S GUIDE 100 (1995).

[54] Kurt A. Strasser, *Cleaner Technology, Pollution Prevention and Environmental Regulation*, 9 FORDHAM ENVTL. L.J. 1, 38-39 (1997) (discussing Ashford's research).

[55] OFFICE OF TECHNOLOGY ASSESSMENT, *supra* note 53, at 99-100.

correctly on the First Amendment, this prohibition could have accelerated the development of verification technologies to identify minors and filtering programs that ensure minors do not access indecent content. These technologies would have arisen as a byproduct of the large amount of indecent content accessible over the Internet.[56] Web sites would have supported technologies that allowed them to continue to provide indecent material. Minors, with limited economic resources, would have found it difficult to find the same material using alternate channels. This illustrates how the CDA could have used society-wide prohibition to shape the development of code.

B. Setting Standards: The Command and Control Approach

Government can shape the development of code by using standards mandating the technological requirements for code. This direct approach has traditionally been known as the command and control approach, with the government acting as both the enforcer and the standard-setter. This approach is often contrasted with the use of market-based incentives, discussed in the following section.[57] The government shapes three types of standards. The first category includes standards that promote transactions, interconnection, and interoperability.[58] Many code-based standards are of this type. Examples of these include standards for wireless communication,

---

[56] A new version of the CDA is now attempting to pass constitutional muster. Child Online Protection Act, Pub. L. No. 105-277, 112 Stat. 2681 (1998) (requiring sites that are harmful to minors to use an age verification barrier). It is being challenged. American Civil Liberties Union v. Reno, 217 F. 3d 162 (3rd Cir. 2000). *See* http://www.epic.org/free_speech/copa/ (providing further supporting documents).

[57] *See infra* Part II.C.

[58] These types of standards are known as process standards. Process standards facilitate transactions, such as standards for bills of lading. *See* Office of Technology Assessment, *supra* note 59, at 100. An important code-based process standard is for interconnection. Government can use interconnection standards for a number of purposes including facilitating competition. *See* Kesan & Shah, *supra* note 26, at 205 (discussing interconnection standards for the competition in telecommunications); Philip J. Weiser, *Internet Governance, Standard-setting, and Self-Regulation,* 28 N. KY. L. REV. 822 (discussing when government should regulate by mandating open, interoperable standards). Interconnection can even aid law enforcement. For example, the Communications Assistance for Law Enforcement Act requires telecommunication firms to ensure their infrastructure allows for wiretapping by law enforcement. Communications Assistance for Law Enforcement Act of 1994, Pub. L. No. 103-414, 108 Stat. 4279 (1994).

such as 802.11b, or for commerce, such as Secure Sockets Layer (SSL). The second category includes product standards, which provide information about a product's characteristics.[59] The U.S. Department of Agriculture (USDA) uses just such a standard in its labeling system for food.[60] A third type of standard protects against societal hazards or problems.[61] These safety-oriented standards are commonly used in environmental and transportation regulation. In this section we first discuss how technologically forward-looking the government should be in its regulatory efforts. Next, we discuss the different methods government can use in mandating standards.

1. Technology-Forcing

Technology forcing, an important issue in standard-setting, refers to regulatory efforts that direct the development of technologies along specific paths.[62] The standards force firms to either innovate or diffuse technologies. In the case of innovation, the government attempts to force the creation of new technologies. When using diffusion, the government forces firms to incorporate

---

[59] Product standards contain information on the characteristics of the products. This information allows for product identification, interoperability, and quality control. *See* OFFICE OF TECHNOLOGY ASSESSMENT, U.S. CONGRESS, GLOBAL STANDARDS: BUILDING BLOCKS FOR THE FUTURE 99 (1992). Government mandated product standards are discussed in more detail in a later section on the disclosure of code's characteristics. *See infra* Part II.E.

[60] U.S. DEPARTMENT OF AGRICULTURE, FOOD STANDARDS AND LABELING POLICY BOOK (1998).

[61] An example of a control standard is the quality requirements for automobile tires. *See* Federal Motor Vehicle Safety Standards, New Pneumatic Tires -- Passenger Cars manufactured after 1948, Part 571, Standard No. 109 (requiring every tire to have information encoded on the sidewall specifying temperature, speed, load, traction, and tread-life ratings). An example of a control standard for code is the requirement for televisions to incorporate closed captioning. Television Decoder Circuitry Act, Pub. L. No. 101-431, 104 Stat. 960 (codified at 47 U. S. C. § 303 (u), § 330 (b) (1990)) (regarding closed captioning); Sy Dubow, *The Television Decoder Circuitry Act—TV for All*, 64 TEMP. L. REV. 609 (1991). Another example is the FCC's regulation of radio frequency devices. Marketing of Radio-Frequency Devices, 47 C.F.R. § 2.801 (2001). *See also* Christopher Smallwood, *FCC Regulation of Computers*, COMPUTER LAW, (Mar. 1992), at 25. Control standards may also be used during the production of code. For example, the FAA and the FDA both use control standards to ensure the development process for code meets strict quality assurance guidelines. *See supra* note 18.

[62] Jerry L. Mashaw & David L. Harfst, *Regulation and Legal Culture: The Case of Motor Vehicle Safety*, 4 YALE J. ON REG. 257, n. 18 (1987) (defining technology-forcing).

existing technologies into their products. This use of technology-forcing regulation has varied by industry. Early automobile regulation used a significant amount of technology-forcing regulation while building code regulations contain little technology-forcing aspects.[63]

The first part of this section discusses and addresses criticisms of government's use of technology-forcing regulation to shape the development of code. The second part discusses code-based technology-forcing regulation and analyzes the Communications Decency Act from a technology-forcing perspective, providing insight into the failure of the CDA from a legal and technological standpoint.

In using technology-forcing regulation, a regulator must consider a number of criticisms.[64] First, why is government directing the development of technologies in specific areas? Critics argue this approach is ineffective, and the government can use other methods, such as market incentives, to shape technologies. Second, how is government able to accurately set technology-forcing regulations? The development of technologies is unpredictable and unforeseen.[65] Additionally, government has an even harder task in ascertaining technical advances than firms because it depends upon firms sharing state-of-the-art information. Such firms have an incentive to withhold and mislead the government to ensure that technology-forcing standards are lax and easily met. A final problem with

---

[63] Richard R. Nelson, *Government Stimulus of Technological Progress: Lessons from American History*, *in* GOVERNMENT AND TECHNICAL PROGRESS 451, 472 (Richard R. Nelson ed., 1982). *See also* Eric Lipton & James Glanz, *Sweeping Changes Pushed For Code On City High-Rises*, N.Y. TIMES, Aug. 2, 2002, at A1 (noting how building codes are slow to change and incorporate new technologies such as sprinkler systems).

[64] A number of commentators have criticized technology-forcing regulation. *See* STEPHEN G. BREYER, REGULATION AND ITS REFORM 106-07 (1982); Robert A. Leone, *Technology-Forcing Public Policies and the Automobile*, *in* ESSAYS IN TRANSPORTATION ECONOMICS AND POLITICS: A HANDBOOK IN HONOR OF JOHN R. MEYER 291 (Jose A. Gomez-Ibanez et al. eds., 1999) (arguing that we must consider alternatives to technology-forcing); Peter Huber, *The Old-New Division in Risk Regulation*, 69 VA. L. REV. 1025, 1061-67 (1983) (noting the problems with technology-forcing regulation); *see infra* note 104 (providing further criticisms on the use of technology-forcing for environmental standards. *But see infra* note 105 (providing a response from supporters of technology-forcing regulation).

[65] Nelson, *supra* note 63, at 454 (noting the uncertainty of technological advance based on a number of case studies); Robert W. Lucky, *Pondering the Unpredictability of the Sociotechnical System*, *in* ENGINEERING AS A SOCIAL ENTERPRISE 89 (Hedy E. Sladovich ed., 1991).

technology-forcing regulation is compliance costs. The more radical a change is, the higher the cost to industry, and the greater the incentive for firms to limit the regulations. Instead of developing or diffusing new technologies, this can lead to firms that try to reduce their costs by regulatory capture and litigation.[66]

In addressing the criticisms listed above, a policymaker must first justify the use of a technology-forcing regulation. In deciding to use a technology-forcing regulation, a regulator uses a stick approach rather than a carrot approach.[67] Both the inefficiency of market-based incentives and their politically unfeasibility favor technology-forcing regulation.

Technology-forcing regulations can be more efficient than market-based regulatory programs in two situations.[68] The first situation occurs when there are no existing technologies that address a societal concern. In this case, industry must be forced to develop new technologies.[69] For example, in passing the Clean Air Act, Congress was addressing public health concerns with little regard to technological or economic limitations.[70] A second situation occurs

---

[66] Another problem is obsolete technology-forcing standards. Since Congress does not revise regulations, periodically technology-forcing standards may become not feasible or in need of revision. This then shifts the problem of setting and enforcing these regulations to courts. Carolyn McNiven, *Using Severability Clauses to Solve the Attainment Deadline Dilemma in Environmental Statutes*, 80 CALIF. L. REV. 1255 (1992) (suggesting courts be given the power through severability clauses to remove obsolete deadlines).

[67] Leone, *supra* note 64, at 303.

[68] *See infra* Part II.C (discussing market-based regulatory programs).

[69] "[F]or some pollutants in particular industries there may be no existing or theoretical control technology; the control of pollution will then require the development of entirely new control equipment or manufacturing processes-that is, it will be necessary to force major technological innovation." La Pierre, *supra* note 70, at 773 (1977).

[70] During the passage of the Clean Air Act, Senator Muskie the manager of the Senate bill stated, "The first responsibility of Congress is not the making of technological or economic judgments or even to be limited by what is or appears to be technologically or economically feasible. Our responsibility is to establish what the public interest requires to protect the health of persons. This may mean that people and industries will be asked to do what seems to be impossible at the present time." 116 Cong.Rec. 32901-32902 (1970). *But see* D. Bruce La Pierre, *Technology-Forcing and Federal Environmental Protection Statutes*, 62 IOWA L. REV. 771, 837 (1977) (noting that although health-based standards can induce major innovation, the EPA and courts have favored technology-based standards that take into account economic constraints). Several commentators have written about the technology-forcing aspects of the Clean Air Act. *See* Bonine, *The Evolution of Technology Forcing In The Clean Air Act*, ENVIR. REP. (BNA) (Monograph No. 21) (1975); Russell V. Randle, *Forcing Technology: The Clean*

when the technology exists, but the technology cost is low while the monitoring cost is high.[71] In this situation, technology-forcing regulation is more efficient than a market-based regulatory program. The second situation involves technology-forcing regulations which can be justified based on political expediency, because they provide a clear objective, a direct method, and a tangible outcome for legislators.[72] In contrast to this approach, addressing market externalities with market incentives can be politically difficult. Economists use this line of reasoning when arguing that the best method for increasing automobile fuel efficiency is a gasoline tax. However, since no politician will support such a measure,[73] instead society has had to rely on technology-forcing regulations for improved fuel efficiency.[74]

Setting technology-forcing standards is a significant issue when the government requires firms to develop new technologies because of the unpredictability of technological advances.[75] In this situation, standard-setting proves difficult because it is not clear what the cost to the firms will be for developing the technology.[76]

Air Act Experience, 88 YALE L.J. 1713 (1979). This issue was recently visited by the Supreme Court. The Court held that the government is not required to consider financial impact when setting air quality standards. Justice Breyer's concurrence explicitly noted the validity of the technology-forcing nature of the Clean Air Act. Whitman v. American Trucking Associations Inc., 531 U.S. 457, 121 S.Ct. 903 (2001).

[71] 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 WISC. L. REV. 887, 937 (1999).

[72] Leone, *supra* note 64, at 295.

[73] In contrast, Europe has used taxes as a regulatory tool. *See* Charles D. Patterson, *Environmental Taxes and Subsidies: What Is the Appropriate Fiscal Policy For Dealing with Modern Environmental Problems*, 24 WM. & MARY ENVTL. L. & POL'Y REV. 121, 167 (2000) (noting the popularity of taxes in other countries).

[74] Technology-forcing standards can focus an industry's attention on a problem in a direct way. For example, in theory automakers historically have always had an interest in auto safety as a way differentiating their products and selling more cars. But in reality, it took Ralph Nader's *Unsafe at Any Speed* and subsequent legislation to focus the automakers on the issue of safety. *See* Leone, *supra* note 64, at 302, 310.

[75] *See* Nelson, *supra* note 65.

[76] *See* Eban Goodstein, *Polluted Data*, AM. PROSPECT, (Nov. 1997) (arguing that industry often inflates its estimated costs of complying with technology-forcing regulation). For example, the Clean Air Act was not concerned about the current level of technological feasibility. Its goal was to radically advance the state-of-the-art technology for reducing air pollution. See supra note 70. The issue of technology-forcing regulation was recently visited by the Supreme Court. The Court held that the government is not required to consider financial impact when

Consequently, in setting technology-forcing regulation, it is necessary for regulators to gather the relevant expertise to understand the state-of-the-art information as well as to understand the industry's history in technological innovation.[77] However, if a government agency cannot gather the necessary information or legislators are concerned about regulatory capture during the information gathering process, an alternative method of regulation may be necessary.[78]

A related issue concerns the need for government to have a clear understanding of the harm it is trying to prevent or the benefit it is trying to produce.[79] Examining automotive safety regulations, one can see that it unclear as to how much harm the National Highway Traffic Safety Administration (NHTSA) wishes to prevent.[80] This example is directly analogous to the issues facing code developers. In order for code-based technology-forcing regulation to be successful, it must be clear what societal concerns are being addressed. Without this clarity, an agency would quickly run into problems persuading the public and firms that its regulations created societal benefits.

Another issue technology-forcing regulation must confront is compliance. Firms are motivated to avoid compliance in a direct

---

setting air quality standards. Justice Breyer's concurrence explicitly noted the validity of the technology-forcing nature of the Clean Air Act. Whitman v. American Trucking Associations Inc., 531 U.S. 457, 121 S.Ct. 903 (2001).

[77] *See* Ashford, *supra* note 52, at 422.

[78] The probability of capture is higher because the government must closely interact with firms for information on their capabilities.

[79] In setting technology-forcing regulation, the regulator must consider the efficacy of the proposed regulation. The standard for efficacy depends upon whether the regulation is focused on forcing firms to create new technologies or incorporating existing technology into their products. In the first case, a regulator is trying to foster innovation. Therefore, the regulation should be focused on bottlenecks to technological development. For example, in the case of electric vehicles being pursued as a method of reducing pollution, Leone argues that technology-forcing regulations have revealed bottlenecks in power plant emission control, lead battery recycling, and consumer learning. Therefore, he believes that technology-forcing regulations for electric vehicles are wasteful. The issues are different when requiring firms to incorporate existing technologies into their products. In this case, the government is concerned with widely diffusing a technology. The success of this method hinges upon the cost of the technology that can be reduced over time. This requires firms to have either an incentive for continued innovation or economies of scale to reduce costs. Leone, *supra* note 64, at 320

[80] Should an automobile survive a 30 m.p.h. head-on crash or a 50 m.p.h. crash? Michael J. Trebilcock, *Requiem for Regulators: The Passing of a Counter-Culture?*, 8 Y. J. REG. 497, 505-06 (1991)

proportion to the cost of the technology-forcing regulation. As such, ensuring that firms comply and develop or diffuse the necessary technology requires a determined regulator. Absent such a regulator, firms will try to delay or reduce technology-forcing regulation. After all, technology-forcing regulation relies upon a stick as opposed to a carrot approach. At times, delay may be the prudent course for society. However, if firms are generally successful in using this tactic it effectively neutralizes the use of technology-forcing regulation.

Regardless of the difficulties found in implementing it, technology-forcing regulation has led to numerous innovations,[81] including improved environmental quality,[82] safer automobiles,[83] cleaner automobile emissions,[84] and improved disclosure.[85] For

---

[81] *See* Ashford et al. *supra* note 52, (providing a number of examples of how technology-forcing regulation led to innovation).

[82] *See* Nicholas A. Ashford, *An Innovation-Based Strategy for a Sustainable Environment, in* INNOVATION-ORIENTED ENVIRONMENTAL REGULATION 67, 85 (Kemmelskamp et al. eds., 2000).

[83] Technology-forcing regulation has led to many safety improvements including seat belts, air bags, and bumpers. These regulations have been acknowledged as successful, because the savings in safety outweighed the regulatory costs. *See* ROBERT W. CRANDALL ET. AL., REGULATING THE AUTOMOBILE 155-56 (1986).

[84] Technology-forcing regulations have led to internal combustion engines that emit ninety six percent less emissions. This type of reduction was thought to be infeasible when the regulations were first mandated. However, the overall assessment of this effort is mixed, because while there are lower automotive emissions, it is not clear whether this has led to clear improvements in public health. *See* CRANDALL, *supra* note 83, at 156-57 (arguing that the costs of emission regulation are higher than its benefits). Moreover, it is not clear whether there were other options, such as emissions fees, that could have led to the same technical advances. *See* Leone, *supra* note 64, at 292. For others, the development of new technologies such as catalytic exhaust treatment and low-emission vehicles show the merit of technology-forcing regulation. *See* Ashley Morris Bale, *The Newest Frontier in Motor Vehicle Emission Control: The Clean Fuel Vehicle,* 15 VA. ENVTL. L.J. 213 (1995).

[85] The Securities and Exchange Commission mandates that companies file their documents electronically through EDGAR, the Electronic Data Gathering, Analysis, and Retrieval system. This system accelerates "the receipt, acceptance, dissemination, and analysis of time-sensitive corporate information filed with the agency." The goal is to "increase the efficiency and fairness of the securities market for the benefit of investors, corporations, and the economy." *Important Information About EDGAR, available at* http://www.sec.gov/edgar/aboutedgar.htm (last modified June 28, 1999). *See also* Joseph A. Grundfest, *The Future of United States Securities Regulation: An Essay on Regulation in an Age of Technological Uncertainty*, 75 ST. JOHN'S L. REV. 83 (2001) (arguing that EDGAR is an example of how the SEC is changing from a technology-forcing strategy to a reactive or obstructionist strategy because the SEC has not updated EDGAR).

example, the development of the automobile airbag resulted from the development of standards for a "passive occupant restraint system." These NHTSA developed these new standards in the late 1960s. While industry fought this requirement, eventually such technology was developed and has since become standard equipment on automobiles.[86] Nonetheless, the NHTSA has moved away from a technology-forcing regulatory approach toward a more reactive approach in automobile regulation.[87]

There are numerous examples of code-based technology-forcing regulation: filtering software,[88] closed captioning,[89] v-chip,[90] accessibility,[91] enhanced 911,[92] and digital broadcasting.[93] While a

---

[86] *See* Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co., 463 U.S. 29, 49 (1983) (noting the technology-forcing nature of the Motor Vehicle Safety Act for automobile airbags).

[87] A reason for the failure of technology-forcing regulation is the judicial system. The NHTSA began by using technology-forcing rulemaking. However, over time the NHTSA has moved toward a reactive strategy based largely around safety defects. It has been argued that this occurred largely because of judicial second-guessing. *See* Frank B. Cross, *Pragmatic Pathologies of Judicial Review of Administrative Rulemaking*, 78 N.C. L. REV. 1013, 1025 (2000). *See generally* JERRY L. MASHAW & DAVID L. HARFST, THE STRUGGLE FOR AUTO SAFETY 69-105 (1990) (documenting the changes in NHTSA from technology-forcing to a more reactive regulation strategy); P. LORANG & L. LINDEN, AUTOMOBILE SAFETY REGULATION: TECHNOLOGICAL CHANGE AND THE REGULATORY PROCESS 149-54 (1977) (discussing NHTSA's difficulties with forcing manufacturers to develop new technologies).

[88] Children's Internet Protection Act, 47 U.S.C. § 254(h)(5)(A) (2001); Cole & Grossman, *supra* note 71.

[89] The incorporation of closed captioning technology was similar to the incorporation of the ultrahigh frequency (UHF) tuner. Before government regulation, consumers were forced to buy an expensive stand-alone decoder. *See* DuBow, *supra* note 61 (providing a history of legislative process to require manufacturers to incorporate closed captioning).

[90] The V-chip was a relatively simply technology based on the modification of the closed captioning technology. *See* Kristen S. Burns, *Protecting the Child: The V-Chip Provisions of the Telecommunications Act of 1996*, 7 DEPAUL-LCA J. ART & ENT. L. & POL'Y 143 (1996); Lisa D. Cornacchia, *The V-Chip: A Little Thing But a Big Deal*, 25 SETON HALL LEGIS. J. 385 (2001).

[91] The Telecommunications Act requires manufacturers of telecommunication products and services to make their products and services accessible whenever it is "readily achievable". Telecommunications Act of 1996, 47 U.S.C. 255 (1996).

[92] In 1996, the FCC adopted regulations that require wireless carriers to deliver 911 calls and provide the location of the wireless emergency call. To meet these regulations, wireless carriers have had to develop new technologies. *See* Matthew Mickle Werdegar, *Lost? The Government Knows Where You Are: Cellular Telephone Call Location Technology and the Expectation of Privacy*, 10 STAN. L. & POL'Y REV. 103 (1998) (noting that the FCC has been repeatedly asked by

thorough assessment of technology-forcing regulations for code is needed, a few lessons can be gleaned from a brief analysis of the examples noted above. First, in code-based regulation, it appears that technology-forcing regulation is often favored over market-based incentives. Government prefers to simply require manufacturers to modify their code. Secondly, regulations focused on preventing harm are easier to justify. Concerns about safety and violence have led to clearer guidelines and more political support. Technology-forcing regulations that produce less clear benefits (which becomes more important when we consider compliance costs), such as accessibility and digital broadcasting, are much harder to justify. The third lesson is that compliance costs matter, especially when firms are forced to provide a vague benefit to the public, such as digital broadcasting. The high cost of compliance with digital broadcasting has led many to wonder if such technology-forcing regulation was needed at all, or whether the market would have been a better mechanism for addressing such uncertain public benefits.[94]

In 1996, the government passed the CDA, making it unlawful to transmit indecent or obscene material over the Internet to minors.[95] While this law focused on prohibition, it served a technology-forcing purpose. The CDA encouraged the development of technologies that limited the transmission of indecent material to minors. The Platform for Internet Content Selection (PICS) was developed, as a direct result of this law, by the World Wide Web Consortium to challenge the constitutionality of the CDA by

---

industry to delay implementation, although it appears that industry will be able to comply); Peter P. Ten Eyck, *Dial 911 and Report a Congressional Empty Promise: The Wireless Communications and Public Safety Act of 1999*, 54 FED. COMM. L.J. 53 (2001) (arguing we need to tighten the existing rules for enhanced 911 to foster the development of a seamless, ubiquitous, and reliable wireless communication network with 911). For background on Enhanced 911 *see* http://www.fcc.gov/911/enhanced/.

[93] In 1997, Congress mandated a transition to digital television by 2006. The technology in 1997 was in its infancy and for the most part not even commercially available. The intent of the law was to spur the development of digital television by not allowing broadcasters to transmit analog signals after 2006. *See* The Balanced Budget Act of 1997, Pub. L. 105-33, 111 Stat. 251 §§ 3003 (1997); CONGRESSIONAL BUDGET OFFICE, COMPLETING THE TRANSITION TO DIGITAL TELEVISION (1999), *available at* http://www.cbo.gov/showdoc.cfm?index=1544&sequence=0&from=1.

[94] Alan Murray, *Failed Policy on HDTV Illustrates Why Free Markets Can Be Trusted*, WALL ST. J., June 4, 2002, at A4.

[95] Communications Decency Act, 47 U.S.C. §223 (1997).

showing that there were less restrictive means for controlling indecent content on the Internet.[96] Nevertheless, PICS has not solved the problem of minors gaining access to inappropriate content. In fact, the CDA has several glaring weaknesses. First, consider that the CDA clearly gave up on the market. While the market was not providing an adequate solution to the problem of the minors gaining access to inappropriate content, there was no reason to believe that the government could not create incentives to encourage the market to address this problem. The second problem with the justification for the CDA was its efficacy. The CDA didn't acknowledge that the technology existed to address the problem. At the time of the CDA, there were filtering products available that ensured minors did not access inappropriate content. It seems clear that if a certain technology exists, the rationale for a technology-forcing regulation should be promoting its diffusion. Clearly, the CDA was not the best method to ensure a wide diffusion of filtering software. Instead, the government should have considered incentives or an outright regulation mandating filtering software. In the end, the justification for the CDA seems to have been more about political expediency than about addressing a societal concern. Indeed, the CDA was largely considered to be unconstitutional, and thus ineffective, from its very beginning.[97]

Another concern is whether the CDA was addressing a well-defined harm. The CDA regulated both obscene and indecent communications, and while the harm from obscene communications was widely recognized, the harm from indecent communications was not agreed upon. In fact, the most vigorous debate over the CDA concerned the banning of indecent material that, in some cases, was useful for minors, such as sexual education material.[98] Such an example illustrates the inappropriateness of technology-forcing regulation when government does not have a well-defined harm to address.

The final problem with the CDA concerns compliance. It was never clear how government would monitor and enforce the

---

[96] Interview with James Miller, Designer for PICS, in Bloomington, Ill. (Aug. 13, 1999).

[97] *See* Robert Cannon, *The Legislative History of Senator Exon's Communications Decency Act: Regulating Barbarians on the Information Superhighway*, 49 FED. COMM. L.J. 51 (1996) (noting the constitutional problems with the CDA).

[98] *Reno*, 521 U.S. at 877.

CDA on a worldwide medium.[99] While government could clearly make an impact, it seemed reasonable that any significant impact would require international cooperation. The CDA did not consider this issue at all.

2. Methods of Standards Regulation

There are two general methods of regulating with standards: using a performance standard or a design standard. Performance standards do not specify a technology, but instead set forth guidelines for how a technology should operate.[100] This allows the market to create and shape a product as it sees fit. This is the principal advantage of performance standards. The flexibility of performance standards is the reason why firms prefer to develop technologies to meet performance standards.[101] At the other extreme, we have regulations specifying design standards. Design standards state precisely how a technology must operate. The advantage of a design standard for the government is enforceability. Manufacturers have strict guidelines for building a product, and an inspector can easily ascertain compliance. In contrast, the flexibility of a performance standard can lead to problems with enforceability due to the lack of specificity over the correct testing procedure to meet a performance standard.[102]

A middle ground between design standards and performance standards are the "best available technology" (BAT) regulations. These regulations are typically focused on gradually removing a harm based upon the available technology. Statutes are often worded to require the use of "reasonably available control technology" or the

---

[99] David L. Sobel, *The Constitutionality of the Communications Decency Act: Censorship on the Internet*, 1 J. TECH. L. & POL'Y 2 (1996) (noting the problems with jurisdiction).

[100] BREYER, *supra* note 64, at 105. An example that Cargill provides is the EU Privacy Initiative, which sets limitations on the use of data mining in Europe. As a result, code that contains these features can no longer be sold in Europe. This performance standard sets a limitation on firms developing code by limiting their potential market. *See* Carl F. Cargill, *The Role of Consortia Standards in Federal Government Procurements in the Information Technology Sector: Towards a Re-Definition of a Voluntary Consensus Standards Organization*, (June 28, 2001), at 5, *available at* http://www.sun.com/standards/HouseWhitePaper_ver2_Final.PDF.

[101] BREYER, *supra* note 64, at 105.

[102] BREYER, *supra* note 64, at 105-06; Cary Coglianese et al., *Performance-Based Regulation: Prospects*
and Limitations in Health, Safety, and Environmental Protection, 55 ADMIN. L. REV. 705 (2003).

"lowest achievable emission rate."[103] While, the main use of BAT regulations has been to reduce pollution, they have been criticized for not accounting for differences among users, imposing a large burden on agencies for enforcement and information gathering, and serving to slow technological innovation.[104] The counterargument to these criticisms is that the BAT approach provides a much simpler regulatory process that is even-handed, easily enforced,[105] and can adapt to changing circumstances because of its reliance on what is reasonably available rather than specifying a numerical value.

Recognizing each of their strengths and weaknesses, all three of these approaches can be used to shape code. However, there clearly are tradeoffs between these options. While performance standards provide a great deal of flexibility and allow for market-based solutions,[106] design standards are fixed approaches, but allow the government to easily ensure compliance. In the development of digital broadcasting, the Federal Communications Commission (FCC) has been criticized for using design standards to protect users from interference.[107] Critics believed these regulations were too precise and instead industry should have been granted more freedom to deal with interference problems.[108] Finally, the BAT approach

---

[103] OFFICE OF TECHNOLOGY ASSESSMENT, ENVIRONMENTAL POLICY TOOLS: A USER'S GUIDE 90 (1995).

[104] *See* CASS R. SUNSTEIN, AFTER THE RIGHTS REVOLUTION 88 (1990). *See also* Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law*, 37 STAN. L. REV. 1333 (1985) (criticizing the Best Available Technology regulation strategy).

[105] *See* Howard Latin, *Ideal versus Real Regulatory Efficiency: Implementation of Uniform Standards and 'Fine-Tuning' Regulatory Reforms*, 37 STAN. L. REV. 1267 (1985) (arguing that best available technology standards are more effective given the costs of regulatory decision-making); Sidney A. Shapiro & Thomas O. McGarity, *Not So Paradoxical: The Rationale for Technology-Based Regulation*, 1991 DUKE L.J. 729 (1991) (responding to Sunstein's criticisms); Wendy E. Wagner, *The Triumph of Technology-Based Standards*, 2000 U. ILL. L. REV. 83 (arguing that the best available technology approach is more expeditious, enforceable, even-handed, and adaptable).

[106] For example, government legislation requires schools and libraries to use some type of "technology protection measure" for online material that is harmful to minors. This performance standard allows schools and libraries to select the solution that best fits their own requirements Children's Internet Protection Act, 47 U.S.C. § 254(h)(5)(A) (2001); Cole & Grossman, *supra* note 71.

[107] Advanced Television Systems Committee, *Transmission Measurement And Compliance For Digital Television, Revision A*, May 20, 2000 *available at* http://www.atsc.org/standards.html.

[108] *See* Federal Communications Commission, *Economic Considerations for Alternative Digital Television Standards*, (Nov. 1, 1996), *available at* http://

encompasses standards that can change over time. An example of a hypothetical code-based BAT standard is requiring government agencies to use the "best available encryption technology in the storage of medical information." This standard would require government agencies to update their systems as more effective technologies are developed.

C. Using Market-Based Regulation

Critics of either standard-setting or the command and control, top-down, approach often propose using market-based incentives as an alternative to direct rulemaking. Market-based incentives can be based upon a number of different economic instruments and are more efficient than standard-setting.[109] That is, the cost of regulating a harm with market-based incentives is generally less than with government mandated standard-setting.

In this section, we focus on the use of taxes and marketable property rights for regulating code. While, taxes can be used to penalize a particular conduct or technology (consider the gas-guzzler tax on automobiles that are not fuel-efficient).[110] Marketable property rights utilize the market as an allocation mechanism to limit conduct or a technology. This regulatory scheme, which allows firms to buy and sell their property rights to others, has been used to address a variety of societal concerns from congestion to pollution.

The choice between marketable property rights and taxes is largely a choice between a price-based system and a quantity-based system. In using taxes, the government is increasing the price of undesirable behavior. In using marketable property rights, the government is fixing the amount of undesirable behavior that is acceptable to society. As a result, a tax-based system has an uncertain impact on undesirable behavior, but the cost is known to

---

www.fcc.gov/Reports/ec961101.txt,http://www.fcc.gov/Bureaus/Mass_Media/Orders/1996/fcc96493.txt (noting the design standards nature of the FCC's requirements by Bruce Owen); Federal Communications Commission, *Advanced Television Systems and Their Impact Upon the Existing Television Broadcast Service*, (Dec. 24, 1996), *available at* http://www.fcc.gov/Bureaus/Mass_Media/Orders/1996/fcc96493.txt (noting comments by the National Cable and Telecommunications Association on the design standard aspect of ATSC standard).

[109] ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, MANAGING THE ENVIRONMENT: THE ROLE OF ECONOMIC INSTRUMENTS (1994) (discussing various economic instruments).

[110] Gas Guzzler Tax, 26 USC § 4064.

firms. A marketable property rights scheme can have a fixed impact on the undesirable behavior, but the cost to firms is unknown. Therefore, a crucial decision for regulators is whether they are concerned about setting a target for reducing the undesirable behavior or for fixing the cost that is borne by firms.[111]

Two principal criticisms of market-based approaches exist. The first is that its theoretical efficiency does not appear in the real world. Rather, the problem of monitoring and funding such programs leads to a higher cost for government than using standard-setting regulation. The second criticism rests on moral/ethical grounds. In using a market-based incentive, society is saying that it is acceptable to engage in a socially undesirable behavior. For some critics, this is intolerable. As an extreme example, it is simply wrong for government to use a market-based approach to regulate murder. In this context, individuals and firms should not be allowed to engage in murder by merely paying a "murder" tax. The following sections address these criticisms and highlight the advantages of these methods in shaping and regulating code.

1. Taxes

The government uses its power of taxation as a powerful tool for shaping code. In using this power, the government can increase an individual's or firm's tax burden to encourage certain behavior. This section examines how taxes or fees can be used to penalize a particular activity or product.[112] As an example, the gas-guzzler tax on automobiles is an alternative to regulation or classic standard-setting.[113] In this section, we discuss when taxes are preferable to using regulation in deterring socially undesirable behavior or products.

There are two approaches to using taxes, fees and penalties. The first approach, fees, usually consists of a monetary penalty on a product or activity that is unrelated to the user's income. In general, a fee is more appropriate when users can be readily excluded from

---

[111] ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, PUTTING MARKETS TO WORK: THE DESIGN AND USE OF MARKETABLE PERMITS AND OBLIGATIONS 26 (1997).

[112] *See* Eric M. Zolt, *Deterrence Via Taxation: A Critical Analysis of Tax Penalty Provisions,* 37 UCLA L. REV. 343 (1989) (discussing the use of tax penalties).

[113] BREYER, *supra* note 64, at 164 (standard-setting); MARK KELMAN, STRATEGY OR PRINCIPLE? THE CHOICE BETWEEN REGULATION AND TAXATION 121 (1999) (providing a detailed discussion on the tradeoffs for using taxes as a substitute for regulation).

receiving the relevant service or product.[114] This is the case with alcohol, the gas-guzzler tax, and fees on the sale of tires to finance cleanup of improper tire disposal sites.[115] The second approach, tax penalties, is analogous to tax expenditures, but serves to penalize rather than reward.[116] Throughout this section, we will use the term taxes to refer to both fees and taxes based on the income tax.

There are several objections to using taxes as an alternative to regulation. The first questions the efficiency of taxes because of the difficulty of setting the right price for a tax. A tax will lead to some taxpayers changing their behavior, but other taxpayers may not change their behavior, and instead, just pay the tax. The critical issue is setting the right level for the tax.[117] If the tax is too high, the government will discourage too much of the activity. If the tax is too low, the government will not discourage enough of the activity. The second objection also considers the efficiency of this approach, but focuses instead on the administrative costs. When using a tax penalty, the government must enforce, collect, and dispose the taxes. This is a weighty burden for government. The final objection is that the use of taxes is morally wrong in certain circumstances. Taxes allow the disfavored behavior to continue as long as the monetary penalties are paid. Entities that have adequate financial resources are not then affected by the tax. Additionally, if the penalty affects the income tax, it will not be a strong deterrent to those firms or individuals with low tax rates. In either situation, the tax is inadequate to prevent certain individuals and firms from performing the socially undesirable activity.

The first issue that a regulator must address is the question of setting the tax accurately. This issue is not formidable. Just as with a regulation, government will have to evaluate the costs and benefits of any action it undertakes. Based on this data, the government can establish a tax at the right level. The advantage of using a tax over other methods is that its initial impact upon the industry can be accurately forecasted. Moreover, if the tax is either too high or too low, it can be later adjusted to the socially optimal level.

---

[114] KELMAN, *supra* note 113.

[115] *See* David J. DePippo, *I'll Take My Sin Taxes Unwrapped and Maximized, With a Side of Inelasticity, Please*, 36 U. RICH. L. REV. 543 (noting sin taxes such as those on alcohol); Stephen M. Johnson, *Economics V. Equity: Do Market-Based Environmental Reforms Exacerbate Environmental Justice*, 56 WASH. LEE L. REV. 111 (noting taxes on pollution).

[116] Zolt, *supra* note 112, at 348-50 (defining tax penalties within the income tax system).

[117] BREYER, *supra* note 64, at 165 (noting the problem of setting regulatory taxes).

The second question concerns administrative costs. When government seeks to reduce undesirable conduct, it will either use regulation or a market-based incentive such as a tax.[118] In both cases, the government will bear the administrative costs. In the case of regulations, the government spends its resources setting and enforcing regulations. With taxes, the government spends its resources collecting, enforcing, and disposing the proceeds.[119] Since government already has an established taxing system, taxes may be preferable to regulations because of their low administrative cost (as long as the tax can be collected with minimal non-compliance).[120]

The third objection to using taxes is a moral one. To address this concern, we believe taxes should be limited to those actions that society deems wrong but allowable. In general, taxes are best used when individuals and firms may be allowed to continue to engage in a socially undesirable activity at a low level. In other words, the cost of discovering the activity is not outweighed by the detriment of the activity. This permits a certain degree of flexibility across a population or industry. As a result, this unevenness in the distribution of burden for taxes limits its use to particular cases. If an activity involves fundamental rights, such as worker safety or discrimination, taxes are generally inappropriate and clear-cut regulation is the preferred solution.[121] This is, at least in part, because we value equal treatment when it comes to individual rights.[122] Consequently, taxes are preferable in situations where society is not confronting basic rights and is comfortable with an unequal distribution of the desired activity across society.[123]

---

[118] KELMAN, *supra* note 113.

[119] BREYER, *supra* note 64, at 170-71 (discussing the disposing of tax revenue proceeds).

[120] KELMAN, *supra* note 113, at 94-95 (noting various factors that affect the administrative cost). *But see* Zolt, *supra* note 112, at 374-76 (questioning the lost administrative costs of tax penalties).

[121] Kelman argues that there is a difference in regulation and taxes when it comes to rights. As Kelman put it "regulation, properly done, has liberal priority over taxation and spending; it purifies the private sphere of rights violations, a task to be achieved before redistribution (through taxing and spending)." KELMAN, *supra* note 113, at 121-22.

[122] *See* Gloria E. Hefland, *Standards Versus Taxes in Pollution Control*, *in* HANDBOOK OF ENVIRONMENTAL AND RESOURCE ECONOMICS 223, 245 (Jeroen C.J.M. van den Bergh ed., 1999) (arguing that although tax penalties are more efficient than standards, standards are the preferred solution by policymakers, because standards emphasize the antisocial nature of polluting).

[123] *See infra* text accompanying notes 142-143 (providing further discussion on the ethical issue of a market-based incentive permitting socially undesirable behavior).

Taxes are preferable to regulation when it is possible to influence consumer behavior.[124] In contrast to the cost of complying with regulatory standards, the cost of paying taxes can be estimated. These costs can then be easily communicated to the consumer in the final cost of the product or through tax advisors. Consumers are thus aware of both the costs as well as the governmental policy disfavoring a specific activity or product. As a result, this influences consumers toward products and activities that are not subject to a tax. Indeed, firms have a continued incentive to innovate and improve their technologies to reduce their tax burden. Similarly, taxes are preferable to tax expenditures or direct spending because they are not limited by budgetary constraints.[125]

There are two reasons why taxes are uncommon. The first is political: no one wants to raise taxes. Instead, a regulation is preferable. The second reason is that established firms prefer a standard-setting regulation to a tax. This is because, from the viewpoint of a firm, taxes cost more than regulation.[126]

One potential application for taxing code is the problem of unsolicited bulk e-mail (spam). By placing a tax on each email message, the government would provide an incentive not to send an email message. This would also reduce email congestion. If this tax was small, *e.g.*, $.01/message, this would have a minimal impact

---

[124] Taxes use market mechanisms to transmit information to the consumer by charging a price for currently unpriced goods and services provided by the natural environment. *See* Wen-yuan Huang & Michael LeBlanc, *Market-Based Incentives for Addressing Non-Point Water Quality Problems: A Residual Nitrogen Tax Approach*, 16 REV. AGRIC. ECON. 427 (1994).

[125] For example, to address concerns about climate change, the government could subsidize the use of alternative fuels. Alternatively, the government could place a tax on conventional fuel. The tax is functionally equivalent to the subsidy of alternative fuels. However, while the subsidy is limited by the government's budget, the tax has no such limitation. Chris Edwards et al., *Cool Code: Federal Tax Incentives to Mitigate Global Warming*, 51 NAT'L TAX J. 465, 475 (1998).

[126] *See* James M. Buchanan & Gordon Tullock, *Polluters' Profits and Political Response: Direct Controls versus Taxes*, 65 AMER. ECON. REV. 139; Thomas W. Merrill, *Explaining Market Mechanisms*, 2000 U. ILL. L. REV. 275, 288. Taxes on ozone-depleting chemicals as well as the gas-guzzler tax have shaped technologies. 26 U.S.C. §§ 4681, 4682 (1988 ed., Supp. III) (ozone tax); 26 U.S.C. § 4064 (gas guzzler excise tax). Other taxed undesirable activities have included doing business with South Africa, engaging in greenmail transactions, and entering into golden parachute arrangements. *See* Zolt, *supra* note 112, at 344 (noting common examples of tax penalties). For example, Singapore has used tax surcharges on older cars and varying toll fees to cut congestion. *Smart Card Taxes Singapore Drivers*, BBC NEWS, Apr. 14, 1998, *available at* http://news.bbc.co.uk/1/hi/world/asia-pacific/78172.stm.

upon most email users, while subjecting bulk e-mailers who may send out millions of e-mail messages to a significant tax burden.[127] The major objection to this proposal is neither the proper setting of the tax nor the moral propriety of such a tax. Instead, the issue is ensuring compliance. A firm or an individual can send e-mail messages, whether bulk or not, with minimal equipment and training. The ease of sending e-mail stems from the open philosophy designed into e-mail technologies with its roots in academia. This has led to proposals that the underlying structure for transmitted e-mail messages be modified.[128] Nevertheless, using current technologies, it would be very difficult to ensure compliance with such a tax. Here, a tax would not serve as an effective method for shaping code.

2. Marketable Property Rights

An alternative market-based regulatory mechanism is the use of a property-based system. Fundamental to this idea is that by creating property or a property right that can then be exchanged in the marketplace, the regulator is depending on the superior allocative efficiency of the market over government allocation.[129] For example, the government can either create property in a tangible or intangible form, such as land, copyright, or even privacy. Government can also create a property right that allows an entity to engage in specific conduct, e.g., to pollute through sulphur dioxide emissions. The resulting property right allows an individual to use the property as well as to sell the property as she sees fit. In some cases, the government may create a trading system for a property right to ensure its efficient transfer. This allows the use of prices as a signal and an incentive, which should theoretically lead to an efficient distribution of the property. Moreover, by limiting and reducing marketable property rights, the government can reduce or eliminate the pertinent conduct. Thus, a marketable property right is

---

[127] *See* Declan McCullagh, *Send Out Spam, Pay the Bill*, WIRED NEWS, Feb. 23, 2000, *available at* http://www.wired.com/news/politics/0,1283,34520,00.html (describing a method to charge senders for sending e-mail messages).

[128] Katharine Mieszkowski, *E-mail is Broken*, SALON, Oct. 2, 2003, *available at* http://www.salon.com/tech/feature/2003/10/02/e_mail/index_np.html.

[129] This concept was first developed in J. DALES, POLLUTION, PROPERTY AND PRICES (1968). *See also* Richard B. Stewart, *Environmental Regulation and International Competitiveness*, 102 YALE L. J. 2039, 2093-2097 (1993) (providing an overview of the use of marketable property rights as an alternative regulatory mechanism).

an efficient method for the government to limit either a harm or a technology.

The creation of marketable property rights has been used to regulate a variety of issues from congestion to pollution.[130] In the United States, marketable property rights have been created for eliminating lead in gasoline, reducing ozone-depleting gases in accordance with the Montreal Protocol, reducing sulphur oxides, and reducing pollutants in the Los Angeles area.[131] In these cases, the government created a system to trade marketable property rights. By limiting and reducing the amount of marketable property rights, the government can control the extent of an activity.

Several problems arise when using marketable property rights. The first is the inefficiency due to the high administrative costs needed in the creation and administration of marketable property rights; government must define, allocate, sell, and monitor the use of these property rights. These high administrative costs suggest that marketable property rights are an inefficient solution as compared to standards based regulation. The second problem concerns the strategic use of marketable property rights. Since there are no perfectly competitive markets, firms can distort the intent of marketable property rights to their advantage. The final problem is that the use of marketable property rights is also questioned on ethical grounds.

Government must acknowledge that there are administrative costs in creating and administering marketable property rights.[132] It needs to evaluate these costs in considering whether to opt for standards based regulation or for a marketable property rights program. The first issue that the government must struggle with is defining the property. The metes and bounds of the property right is not a trivial issue – it will be contested.[133] Second, once a

---

[130] ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, *supra* note 111.

[131] Tom Tietenberg, *Lessons From Using Transferable Permits to Control Air Pollution in the United States*, *in* HANDBOOK OF ENVIRONMENTAL AND RESOURCE ECONOMICS 275, 275 (Jeroen C.J.M. van den Bergh ed., 1999).

[132] *See* OFFICE OF TECHNOLOGY ASSESSMENT, *supra* note 103, at 170 (providing background on the administrative issues); James T.B. Tripp & Daniel J. Dudek, *Institutional Guidelines for Designing Successful Transferable Rights Programs*, 7 YALE J. REG. 369, 374-77 (1989) (noting administrative issues in the use of marketable property rights).

[133] The defining of property rights is a continuing issue for government, because uncertainty can lead to inefficiencies. *See* Robert W. Hahn & Gordon L. Hester,

marketable right is established, how should the rights be allocated? For example, should they be auctioned?[134] Or should existing users get free marketable rights through grandfathering?[135] Third, government may have to create and administer a trading system for the property right. This is a crucial ingredient since an efficient market depends upon low transactions costs for property transfer.[136] The final issue for the government is ensuring compliance. Government must ensure that firms have the proper property rights to engage in the regulated conduct. Otherwise, firms will continue to conduct the activity or use the technology without specific property rights. In fact, low monitoring costs are essential for a marketable property rights scheme to be successful.[137]

Although theoretical, a perfect market in which no actor has market power does not actually exist.[138] Hence, one expects firms to attempt to distort the market to their advantage. Firms could use their influence to collude to keep prices low or set pricing levels.[139] Or firms could buy up the marketable property to create a barrier to entry for new firms.[140] The government must strive to achieve a closely competitive market when establishing the marketable property right. Otherwise, government must rely upon antitrust law to ensure competition.[141]

The final issue to address is the moral argument against marketable property rights.[142] This issue is focused not on efficiency, but on ethical concerns. When government creates a

---

Where Did All The Markets Go? An Analysis of EPA's Emissions Trading Program, 6 YALE J. REG. 109 (1989).

[134] *See* Paul Koustaal, *Tradable Permits in Economic Theory*, *in* HANDBOOK OF ENVIRONMENTAL AND RESOURCE ECONOMICS 265, 271-02 (Jeroen C.J.M. van den Bergh ed., 1999). *See also* Robert W. Hahn, *Market Power and Transferable Property Rights*, 99 Q.J. ECON. 753, 753-65 (1984) (noting how allocation can affect the efficiency of marketable property rights).

[135] Koustaal, *supra* note 134, at 268. *See also* Merrill, *supra* note 126, at 284 (noting the predominant use of grandfathering).

[136] BREYER, *supra* note 64, at 173; Koustaal, *supra* note 134, at 270-71 (noting transactions costs in trading).

[137] *See* Cole & Grossman, *supra* note 71, at 937; Koustaal, *supra* note 134, at 271; Youngsoo Oh, *Surveillance or Punishment? A Second-Best Theory of Pollution Regulation*, INTER. ECON. J., Autumn 1999, at 89.

[138] Koustaal, *supra* note 134, at 266.

[139] BREYER, *supra* note 64, at 173.

[140] *Id.*

[141] *Id.*

[142] *See* STEVEN KELMAN, WHAT PRICE INCENTIVES? : ECONOMISTS AND THE ENVIRONMENT (1981) (providing a thorough discussion of the moral basis argument).

property right, they are tacitly approving the behavior. Moreover, government is removing the stigma attached to the conduct by creating property rights. This is one of the reasons why people have been opposed to market-based approaches to minimize pollution. This is similar to concerns about inequality in using taxes.[143] Therefore, a regulator should try to avoid creating a marketable property right when society uniformly regards an activity as morally wrong.

An advantage to using marketable property rights is that they are generally more efficient than standard-setting regulatory approaches.[144] In using marketable property rights, entities allocate the marketable property rights among themselves using a pricing mechanism. This approach is much more efficient than when the government mandates the allocations of property rights for each entity. It simply would be too expensive and burdensome for the government to collect information on individual costs to make this allocation. Moreover, the pricing mechanism provides firms with flexibility because they can choose their own allocation of property rights. Firms may decide to purchase additional property rights or they may choose to earn revenue by selling their property rights. This flexibility contrasts with the uniformity of standard-setting measures. As a result, theoretically, the marketable property right scheme is more efficient than standard setting regulatory approaches. However, in assessing whether to use marketable property rights, the government must consider the inefficiencies that emerge in administering property rights and the consequences of the lack of a perfectly competitive market. Nevertheless, marketable property rights, in some circumstances, such as those involving low monitoring costs, can save billions of dollars compared to standard-setting regulatory approaches.[145]

Another advantage of marketable property rights is the benefit created from continued technological innovation. Firms also have an incentive to innovate because technological innovations can allow them to sell off or use their marketable property rights more

---

[143] *See supra* text accompanying notes 121-123.

[144] *See* Ackerman & Stewart, *supra* note 104; Ruud A. de Mooij, *The Double Dividend of an Environmental Tax Reform, in* HANDBOOK OF ENVIRONMENTAL AND RESOURCE ECONOMICS 293, 302 (Jeroen C.J.M. van den Bergh ed., 1999) (noting the efficiency of market-based mechanisms through Coase's theorem).

[145] Hahn & Hester, *supra* note 133, at 111.

efficiently.[146] Compare this to a standard, where once the firm meets the set standard, they have little incentive for further innovation.

In the realm of code, the first notable creation of marketable property rights has been for the domain name system (DNS).[147] In this case, the government supported the creation of additional domain names for greater consumer choice, lower prices, and better service. To administer this process, the government turned over the management of the DNS to a private actor.[148] However, the government has maintained oversight to ensure the system is not used strategically for the benefit of a few.[149] This is necessary considering the persistent problems with the DNS privatization process. In fact, the government has advocated creating more property and lowering the cost for consumers.[150] The government's efforts to date have been focused on creating property rights for greater consumer choice, not a regulatory mechanism. However, one possible intervention is the government's interest in creating new top level domains such as .xxx, .adult, or .kids.[151] This intervention is not about limiting behavior or allocating scarce resources, but is instead attempting to "fence off" or contain an activity to a specific

---

[146] Ackerman & Stewart, *supra* note 104, at 1336.

[147] A number of commentators have considered whether a domain name is property. *See* David F. Fanning, *Quasi in Rem on the Cyberseas*, 76 CHI.-KENT L. REV. 1887 (2001); Susan Thomas Johnson, *Internet Domain Name and Trademark Disputes: Shifting Paradigms in Intellectual Property*, 43 ARIZ. L. REV. 465 (2001).

[148] A few of the major works on the privatization of the DNS are as follows. ELLEN RONY & PETER RONY, THE DOMAIN NAME HANDBOOK (1998); A. Michael Froomkin, *Of Governments and Governance*, 14 BERKELEY TECH. L.J. 617 (1999); A. Michael Froomkin, *Wrong Turn in Cyberspace: Using ICANN to Route Around the APA and the Constitution*; Milton Mueller, *ICANN and Internet Governance: Sorting Through the Debris of 'Self-Regulation'*, 1 J. POL'Y, REG. & STRATEGY FOR TELECOMMS. INFO. & MEDIA 497 (1999); Jonathan Weinberg, *ICANN and the Problem of Legitimacy*, 50 DUKE L.J. 187 (2000); Kesan & Shah, *supra* note 26.

[149] Kesan & Shah, *supra* note 26, at 176-77 (noting actions taken by the government to ensure the governance of the DNS was transparent).

[150] David McGuire, *Commerce Department Urges ICANN to Add More New Domains*, NEWSBYTES, (May 25, 2001).

[151] Oscar S. Cisneros, *Surfers Need to Roam Porn-Free*, WIRED NEWS, (Aug. 4, 2000, *available at* http://www.wired.com/news/politics/0,1283,37991,00.html (reporting on the consideration of an adult top level domain name by the Child Online Protection Act Commission); April Mara Major, *Internet Red Light Districts: A Domain Name Proposal for Regulatory Zoning of Obscene Content*, 16 J. MARSHALL J. COMPUTER & INFO. L. 21 (1997); David McGuire, *President Signs 'Dot-Kids' Legislation*, WASH. POST, Dec. 4, 2002, *available at* http://www.washingtonpost.com/ac2/wp-dyn/A8016-2002Dec4 (noting the creation of a .kids domain name with the .us space).

piece of property (more akin to zoning of real property than as an alternative for standard-setting regulation).

The second use of marketable property rights for code could be in the privacy area. Scholars have argued that the creation of a property right in privacy could correct market failures by providing people with control over their personal information.[152] The property right would lead to firms bargaining for a person's information, rather than the current system in which the incentives are for firms to disclose information without consent. However, it is not clear whether this approach is warranted. It appears that the creation of a privacy property right may not truly meet the needs of its proponents. The problem for most proponents is not the quantity of privacy, i.e., too much or too little. Instead, the problem is the lack of negotiation and meaningful assent between parties during a transaction.[153] This is not a problem that marketable property rights can address. Marketable property rights work best to limit a quantity of harm and are not helpful in facilitating informed negotiations. Additionally, the purpose of property rights is to allow the market to allocate scare resources, and it is not clear how the market can allocate privacy property rights that are tied to individuals. Furthermore, it is not clear how such a privacy property rights system will be administered.[154] Finally, there is a moral objection to allowing people to buy and sell privacy.[155] In sum, the creation of a marketable property right in privacy is not a suitable alternative to regulation.

D. Modifying Liability

Changes in liability doctrine are currently driving changes in the code.[156] This section examines two different ways government

---

[152] Lawrence Lessig, *Law of the Horse: What Cyberlaw Might Teach*, 113 HARV. L. REV. 501, 520 (1999). There are critics of this approach. *See* Paula Samuelson, *Privacy as Intellectual Property*, 52 STAN. L. REV. 1125 (2000); Jessica Litman, *Information Privacy/Information Property*, 52 STAN. L. REV. 1283 (2000).

[153] *See* Samuelson, *supra* note 152, at 1134.

[154] *Id.* at 1138.

[155] *Id.* at 1136.

[156] John Gilligan, chief information officer for the U.S. Air Force's computer network, wants software companies to be subject to legal action for failing to create and maintain secure products. Alex Salkever, *A World Wide Web of Organized Crime*, BUS. WK., Mar. 13, 2001. He believes that changing liability standards can improve product quality by requiring accountability from the developers of code. His call for accountability through liability is backed by a

can use liability to shape code. The first is through the law of torts, specifically product liability law. The second is through the law of contracts. We end by discussing how the relationship between increased liability and insurance companies can encourage the development of third party regulators, such as the Underwriters Laboratories, to shape code to address societal concerns.

1. Product Liability Law

Product liability law is governed by tort law and can affect the development of code.[157] It depends not upon government agencies, but on persons who have been physically harmed and are seeking compensation in the courts.[158] One function of product liability law is to encourage firms to improve the safety of their products.[159] This section discusses how products liability law can serve as an alternative form of regulation to encourage the development of safer code.[160]

---

range of supporters; these supporters range from the National Academy of Sciences to the *Economist*. Alex Salkever, *A World Wide Web of Organized Crime*, BUS. WK., Mar. 13, 2001; COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD, CYBERSECURITY TODAY AND TOMORROW: PAY NOW OR PAY LATER (2002), *available at* http://books.nap.edu/html/cybersecurity/; *A Lemon Law for Software?*, ECONOMIST, Mar. 14, 2002.

[157] MICHAEL J. MOORE & W. KIP VISCUSI, PRODUCT LIABILITY ENTERING THE TWENTY-FIRST CENTURY: THE U.S. PERSPECTIVE 7 (2001) (providing a short history of product liability law).

[158] Susan Rose-Ackerman, *Tort Law in the Regulatory State*, *in* TORT LAW AND THE PUBLIC INTEREST 80 (Peter H. Schuck ed., 1991) (noting that product liability is a form of private law).

[159] MOORE & VISCUSI, *supra* note 157, at 8-9; Richard M. Marrow, *Technology Issues and Product Liability*, *in* PRODUCT LIABILITY AND INNOVATION: MANAGING RISK IN AN UNCERTAIN ENVIRONMENT 23, 25 (Janet R. Hunziker & Trevor O. Jones eds., 1994).

[160] BREYER, *supra* note 64, at 177 (noting that changing liability rules may be a substitute or supplement for classic regulation). As an adjunct to product liability law, the government could require professional standards for the developers of code. This would provide an alternative basis for liability. There are many trades such as engineering, interior decorating, and hairdressing that require licenses. The same could be done for the creators of code. Currently, most licensing is done by the private sector, such as Microsoft's Certified Professional program. The Association for Computing Machinery (ACM), the largest organization for computer programmers, is currently opposed to the licensing of software engineers. The licensing could be enforced by government as well as through malpractice suits. *See* Letter from Barbara Simons, ACM President, ACM's Position on the Issue of Licensing of Software Engineers, *available at* http://www.acm.org/serving/se_policy/position.html (July 8, 1999). *See also*

Product liability law is a controversial area of the law.[161] Its impact has varied considerably by industry.[162] As of yet, product liability law has not had a substantial impact on code.[163] This is not surprising considering that most losses from code are merely economic with no accompanying physical injury.[164] Nevertheless, it is entirely foreseeable that as the use of code grows, it may increasingly be involved in physical injuries. As a result, product liability will grow in importance and will begin to shape code.[165] However, the broadening of product liability to code may not become fully obvious because code is often contained within the systems of larger products that have traditionally been subject to product liability, such as automobiles or medical devices.[166]

One prominent example of product liability law shaping a technology is *Larsen v. General Motors Corp*.[167] General Motors argued that it had no duty to design an automobile that protects occupants in the event of a crash. Crashing an automobile was outside its intended use. However, the court disagreed. It held that the manufacturer of a vehicle has a duty to design one with reasonable care. This meant protecting occupants of the automobile

---

Patricia Haney DiRuggiero, *The Professionalism of Computer Practitioners: A Case for Certification*, 25 SUFFOLK U. L. REV. 1139 (1991) (discussing government licensing versus an industry certification program).

[161] Peter H. Schuck, *Introduction*, *in* TORT LAW AND THE PUBLIC INTEREST 17, 27-29 (Peter H. Schuck ed., 1991) (noting the politicization of law to limit liability).

[162] Peter W. Huber & Robert E. Litan, *Overview*, *in* THE LIABILITY MAZE: THE IMPACT OF LIABILITY LAW ON SAFETY AND INNOVATION 1, 4 (Peter W. Huber & Robert E. Litan eds., 1991).

[163] There was potential for product liability due to the year 2000 problem with code. Industry was claiming potential liability losses of one trillion dollars. This led to the passage the Y2K Act which limited liability. Y2K Act, Pub. L. No. 106-37, 113 Stat. 185 (1999); John Wilen, *Report: Number of Y2K Lawsuits Dropping*, USA TODAY, Aug. 25, 1999.

[164] Thomas G. Wolpert, *Product Liability and Software Implicated in Personal Injury*, 60 DEF. CONS. J. 519, 519 (1993).

[165] Helen Nissenbaum, *Accountability in a Computerized Society*, SCI. & ENGINEERING ETHICS, Jan. 1996, at 25 (arguing that as computing matures liability may be necessary to protect the public).

[166] *See* Wolpert, *supra* note 164, at 523. Although recently Microsoft has changed its contractual terms to remove a liability cap on third party injury from its products. *See* Michael Kanellos, *Microsoft Easing Customers' Legal Stress*, CNET NEWS.COM, July 22, 2003, *available at* http://news.com.com/2100-1012-5050986.html.

[167] Larsen V. General Motors Corp., 391 F.2d 495 (8th Cir. 1968).

in the event of a crash, even though crashing is not the intended use.[168]

There are several objections to using products liability law to shape technologies. First, critics argue that product liability law is inefficient. They suggest that a more efficient method would be to allow consumers to select technologies based on their own evaluation of risk and safety concerns. As the argument goes, this would encourage the market to develop a wide range of technologies that are responsive to consumer needs. This would also save firms substantial litigation costs.[169] Second, critics argue that the unpredictability of products liability law can lead to uneven results, since firms have difficulty predicting their liability exposure.[170] The third objection is that product liability law has a chilling effect upon innovation. In essence, the potential of product liability reduces innovation and keeps beneficial products off the market.[171]

While the market is theoretically more efficient, many of its assumptions are violated in the real world. Product liability law can be more efficient than other alternatives, which are subject to market defects and transaction costs. These defects can include buyers who are unaware of the risks or accorded inadequate opportunities to bargain for a safer and more expensive product.[172] In the case of a complex product, where a buyer could not ascertain the risks adequately, scholars have argued that it may be best to place liability on the manufacturer because it could best weigh the associated costs.[173] The threat of liability causes manufacturers to internalize social costs into their products, thereby increasing costs for the manufacturer.[174] However, these costs produce safer products. Whether the costs of liability law are outweighed by its benefits is difficult to ascertain, because the deterrence aspect of product liability law provides a benefit to society that cannot be easily

---

[168] John D. Graham, *Product Liability and Motor Vehicle Safety*, *in* THE LIABILITY MAZE: THE IMPACT OF LIABILITY LAW ON SAFETY AND INNOVATION 120, 121 (Peter W. Huber & Robert E. Litan eds., 1991).

[169] COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION, PRODUCT LIABILITY REFORM ACT OF 1997, S. REP. NO. 105-32, at 3-4 (1997).

[170] *Id.* at 5-6.

[171] *Id.* at 8-10.

[172] BREYER, *supra* note 64, at 175.

[173] *Id*.

[174] There is little evidence that product liability costs and insurance costs are too high. *See* MOORE & VISCUSI, *supra* note 157, at 13 (noting that in real terms insurance premiums have fallen between 1988 and 1998); COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION, *supra* note 169, at 65.

measured.[175] It is also difficult to account for what society gains from firms not releasing unsafe products. There is considerable evidence that product liability laws have led to safer products. For example, the change from a negligence standard to a strict liability standard has resulted in far fewer deadly accidents.[176] Some even argue that if product liability laws were more stringent, we would have even safer products.[177]

Product liability law is typically unpredictable through its use of punitive damages, which often vary because they punish defendants for their conduct.[178] In fact, in product liability cases in state and federal courts between 1965 and 1990, punitive damages were only awarded 355 times over the entire twenty-five year period![179] The purpose of punitive damages is twofold. First, punitive damages express to defendants that their conduct is intolerable.[180] Secondly, punitive damages serve as a deterrent because they reward plaintiffs subject to serious misconduct above their actual damages.[181] As a result, punitive damages provide firms with a strong incentive to ensure their products meet society's minimal standards for safety. As a deterrent, there is evidence that punitive damages can result in safer products.[182] Third, there is not a simple direct relationship between increased liability and decreased innovation.[183] At high levels of liability, there is lower research and

---

[175] Robert Litan, *The Liability Explosion and American Trade Performance: Myths and Realities, in* TORT LAW AND THE PUBLIC INTEREST 127, 135 (Peter H. Schuck ed., 1991).

[176] BREYER, *supra* note 64, at 175.

[177] Nicholas A. Ashford & Robert F. Stone, *Liability, Innovation, and Safety in the Chemical Industry, in* THE LIABILITY MAZE: THE IMPACT OF LIABILITY LAW ON SAFETY AND INNOVATION 367, 414 (Peter W. Huber & Robert E. Litan eds., 1991).

[178] The awarding of punitive damages is rare; *e.g.*, one study found that punitive damages were awarded less than five percent of the time in civil jury verdicts. Stephen Daniels and Joanne Martin, *Myth and Reality in Punitive Damages*, 75 MINN. L. REV. 1, 31 (analyzing 25,627 civil jury verdicts in forty-seven counties in eleven states for the years 1981-85).

[179] Michael Rustad & Thomas Koenig, *Punitive Damages in Products Liability: A Research Report,* 3 PROD. LIAB. L.J. 85, 89 (1992) (performing a comprehensive survey of punitive damages in product liability verdicts).

[180] Jane Mallor & Barry Roberts, *Punitive Damages: Toward a Principled Approach,* 31 HASTINGS L.J. 639, 648 (1980).

[181] *Id.* at 649-50.

[182] COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION, *supra* note 169, at 75.

[183] One systematic study across several industries found that low levels of liability risk were associated with higher levels of research, development, and innovation.

development activity, and thus, less innovation.[184] A degree of product liability risk creates an incentive to develop safer products, but at extremely high-risk levels, there is a reduction in the development of new products. This leads to the conclusion that there is a balancing point between increasing safety and slowing of technological progress.[185] Thus, a certain degree of liability can actually increase innovation. Other research has found that innovation and safety can't be separated; liability affects both. In fact, liability promotes safety and innovation of desirable products, while also discouraging the development of unsafe products that may be innovative.[186]

One distinct advantage of product liability law is its public visibility.[187] The publicity of a product liability lawsuit can serve to stimulate safety through a variety of societal institutions.[188] Naturally, a products liability lawsuit will lead manufacturers to reexamine their practices. Moreover, the publicity can also spurn regulatory agencies to action as well as leading to consumer demand for safety.[189] Moreover, there is also evidence that product liability lawsuits provide firms with an incentive for developing safer products by affecting their wealth through the stock market.[190]

Product liability already plays a role in shaping the development of code. In industries where defective code can cause physical injury, e.g., aerospace and medicine, developers strive to make safer code. There are many reasons, besides purely regulatory concerns, why firms avoid developing unsafe code. These include a loss of revenue and reputation, as well as product liability costs. As a result, firms developing code for aerospace applications and

---

[184] MOORE & VISCUSI, *supra* note 157, at 25.

[185] *See* MOORE & VISCUSI, *supra* note 157, at 26; W. Kip Viscusi & Michael J. Moore, *An Industrial Profile of the Links between Product Liability and Innovation*, *in* THE LIABILITY MAZE: THE IMPACT OF LIABILITY LAW ON SAFETY AND INNOVATION 81 (Peter W. Huber & Robert E. Litan eds., 1991). *See also* Litan, *supra* note 175, at 149 (arguing that product liability diminishes innovation, but it is not clear what the net effect is on society, because of deterrence and justice benefits).

[186] COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION, *supra* note 169, at 77-78.

[187] Schuck, *supra* note 161, at 20-27.

[188] Graham, *supra* note 168, at 181-82.

[189] This was evident in several vehicle product liability suits such as the Ford Pinto, shoulder belts, and all-terrain vehicles. *Id.* at 181 (providing examples on the role of publicity from lawsuits).

[190] MOORE & VISCUSI, *supra* note 157, at 27.

medical devices use a number of developmental strategies to ensure high quality code.[191]

Product liability can also play a role in shaping the future development of code. One such potential application is to hold firms liable for failing to properly secure their computer systems.[192] Firms that do not implement appropriate levels of security not only place themselves at risk, but may also serve as unwitting pawns in attacks on other computer systems. Analysts have argued that one solution to this problem is the imposition of tort liability.[193] Such liability would motivate firms into adopting more secure code and better security procedures.

2. Contract Law

A second option for regulating with liability is by using contract law. Typically a transaction involving code falls under the Uniform Commercial Code (UCC), which has been virtually fully enacted by all fifty states.[194] The UCC contains default rules for contracts, rules that govern all contracts, and default rules regarding warranties.[195]

Recently, there has been a movement to amend the UCC to better handle transactions with intellectual property and software. This was initially titled Article 2B. However, sharp differences of opinion emerged from the drafting process. Eventually, the American Law Institute withdrew from the process and eliminated Article 2B as an amendment to the UCC. However, supporters of Article 2B renamed the legislation the Uniform Computer Information Transactions Act (UCITA).[196] UCITA has since been

---

[191] RICHARD C. FRIES, RELIABLE DESIGN OF MEDICAL DEVICES (1997).

[192] Alan Charles Raul et al., *Liability for Computer Glitches and Online Security Lapses*, 6 BNA ELECTRONIC COM. L. REP. 849 (2001).

[193] *Id.*

[194] In dealing with code, there is often a question whether the sale of software is considered a good or a license under the UCC. Most courts have considered code a good and therefore a transaction falls under the UCC. *Computer Software as a Good Under the Uniform Commercial Code: Taking a Byte out of the Intangibility Myth*, 65 B.U. L. REV. 129 (1985); Douglas E. Phillips, *When Software Fails: Emerging Standards of Vendor Liability Under the Uniform Commercial Code*, 50 BUS. LAW. 151, 157-58 (1994).

[195] For example, the default rule for contracts is for an Implied Warranty of Merchantability in the purchase of a good. U.C.C. § 2-314.

[196] NATIONAL CONFERENCE OF COMMISSIONERS ON UNIFORM STATE LAWS, UNIFORM COMPUTER INFORMATION TRANSACTIONS ACT, *available at* http://www.law.upenn.edu/bll/ulc/ucita/ucita01.htm (2001).

enacted in Virginia and Maryland and is being considered by other states.

UCITA is a contemporary example of how changes in liability affect code. The pro-UCITA movement is being led by the software industry vendors and has led to two states adopting UCITA. However, a number of organizations have been fighting the adoption of UCITA. This has led a few states to pass anti-UCITA legislation, bomb-shelter legislation, which protects their residents against licensing provisions in contracts governed by UCITA.[197] Without addressing the merits of UCITA, we will highlight some provisions of UCITA and changes in contractual liability that could affect the development of code.

UCITA allows developers to insulate themselves from liability for damages caused by software.[198] According to Barbara Simons, "we know that it is almost impossible to write bug-free software, [b]ut UCITA will remove any legal incentives to develop trustworthy software, because there need be no liability."[199] As a result, many software industry insiders believe that UCITA will only lead to even lower quality standards for code.

A second criticism of UCITA is that it would create enforceable provisions against reverse engineering, the process of analyzing code to determine how it operates. Reverse engineering is an accepted practice under copyright and trade secret law, and is usually for the purpose of duplication by competitors who wish to develop rival code. [200] However, UCITA allows firms to prohibit reverse engineering of products. Undoubtedly, this provision will

---

[197] Ed Foster, *Maryland Legislature Caves to UCITA, but Iowa May Offer a Safe Haven from Law*, INFOWORLD, Apr. 21, 2000, *available at* http://www.infoworld.com/articles/op/xml/00/04/24/000424opfoster.xml.

[198] Cem Kaner, *Software Engineering and UCTICA*, 18 J. MARSHALL J. COMPUTER & INFO. L. 435 (1999) (discussing how UCITA's provisions for limited accountability will serve as an incentive for the software industry to develop shoddier products). *See also* Andrea L. Foster, *New Software-Licensing Legislation Said to Imperil Academic Freedom*, CHRON. HIGHER EDUC., Aug. 11, 2000, *available at* http://chronicle.com/free/v46/i49/49a04701.htm; Rochelle Cooper Dreyfuss, *Software as Commodity: International Licensing of Intellectual Property: Commentary: UCITA in the International Marketplace: Are We About to Export Bad Innovation Policy*?, 26 BROOK. J. INT'L L. 49 (2000).

[199] Barbara Simons, President of the Association of Computing Machinery, *Shrink-Wrapping Our Rights*, COMM. ACM, Aug. 2000, at 8, *available at* http://www.acm.org/usacm/copyright/ucita.cacm.htm.

[200] Cohen & Lemley, *supra* note 382, at 16-37 (arguing that the traditional right to reverse engineer software under copyright and trade secret law should be extended to patents).

make it more difficult to develop competing products. While it may be difficult to enforce, this provision will still have an unsettling effect upon code development.[201]

A third criticism of UCITA is that it allows developers to enforce contractual provisions against public criticisms of software, potentially affecting the writing of reviews, comparisons, and benchmark tests on code. These writings serve to inform consumers and create a more competitive marketplace.[202] While this provision may be found to be unenforceable on public policy grounds, it will still have a chilling effect upon the reviews of code.[203]

UCITA is an example of how changes in liability can shape code. Although, it is highly questionable whether UCITA in its present form will be widely adopted, the fundamental concepts behind the creation of UCITA are very relevant. In essence, UCITA is a balancing of various liabilities and conditions for the use of code between developers and consumers. Whatever the outcome is, it will serve to shape the code developed in a post-UCITA world.

2. Insurance and Third Party Regulators

One consequence of liability is the development of institutions to lessen and spread the risk of liability. Insurance has long been a mechanism to spread the risk of liability from events such as fire or earthquakes.[204] Of even greater interest is how liability and insurance companies can foster the development of third party institutions to regulate products. The archetype of this concept is the Underwriters Laboratories (UL), which conducts uniform testing of electrical appliances to assess their safety. A similar, code-based laboratory could be established to ensure that code meets various societal concerns.

In order to foster similar results, it is necessary to consider the factors that led to the growth of the Underwriters Laboratories (UL). UL's history began with a rash of electrical fires in major

---

[201] Kaner, *supra* note 198, at 473-74.

[202] The Institute of Electrical and Electronics Engineers, *Opposing Adoption of the Uniform Computer Information Transactions Act (UCITA)*, *available at* http://www.ieeeusa.org/forum/POSITIONS/ucita.html (Feb. 2000).

[203] Kaner, *supra* note 198, at 470.

[204] Orna Raz and Mary Shaw, *Software Risk Management and Insurance*, Third International Workshop on
Economics-Driven Software Engineering Research, Toronto, Canada, May 14-15, 2001, *available at* http://www.cs.virginia.edu/~sullivan/edser3/raz.pdf.

American cities in the 1890s.[205] This led a number of insurance companies, such as the Chicago Board of Fire Underwriters, Western Insurance Association, and the Electrical Bureau of the National Board of Fire Underwriters, to fund a testing laboratory.[206] The laboratory became the UL and provided rigorous, unbiased, testing of electrical devices for fire prevention.[207] Today, the UL works with over sixty thousand manufacturers with its label present on over one hundred thousand products, each evaluated for safety.[208] The success of the UL is the result of a close relationship with insurance companies and government regulators. This relationship ensures manufacturers follow UL's safety standards. As a result, consumers and manufacturers consider products bearing the UL label to be safe.

As a result of recent concerns about security, the government is attempting to foster a similar system for code.[209] Such a system begins with companies purchasing insurance for cyber security. Insurance companies provide discounts to firms with better security practices and those who use more reliable security products. This would encourage the creation of an analogous UL for testing code. Ideally, this laboratory could work as efficiently as the UL and be able to test the vast amounts of code-based products in a timely manner. Companies using these approved pieces of code would have their premiums reduced thereby increasing demand for more secure code and creating an incentive for developers to make sure their products met the standards of the code-based UL.

The aforementioned approach is very compelling. It is largely based on private actors with government merely promoting and using the tested products. The incentive structure for insurance companies, the insured, and developers appears to be very clear. While this scheme has proved successful for the UL and electrical products, there are significant issues with using insurance and third party regulators for code. Consequently, our approach also addresses

---

[205] NORM BEZANE, THIS INVENTIVE CENTURY: THE INCREDIBLE JOURNEY OF THE UNDERWRITERS LABORATORIES 6 (1994).

[206] *Id.* at 7.

[207] The UL asserts that it is "testing for public safety. Our goal is to serve, not to profit." *Id.* at 6.

[208] Underwriters Laboratories, *2001 Annual Report, available at* http://www.ul.com/annualreport01/index.html (last visited July 23, 2002).

[209] Brian Krebs, *White House Pushing Cybersecurity Insurance*, WASH. POST, June 27, 2002, *available at* http://www.washingtonpost.com/wp-dyn/articles/A55719-2002Jun27.html; Nancy Gohring, *Cyberinsurance May Cover Damages of Computer Woes*, SEATTLE TIMES, July 29, 2002.

how to regulate code consisting of a large number of products that change rapidly.

We believe that there are three issues the government must consider in trying to encourage the development of an insurance system for code. First, insurance is not appropriate for potential losses where self-protection measures play an important role. Insurance works best in situations when its price is largely independent of expenditures on self-protection.[210] For example, homeowners demand insurance against fire and earthquakes because these are events that are largely independent of self-protection measures. Conversely, when the price of market insurance depends upon self-protection, there will be a small demand for market insurance and a large demand for self-protection measures.[211]

The importance of self-protection for Internet security lessens the need for insurance. In the current state of the Internet, self-protection measures play an important role in reducing losses. This is evident in the vast industry devoted to developing and teaching self-protection skills to firms.[212] As a result of the importance of self-protection, the natural inclinations of the market will not foster the development of market insurance for security. Thus, government's encouragement will not be enough to foster the development of an insurance system.

Without a viable insurance system, there is little incentive for insurance companies to encourage third party regulators for code. Moreover creating third party regulators, which are not backed by insurance companies or some other entity that can force compliance, is bound to fail.[213] Absent the support of insurance companies and

---

[210] Isaac Ehrlich & Gary S. Becker, *Market Insurance, Self Insurance, and Self Protection*, 80 J. POL. ECON. 623, 642 (1972).

[211] Consider the following examples for code. There is little a firm can do to protect itself from a major Internet outage. However, a firm can protect itself from a minor Internet outage through the use of redundant Internet service providers. Therefore, one would expect a demand for insurance against losses from a major Internet outage, but not from a minor Internet outage.

[212] One exemplary program is the SANS (System Administration, Networking and Security) Institute, which is devoted to defending computer systems and networks against the most dangerous threats. Information can be found at its web site, at http://www.sans.org/newlook/home.php.

[213] For example, a third party private regulator for privacy, TrustE, has largely failed. This occurred because it has no enforcement authority or "stick" to ensure compliance.[213] There were no laws holding actors accountable for privacy violations. Therefore, TrustE could not meaningfully regulate violators' activity. The use of private regulators such as TrustE has proven unsuccessful. TrustE is ineffective because it cannot force parties to comply. If a party does not comply

the subsequent threat of financial repercussions, there is little incentive for the growth of vigorous third party regulators for code.[214]

Another problem with insurance for code is the need for determinable damages. If losses cannot be estimated by insurance companies, they cannot provide market insurance that is priced in accordance with the risk.[215] The problem is that code-based damages are different than a loss from a fire or hazard, because damage from a fire is tangible, obvious, and irreplaceable. Code in the form of software, in databases, and other similar media is often intangible. Moreover, it is not obvious what the losses actually are when many code-based losses are reversible.[216] Examples of these are computer viruses, hacker attacks, and the defacement of web pages. The remedy for many code-based security losses is that members of a firm's staff must perform activities such as removing viruses from computers and restoring backups. Therefore, predicting and assessing a firm's damages is difficult. Moreover, it may be that damages are so low that firms prefer to self-insure.

Yet another problem concerns the appropriate purchaser of insurance. Throughout the government's efforts to improve security, it has focused on insurance for firms who use the Internet in their daily business. If its goal is developing more secure products, the government should focus on insurance for code developers, thereby addressing the problems of self-protection and determination of damages. If these firms were subject to liability, then they and their insurers would have a tremendous incentive to address that liability, which could lead to several outcomes.[217] The developers could

---

with TrustE they lose slight reputation capital. There is little liability at stake. In contrast, not complying with standards set by Underwriters Laboratories can lead to problems in terms of lawsuits, loss of insurance coverage, and government oversight. Thus there are very real penalties for violating or ignoring the standards promulgated by Underwriters Laboratories. *See* Kesan & Gallo, *supra* note 26 (discussing the failure of third party institutions in regulating online privacy); Paul Boutin, *Just How Trusty is Truste?*, WIRED NEWS, Apr. 9, 2002, *available at* http://www.wired.com/news/print/0,1294,51624,00.html (noting the lack of an enforcement mechanism by TrustE).

[214] *See* Kesan & Gallo, *supra* note 26 (calling for government participation to spur the growth of third party institutions to regulate firms).

[215] *See* Raz & Shaw, *supra* note 204.

[216] Krebs, *supra* note 209 (noting the problem with assessing damage).

[217] *Id.* (noting that security expert Bruce Schneier believes that firms aren't going to improve security until they face either product liability lawsuits or stringent standards).

adopt voluntary "best practices" industry standards for security.[218] Their insurers could then require them to adopt these new practices. Insurers could also encourage the development of a third party regulator to test products to ensure they are secure. Finally, the industry could seek government regulation of code as a way to limit their liability. All of these are ways that product liability and insurance can proactively shape code.

E. Requiring Disclosure

The government can shape the development of code by requiring disclosure, thereby requiring firms to provide information about their products. This differs from educational campaigns funded by the government, which we discuss later.[219] Disclosure is intended to inform consumers, which then allows markets to work more efficiently.[220] In many cases, the technical sophistication of code leads to few people understanding it. As an example, most users didn't understand the privacy risks of cookies until the media reported them. Cookies are a technology that web sites can use to maintain information on their visitors. Many people still don't really understand how cookies operate and their privacy implications.[221] As a result of their limited knowledge, many people are not able to protect their privacy, and consequently, their personal information is being collected.[222] These privacy problems may be substantially reduced if firms are required to meaningfully disclose the privacy risks of cookies.

---

[218] Dan Verton, *Tech Consortium Created to Improve Software Reliability*, COMPUTERWORLD, May 20, 2002, *available at* http://www.computerworld.com/securitytopics/security/story/0,10801,71297,00.html (noting that the insurance industry can aid in promoting "positive behavior" among developers).

[219] *See infra* Part III.D.

[220] BREYER, *supra* note 64, at 161. Disclosure can also be used to outlaw particular conduct, for example requiring the disclosure of large currency transactions aids in finding violations of tax and drug laws.

[221] Similarly, people have difficult understanding the complex privacy policies put forth by web sites. *See* Brian Krebs, *Standard, Plain-English Privacy Policies Wanted – Update*, NEWSBYTES, Dec. 3, 2001, *available at* http://www.newsbytes.com/news/01/172628.html.

[222] Elinor Mills Abreu, *CIA-Backed Web Privacy Firm Closes Service*, WASH. POST, Nov. 20, 2001, *available at* http://www.washtech.com/news/software/13778-1.html (noting that people don't understand privacy issues on the Internet).

According to Justice Breyer, disclosure works most effectively when the following three conditions are met.[223] First, the public has to be able to understand the information disclosed. Regulations are of no use if the information provided is too complex. Second, the public must have a choice within the market. Disclosure is of no use if the public can't select a different alternative. Third, the public must find the information materially relevant. If the public finds no value in the disclosure, there is little utility in requiring such disclosure. Based on this analysis, we offer several potential approaches for government to regulate code with disclosure. These include the use of disclosure to set product standards, disclosure for certain products or activities, and industry-wide disclosure.

To provide the public with better information, the government can require firms to label their products with product standards.[224] For such a label to be successful, it must be able to convey information in a meaningful and concise manner. An example of a labeling standard is the United States Department of Agriculture's standards for food quality.[225] Another problem, unsolicited bulk email (spam), led the government to require the origin and the subject line of commercial email messages to not be deceptive.[226] This disclosure ensures people are better informed about the source and content of commercial email messages.

Government can also mandate disclosure to ensure consumers are adequately informed. This is a step beyond labeling and includes measures such as requiring firms to affirmatively provide information. Indeed, the Securities and Exchange Commission requires public companies to disclose meaningful information, including financial information, to the public. This inspired a California law, which required public disclosure of any computer security breaches in which the confidential information of a California resident may have been accessed.[227] Another example of a code-based disclosure policy is the Children's Online Privacy Protection Act. This law requires web sites to report what children's

---

[223] BREYER, *supra* note 64, at 163-64. *See also* WESLEY A. MAGAT, & W. KIP VISCUSI, INFORMATIONAL APPROACHES TO REGULATION (1992); SUSAN G. HADDEN, READ THE LABEL (1986).
[224] *See supra* text accompanying note 59.
[225] *See supra* note 60.
[226] Controlling the Assault of Non-Solicited Pornography and Marketing Act of 2003, Pub. L. No. 108-127 (2004).
[227] Notice of Security Breach, CAL. CIV. CODE § 1798.82 (2004).

information it collects, uses, and discloses, thus allowing parents to make an informed decision about what web sites their child should visit.[228]

A final method of disclosure is encouraging communication within an industry or to the government. In some circumstances, the public can benefit when firms share information. It is also in the interest of government to support such collaboration. For instance, the government-supported CERT Coordination Center collaborates with industry to disclose all known security incidents.[229] This communication benefits the public by allowing the developers of code to react quickly to potential security problems.[230] However, there is a concern that this creates room for some firms to behave opportunistically. Firms could also use these disclosure regulations to favor certain firms over others. This places a burden on the government to ensure that these regulations are not used to create an uneven competitive playing field. Other firms may even be deliberately left out of the communication loop. The government can also encourage firms to disclose information. In such an instance, proposed legislation would provide firms additional protection from disclosure of computer attacks to government law enforcement agencies.[231] Although there is a concern that this protection is too broad and could lead to less public information on the behavior of firms, it would provide an incentive for firms to provide information to the government.

F. Need for a Comprehensive Regulatory Strategy

A coherent and comprehensive regulation strategy for code has been inadequately considered by policymakers. The regulation of code is spread over a variety of agencies including the FAA, FCC,

---

[228] Children's Online Privacy Protection Act, 16 U.S.C. § 6501 (2001).

[229] CERT Coordination Center was originally called the computer emergency response team. *See*, Robert Lemos, *U.S. Creates Cyberalert System*, CNET NEWS.COM, (Jan. 28, 2004), *available at* http://news.com.com/2100-7348-5148877.html.

[230] Elizabeth Hurt, *New Alliance Takes on Security: CERT Teams Up with Trade Group to Raise Awareness of Information Security Risks*, BUSINESS2.0, (Apr. 19, 2001), *available at* http://www.business2.co.uk/articles/web/0,1653,15984,FF.html (discussing the collaboration between industry and government in disclosing security issues).

[231] Critical Infrastructure Information Security Act of 2001, S. 1456, 107th Cong. (2002).

FDA, FTC, and NHTSA.[232] There are no guiding principles or rationales for this regulatory approach. In contrast, the regulations for other areas, including automobile technology and biotechnology, have distinct rationales that guide the development of regulation.

Before the National Traffic and Motor Vehicle Safety Act required the government to develop safety standards for automobiles, auto safety had been largely unregulated.[233] Today, one agency, the NHTSA, is responsible for setting the safety standards that automobile manufacturers must meet. In contrast, the regulation of biotechnology is not done by one federal agency, but instead relies upon a coordinated framework of federal agencies. This approach was recommended in a report by the Office of Science and Technology Policy (OSTP).[234] The OSTP found that the current laws in this area were largely adequate. This led to two guidelines for the regulatory activity. First, each agency would operate in an integrated and coordinated fashion with other agencies. Second, the responsibility for a product's use would lie with a single agency. As a result, the USDA, EPA, and FDA are each responsible for different phases in the development of biotechnology products ranging from research in laboratories to products in the marketplace.[235]

We believe that the approach used in the regulation of biotechnology is appropriate for code, which also has many different uses and is created by a wide variety of parties. This diversity would

---

[232] The NHTSA is responsible for automobile safety and this now includes code. This is because computers are now used in motor vehicle systems such as pollution control, transmission, antilock brakes, electronic and mechanical systems, heating and air-conditioning, sound, and steering. For example, faulty electronic components and software flaws have caused problems with air bag deployment, powertrain controls, and ignition systems, and even led to deaths. Nedra Pickler, *GM to Recall Cadillac DeVilles for Faulty Air Bags*, DETROIT NEWS, Oct. 21, 2000, *available at* http://detnews.com/2000/autos/0010/22/autos-137213.htm (airbags); Justin Hyde, *Ford Recalls Explorers, Mountaineers*, DETROIT NEWS, Dec. 11, 2000, *available at* http://detnews.com/2000/autos/0012/11/-160923.htm (power train); Stephen LaBaton & Lowell Bergman, *Documents Indicate Ford Knew of Engine Defect but Was Silent*, N.Y. TIMES, Sep. 12, 2000 (ignition systems).

[233] National Traffic and Motor Vehicle Safety Act of 1966, Pub. L. No. 89-563, 80 Stat. 730.

[234] U.S. Office of Science and Technology Policy, Coordinated Framework for Regulation of Biotechnology, 51 Fed. Reg. 23303 (1986).

[235] Linda Maher, *The Environment and the Domestic Regulatory Framework for Biotechnology*, 8 J. ENVTL. L. & LITIG. 133 (1993). *See also* Kurt Eichenwald et al., *Biotechnology Food: From the Lab to a Debacle*, N.Y. TIMES, Jan. 25, 2001 (providing a history of the industry's approach in courting and combating regulation).

cause enormous difficulties for one agency attempting to regulate all forms of code. Instead, regulatory authority should be given based on product use to a single agency.[236] We see a movement in this direction with recent concerns over security and the government's efforts in attempting to unify coordination of code-based security.[237] Nevertheless, we believe government needs to expend more resources in developing a coordinated strategy for the regulation of code.[238]

III. SHAPING CODE THROUGH GOVERNMENT SPENDING

Government can encourage the development and use of socially beneficial code with its fiscal power as it does in supporting medical research, subsidizing agriculture, and building the interstate highway infrastructure. This section discusses four different ways (summarized in Table 2) that government's spending can influence the development of code.

Method	**One word summation**	**Rationale**	**Examples**
Supporting research and development	R&D	Funding the creation of new technologies	National Science Foundation Grants National Institute of Standards and Technology efforts
Procurement power	Buying	Purchasing certain types of technologies for government use	Section 508 (accessibility) requirements Energy star requirements
Tax expenditures	Deductions	Favoring certain technologies through reduction of taxes	Electric car tax deduction

[236] This is similar to the argument that the regulation of code should be application specific and not technology specific. Timothy Wu, *Application v. Internet - An Introduction to Application Centered Internet Analysis*, 85 VA. L. REV. 1163 (1999).

[237] U.S. GENERAL ACCOUNTING OFFICE, CRITICAL INFRASTRUCTURE PROTECTION: SIGNIFICANT CHALLENGES IN SAFEGUARDING GOVERNMENT AND PRIVATELY CONTROLLED SYSTEMS FROM COMPUTER-BASED ATTACKS (2002); Ted Bridis, *U.S. Cyber-Security Efforts Faulted*, ASSOCIATED PRESS ONLINE, July 22, 2002.

[238] The government has a history of coordinating research for code through the National Coordination Office for Information Technology Research and Development *at* http://www.hpcc.gov/.

Method	One word summation	Rationale	Examples
Education and training	Education	Informing and promoting socially responsible behavior	Campaigns to educate people about firewalls and computer security

Table 2. Fiscal methods for encouraging the development of code

A. Government Support of Research and Development

The government can support and shape the development of code by funding research and development activities intended to develop code.[239] Society's research and development spending on computers and electronics alone totaled thirty six billion dollars in 2000.[240] While the majority of this funding is from industry for industry, the federal government accounts for about six billion dollars spent on research and development for computers and electronics.[241] In spending money on research and development, the federal government can use two distinct approaches. We suggest that while government support of basic, knowledge-seeking research is essential for long-term innovation, we also believe that mission-oriented funding can address and shape code that meets societal concerns.

In discussing government support of research and development, we wish to avoid the common distinction between basic and applied research. Instead, we believe a better distinction is to view research as being basic, knowledge-seeking, or more mission-oriented.[242] Thus, in discussing the funding of basic and mission-oriented research, we focus on the motivations of the research and not on the methods or outcomes.[243] Accordingly, we

[239] *See infra* note 351 (noting an alternative to government funding of research and development is the use of a tax expenditure to subsidize research).

[240] NATIONAL SCIENCE BOARD, SCIENCE AND ENGINEERING INDICATORS – 2002 (2002), at Table 4-3.

[241] *Id.* at Table 4-31, 4-33.

[242] Lewis M. Branscomb, *From Science Policy to Research Policy, in* INVESTING IN INNOVATION 112, 129-33 (Lewis M. Branscomb & James H. Keller eds., 1998).

[243] All too often research is divided into basic and applied. In this division, research with no clear application is basic research, while applied research is one with a practical application. Research conducted in academic laboratories is basic research, while research conducted in industry laboratories is applied research. Theoretical work is basic research, while experimental work is applied research.

will use the terms basic research and mission-oriented research in our discussion.

1. Funding Basic Research

Basic research strives to understand how things work without having specific applications in mind. This type of research has resulted in great innovations, including government funded basic research leading to the development of the Internet and the World Wide Web. The rationale for such government funding is that the private sector will not perform an adequate amount of basic research. This market failure exists for a number of reasons. First, firms cannot predict the future economic value of basic research.[244] The core characteristic of basic research is that it is unknown what application it may serve. Secondly, once the knowledge is produced, it is difficult to keep the knowledge from others.[245] The benefits of funding research and development cannot be entirely captured by a firm. Consequently, this leads rational-acting firms to concentrate

---

Science is produced by basic research, while technology comes from applied research. Moreover, implicit in this distinction is a linear model of development. This holds that basic research leads to applied research and that advances in science lead to advances in technology. We believe these divisions between what is being studied, the methods, outcome, and resulting linear model are an anachronism and lead to a poor understanding of technological development. Relying on this conception of technological development does not allow us to understand the development of code, especially in relation to government support of code. This is why more recent material ignores these divisions. *Id.* at 120. *See also* COMMITTEE ON CRITERIA FOR FEDERAL SUPPORT ON RESEARCH AND DEVELOPMENT, ALLOCATING FEDERAL FUNDS FOR SCIENCE AND TECHNOLOGY (1995), *available at* http://www.nap.edu/readingroom/books/fedfunds/part1/determining.html.

[244] Richard R. Nelson, *The Simple Economics of Basic Scientific Research*, 67 J. POL. ECON. 297 (1959). Nelson's approach is referred to as the informational approach. Today, most scholars don't believe the knowledge produced is just information which can be easily transmitted. Instead, it is necessary to acknowledge that information implicitly requires a capacity to use it in a meaningful way and gaining this capacity is not trivial. This is referred to as the evolutionary economic approach. *See* Ammon J. Salter & Ben R. Martin, *The Economic Benefits of Publicly Funded Basic Research: A Critical Review*, 30 RES. POL'Y 509, 511 (2001).

[245] Nelson, *supra* note 244. *See also* COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD, NATIONAL ACADEMY OF SCIENCES, FUNDING A REVOLUTION: GOVERNMENT SUPPORT FOR COMPUTING RESEARCH (1999). (providing the economic rationale for government supported research and development).

their resources on applied problems whose benefits are better captured by the firm.[246]

The problem of under-funding by the private sector led to calls for government funding. The most celebrated and influential supporter of government funding was Vannevar Bush, who argued that researchers should be allowed to perform research without concerns about its practicality.[247] He believed that curiosity-driven research eventually leads to technological innovation. Therefore, if government wants to increase technological innovation, it should fund more basic research.[248] This argument has been very persuasive and has resulted in substantial government funding for basic research and development. In the field of computer science, the government spent almost $900 million on academic research in 1999.[249] Historically, this emphasis on basic research has led to the development of many technological innovations of code. Besides the development of the web, government's support has been instrumental for a number of other important computer innovations such as timesharing, computer networking, workstations, computer graphics, the mouse, the windows interface, VLSI circuit design, RISC computing, parallel computing, and digital libraries.[250] We have no doubt that additional basic research will lead to further innovations in the future, and this is why we support government funding of basic research.

A few critics argue that government funding of basic research is not needed. For them, government funding is simply wasteful and unneeded.[251] This position has been harshly criticized.[252] For

---

[246] *See* Gregory Tassey, *R&D Trends in the U.S. Economy: Strategies and Policy Implications*, NIST Briefing Note, Apr. 1999, *available at* http://www.nist.gov/director/prog-ofc/R&DTrends.htm (providing additional arguments on why industry under invests in research and development).

[247] VANNEVAR BUSH, SCIENCE THE ENDLESS FRONTIER (1945).

[248] Michael Crow & Barry Bozeman, *R&D Laboratory Classification and Public Policy: The Effects of Environmental Context on Laboratory Behavior*, 16 RES. POL'Y 229 (1987) (finding that public institutions are best in carrying out basic research and development).

[249] NATIONAL SCIENCE BOARD, SCIENCE AND ENGINEERING INDICATORS – 2002 (2002), at Table 5-9.

[250] COMMITTEE TO STUDY HIGH PERFORMANCE COMPUTING AND COMMUNI - CATIONS, EVOLVING THE HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS INITIATIVE TO SUPPORT THE NATION'S INFORMATION INFRASTRUCTURE 17-18 (1995), *available at* http://www.nap.edu/ catalog/4948.html.

[251] *See* TERENCE KEALEY, THE ECONOMIC LAWS OF SCIENTIFIC RESEARCH (1996) (criticizing government funding for research).

example, Nelson found in a variety of industries that government support of research and development was valuable; even in industries with a high level of private research and development, there was a substantial role for government supported research and development.[253]

The criticisms of government funding are largely about what research to conduct. In basic research, scientists, not society, decide what is important. Yet, this research is funded by society who, quite rightly, wants to ensure that there are tangible, societal and economic benefits flowing from this research. Moreover, society believes certain areas of research demand higher priority. Recently, this has been manifested in a rapid increase for basic research in medicine, which has led to reduced funding in other areas such as energy and astronomy.[254] Since the basic research model cannot address immediate societal problems, another model for funding research and development merits consideration.

2. Supporting Mission-Oriented Funding

The mission-oriented approach seeks to force the development of scientific knowledge and technologies through increased funding on specific subjects.[255] This approach recognizes the need for basic research, but suggests that we must also prioritize and allocate resources based on societal concerns. Though unconcerned with learning about the world merely for the sake of learning, this approach is concerned with problems that affect

---

[252] *See* Paul A. David, *From Market Magic to Calypso Science Policy: A Review of Terence Kealey's The Economic Laws of Scientific Research*, 26 RES. POL'Y 229 (1997) (critiquing Kealey's arguments).

[253] Nelson, *supra* note 63.

[254] Dan Vergano, *Medical Research Has Healthy Budget*, USA TODAY, Mar. 20, 2001, *available at* http://www.usatoday.com/news/health/2001-03-20-medical-research.htm. To protect against a pure politicization of research funding, agencies such as the NSF use peer review for the allocation of research funds.

[255] This approach can be phrased as a Jeffersonian approach with an emphasis on both traditional basic and applied research. *See* Gerald Holton & Gerhard Sonnert, *A Vision of Jeffersonian Science*, ISSUES SCI. & TECH, Fall 1999, *available at* http://www.nap.edu/issues/16.1/holton.htm; Lewis M. Branscomb, *The False Dichotomy: Scientific Creativity and Utility*, ISSUES SCI. & TECH, Fall 1999, *available at* http://www.nap.edu/issues/16.1/branscomb.htm. *See also* Michael Crow & Christopher Tucker, *The American Research University System as America's de facto Technology Policy*, 28 SCI. & PUB. POL'Y 2 (2001) (arguing that such targeted research is the de facto policy in America, despite the rhetoric supporting Vannevar Bush's ideas for government support of basic research).

society. We believe that the mission-oriented approach permits society to shape code to address specific societal concerns, such as privacy and security.

While we support the use of mission-oriented funding, we also recognize that without funding for basic research, this approach may lead to long-term problems. History has shown that advancement in any field depends upon advances in other, seemingly irrelevant, fields. For example, recent successes in medicine can be attributed to advances in high-energy physics, computing, and mathematics.[256] Another caveat from our case studies, as well as the literature on innovation, shows that technological innovation is often unpredictable.[257] As a result, the government may squander resources by paying too much for a solution or failing to develop a solution in its search for a technological solution.

There are two different mission-oriented approaches that the government can use to shape code. The first approach is when the government is the predominant purchaser of a product, such as defense. In this case, the government has a legitimate interest in shaping the technology.[258] The government's procurement interest allows it to define its technological needs based on its own expertise.[259] Government funding for research and development allows government to meet its needs, because firms would not develop products because of the lack of a private market and the uncertainty of government procurement. Although the mechanics of the actual funding may be a procurement contract, in essence, this approach is focused on increasing the supply of technologies with the government funding the research and development of these technologies.[260] Critics argue that this approach is too expensive and wasteful. In fact, there is ample evidence that some technology decisions made by the Department of Defense have been costly and wasteful.[261] Such waste usually occurs because of both the politics

---

[256] Vergano, *supra* note 254.
[257] *See supra* note 65.
[258] Nelson, *supra* note 63, at 460.
[259] *Id*.
[260] The government can finance the research and development in a variety of ways from funding basic research and development, supporting direct research and development support for a procurement contract, or hiding the cost of research and development within a procurement contract. Nelson, *supra* note 63, at 460.
[261] U.S. GENERAL ACCOUNTING OFFICE, HIGH-RISK SERIES - DEFENSE WEAPONS SYSTEMS ACQUISITION (1992) *available at* http://www.fas.org/man/gao/hr9307.htm.

and the sheer size of defense spending.[262] However, this funding can affect society broadly through spillover effects, which occur when the private sector finds a commercial application for a government supported technology.[263] These spillover effects mitigate the inherent inefficiencies in government funding of research and development for products that it will later purchase.[264]

The Defense Advanced Research Projects Agency (DARPA) is an example of an agency that funds mission-oriented research and basic research for the Department of Defense. Its achievements include the F-117 stealth fighter, the Joint Surveillance and Target Attack Radar System, and precision guided munitions, all of which were used in Operation Desert Storm, the Persian Gulf War of 1990.[265] DARPA's achievements have spilled over beyond the military. For example, DARPA's funding of ARPANET, the precursor to the Internet, as well as the seed funding for the W3C are prominent examples of technology spillovers from defense to society.[266]

The second form of useful mission-oriented funding is pursued by government agencies with an agenda. By an agenda we mean an agency is supporting research and development that advances its own well-defined purposes.[267] It can then evaluate and selectively fund projects that further those interests. This is an effective way of supporting research that directly addresses societal concerns. A good example of such a government agency is the

---

[262] William Hartung, *Corporate Welfare for Weapons Makers: The Hidden Costs of Spending on Defense and Foreign Aid*, *available at* http://www.cato.org/pubs/pas/pa350.pdf (Aug. 12, 1999).

[263] *Id*.

[264] CONGRESSIONAL BUDGET OFFICE, THE ECONOMIC EFFECTS OF FEDERAL SPENDING ON INFRASTRUCTURE AND OTHER INVESTMENT (1998) (concluding that justifying mission-oriented funding involves considering both its purpose as well as the spillover effects). *But cf.*, Frank R. Lichtenberg, *Economics of Defense R&D*, *in* HANDBOOK OF DEFENSE ECONOMICS 431, 447-48 (Keith Hartley & Todd Sandler eds., 1995) (finding a low rate of return for government research and development funding for defense).

[265] Defense Advanced Research Projects Agency, *Technology Transition*, Jan. 1997, *available at* http://www.darpa.mil/body/pdf/transition.pdf (describing how various DARPA technologies have been incorporated into the military capabilities for U.S. forces).

[266] *See* Charles Piller, *Funding the Impossible a Specialty for DARPA*, L.A. TIMES, Oct. 28, 2001, *available at* www.latimes.com/news/nationworld/nation/la-102801darpa.story; World Wide Web Consortium, *DARPA Support of the Web*, *available at* http://www.w3.org/Consortium/Prospectus/DARPA.html (last modified July 31, 2001).

[267] Nelson, *supra* note 63, at 460.

National Institute of Health, which supports research addressing specific diseases. The criticism of this approach is the government's "picking" of winners. Critics argue that there is a market for this research, and therefore, government funding is unnecessary. Additionally, they insist that government funding essentially subsidizes a narrow class of winning firms that gain government support.[268]

We readily agree that government generally is no match for the market in picking winners. However, we believe that in certain instances, government can positively shape the development of technologies. Our support is limited to areas where there are government agencies with defined missions. This ensures that there are solid criteria and goals for the funding decisions as well as public support and accountability. Moreover, an agency with a strong mission is likely to have the expertise available to make such funding decisions. Expertise, along with a funding policy that is based upon evaluation of competitive proposals by informed agency officials and/or peer review, should aid in preventing wasteful expenditures.[269]

Government itself could fund projects to advance the development of code to address societal concerns. For example, security has now become a major concern for code. It is well known that there are fundamental problems with key components of the Internet's infrastructure.[270] The federal government is expected to

---

[268] Mission-oriented funding approaches can lead to politicians and not scientists picking technologies. An example in medicine is when the government allocates resources for particular problems such as breast cancer or Parkinson's disease. In 1993, Congress set aside $77 million in new funding specifically for breast, ovarian, and other cancers. This funding was outside the traditional method of using peer review to select the funding for what research to pursue. This meant NIH was forced to cut funding in other areas such as colon cancer to make up the shortfall. In 1997, Congress passed legislation authorizing $100 million for research on Parkinson's disease. *See* Sue Kirchhoff, *Progress or Bust: The Push to Double NIH's Budget*, CONG. Q., May 8, 1999, *available at* http://ugsp.info.nih.gov/info_items/info22.htm. There is also ample historical evidence of the government's inadequacies in picking winners. According to the old adage, legislators and government bureaucrats shouldn't pick technologies, instead consumers should. *Id.*

[269] *See* Steven Kelman, *The Pork Barrel Objection*, AM. PROSPECT, Sep. 1, 1992, *available at* http://www.prospect.org/print-friendly/print/V3/11/kelman-s.html (providing recommendations to prevent funding from turning into congressional pork barreling).

[270] Carolyn Duffy Marsan, *Fed Plan Exposes 'Nets Weak Links*, NETWORKWORLD, Oct. 7, 2002, at 1 (noting problems with IP, DNS, and the Border Gateway Protocol (BGP).

drastically increase its spending on computer security to more than four billion dollars a year.[271] This involves supporting further government research and development with federal agencies such as the NSF and the National Institute of Standards and Technology (NIST) that will trickle down to universities.[272] However, there is not one government agency solely overseeing or coordinating code development. Based on our analysis, we would recommend funding for an existing agency in which security issues related to code are part of its mission.[273] Otherwise, it is unlikely to have the expertise to fund projects judiciously.[274]

Government funding should also consider its role in creating and participating in the development of standards because they are considered impure public goods and will be under-produced.[275]

---

[271] *Bush Gives $1.7 Billion Boost to Cybersecurity*, SILICONVALLEY.COM, May 23, 2002, *available at* http://www.siliconvalley.com/mld/siliconvalley/news/332403.htm.

[272] COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD, *supra* note 156; Carolyn Duffy Marsan, *Congress: Tighten IT Security*, NETWORK WORLD FUSION, Apr. 22, 2002, *available at* http://ww.nwfusion.com/news/2002/0422nist.html; Brian Krebs, *Bush Signs $900 Million Cybersecurity Act*, WASH. POST, Nov. 27, 2002 (noting the new increases in spending for cybersecurity); Florence Olsen, *Universities Expand Their Anti-Cyberterrorism Research*, CHRON. HIGHER EDUC., Jun. 25, 2002, *available at* http://chronicle.com/free/2002/06/2002062501t.htm (noting how universities are shifting research priorities because of new financing).

[273] Currently there are a number of agencies conduct researching into security aspects of code including the National Security Agency, National Science Foundation, and the National Institute of Standards and Technology.

[274] National Science Foundation, *Program Announcement: Trusted Computing*, NSF-01-160, (Dec. 5, 2001), *available at* http://www.nsf.gov/pubs/2001/nsf01160/nsf01160.html. To further improve efficiency, the government should consider charging one agency, such as the National Institute of Standards and Technology with conducting research into code-based security issues. This would also help to prevent duplicative research as well as losing research results between various agencies. An even better focus would be to fund an agency that needs to procure more security conscious code for its mission. This agency would have an interest in not only funding such research, but also in ensuring this research is transferred to the private sector. P.A. Geroski, *Procurement Policy as a Tool of Industrial Policy*, INTER. REV. APPLIED ECON., June 1990, at 182, 189 (noting value of users in the procurement process for the creation of innovative products).

[275] Goods like education and standards are impure public goods. These combine aspects of both public and private goods. Although they serve a private function, there are also public benefits associated with them. Impure public goods may be produced and distributed in the market or collectively through government. How they are produced is a societal choice of significant consequence.

There are several different kinds of standards that the government can develop, including those promoting interconnection and interoperability as well as standards that benefit public health and safety.[276] This includes work on the "Common Criteria", a set of mandatory security standards for code used in national security systems.[277] Funding this type of research is another way government can shape to code to meet societal concerns.

B. Procuring Code

The government can use its power of procurement to develop or support particular code.[278] Government's procurement power can create or increase the market for a particular product. This "power of the purse" focuses on the demand side of technology, in contrast to the supply-side policies discussed previously. There is a long history of the use of procurement power from standardized clothing sizes during the Civil War to the U.S. Army's giving credibility to generic drugs.[279] This power follows from the immense amount of government expenditures.[280]

Cargill, *supra* note 100 (quoting OFFICE OF TECHNOLOGY ASSESSMENT, U.S. CONGRESS, GLOBAL STANDARDS: BUILDING BLOCKS FOR THE FUTURE 14 n.23 (1992)).

[276] *See supra* text accompanying notes 58-61. For example, in response to concerns over computer security, NIST is expanding its efforts in setting federal security standards. Marsan, *supra* note 272.

[277] Ellen Messmer, *Sun Earns Certification for Trusted Solaris 8*, NETWORK WORLD FUSION, May. 1, 2002, *available at* http://www.nwfusion.com/news/2002/0501trustedsolaris.html; Ellen Messmer, *System Security Finds Common Ground*, NETWORK WORLD, July 8, 2002, at 42; Common Criteria's web site is *at* http://www.commoncriteria.org/.

[278] We emphasize government procurement because it is the policy of the government to rely on private producers for goods and services rather than make or manufacture the goods. *See* 48 C.F.R. § 7.301 (1999). Also we are focusing on procurement policies that affect code. Government procurement strategies can have other goals such as equitable distribution of contracts to businesses of all sizes. Some of the procurement mandates include preferences for disadvantaged businesses and women-owned businesses, the application of labor laws, environment, conservation, occupational safety, drug-free workplaces, domestic preferences, the Indian Incentive Program, and minority university institutions. Steven L. Schooner, *Fear of Oversight: The Fundamental Failure of Businesslike Government*, 50 AM. U. L. REV. 627, n.182-83 at 683-84 (2001).

[279] This position would predict that the government requirement of filtering in libraries and school would enlarge the market for filtering software.

[280] Federal government spending is expected to be over two trillion dollars in 2003, almost twenty percent of the Gross Domestic Product (GDP). OFFICE OF MANAGEMENT AND BUDGET, BUDGET OF THE UNITED STATES GOVERNMENT:

This section suggests that the government's procurement power can also be effective in shaping information technologies.[281] As the largest single purchaser of code, the government will spend over fifty billion dollars on information technologies in 2003,[282] including almost nine billion dollars spent by state and federal governments on prepackaged software in 2001.[283] This makes up a small, but significant, part of the $800 billion market for information technologies in the United States in 2001.[284] Such a large purchasing power can be used to influence the development of code by the private sector.[285]

The reasoning behind using government procurement to shape code is that new products take time to develop as innovators create and expand a market. This process is risky and is usually characterized by slow growth. But when government uses its

---

FISCAL YEAR 2003, *available at* http://www.whitehouse.gov/omb/budget/ (last visited Jun. 5, 2003). Of this, more than $200 billion will be spent directly on procuring goods and services. This amount involves goods and services and not civil service or military personnel salaries, grants, foreign aid, etc. *See* Federal Procurement Data System (FPDS), *Federal Procurement Report, at* http://www.fpdc.gov/fpdc/FPR2000a.pdf (last visited June 5, 2002). *See also* Schooner, *supra* note 278, n.7 at 631 (noting the limitations of this procurement data).

[281] A number of commentators have discussed government's procurement power. *See* C. Edquist and L. Hommen, *Public Technology Procurement and Innovation Theory*, *in* PUBLIC TECHNOLOGY PROCUREMENT AND INNOVATION (Charles Edquist et. al. eds., 2000); OFFICE OF TECHNOLOGY ASSESSMENT, *supra* note 11 at 37-38; Geroski, *supra* note 274.

[282] *Bush Gives $1.7 Billion Boost to Cybersecurity,* SILICONVALLEY.COM, May 23, 2002, *available at* http://www.siliconvalley.com/mld/siliconvalley/news/332403.htm; Office of Management and Budget, *Report on Information Technology Spending for the Federal Government, available at* http://www.whitehouse.gov/omb/inforeg/final53.xls (April 9, 2001) (providing 2002 figures).

[283] Bureau of Economic Analysis, Tables 1, 11, *available at* http://www.bea.doc.gov/bea/papers/tables.pdf (May 3, 2002), cited in David S. Evans & Bernard Reddy, *Government Preferences for Promoting Open-Source Software: A Solution in Search of a Problem,* n. 51, *available at* http://ssrn.com/abstract id=313202 (May 21, 2002). The total sales of prepackaged software was seventy four billion dollars.

[284] WORLD INFORMATION AND TECHNOLOGY SERVICES ALLIANCE, DIGITAL PLANET 2002: THE GLOBAL INFORMATION ECONOMY (2002).

[285] Recently, the Consumer Project on Technology called for the government to consider competition and security in its procurement decisions for code. Ralph Nader and James Love, Consumer Project on Technology, *Procurement Policy and Competition Security in Software Markets,* June 4, 2002, *available at* http://www.cptech.org/at/ms/omb4jun02ms.html.

purchasing power, it creates a much larger market. This grants producers economies of scale, lower unit costs, and lower risks, thereby leading to the incorporation of new technologies and lower prices for the public in a shorter time.[286]

There are two major rationales for government's use of its procurement power to favor certain products. The first is an efficiency rationale that government should spend its resources wisely. This leads to a number of potential measures that the government can take, including buying goods in volume to save money.[287] For instance, there are efforts to procure inexpensive products, such as generic medicines.[288] Another measure could require government purchasers to consider the total cost of ownership instead of just the initial cost. This second rationale takes into account the effect of externalities, which are costs or benefits not contained in the price of a product. Government procurement has historically internalized environmental and other social externalities.[289] This has meant that government affirmatively acted to ensure these externalities were accounted for in the purchase of products. If government did not account for these externalities it was essentially saying externalities were not important by setting their price to zero.[290] Hence, by accounting for externalities, the government strives to "set an example to the private sector, advance . . . [specific societal] goals, and best serve the public interest."[291]

There are three major criticisms with using government procurement to shape technologies. The first is that it consists of an unnecessary meddling with the market. Government should act as a passive consumer and not attempt to influence the actions of private industry. The second criticism is that government "meddling" will

---

[286] Ralph Nader, *Shopping for Innovation: Government as a Smart Consumer*, AM. PROSPECT, Sep. 1, 1992, *available at* http://www.prospect.org/printer-friendly/print/V3/11/nader-r.html.

[287] For example, the General Services Administration serves as a central purchasing agency for the federal government. Its enormous purchasing power allows it to negotiate volume purchase arrangements. *See* General Services Administration, *GSA Federal Supply Service*, *available at* http://www.gsa.gov/Portal/content/orgs_content.jsp?contentOID=22892&contentType=1005 (last modified Apr. 11, 2002).

[288] Nader, *supra* note 286 (noting the role of the U.S. Army in establishing the credibility of generic drug products).

[289] *See supra* note 278.

[290] F. Paul Bland, *Problems of Price and Transportation: Two Proposals to Encourage Competition from Alternative Energy Resources*, 10 HARV. ENVTL. L. REV. 345, 386-87 (1986).

[291] Nader, *supra* note 286.

be useless or may even partially backfire.[292] Critics argue that government support of a particular technology may not have much influence on the development of a technology and can even retard use by the private sector. The final objection is that the addition of such criteria leads to a more complicated procurement process, and therefore, raises administrative costs.

The government has a long and successful history of activism in shaping technologies that have no market, e.g., high technology weapons. Similarly, it can influence the development of commercial, off-the-shelf products.[293] The rationale here is that government must buy something, so why not buy products that offset certain externalities. In doing so, government could set an example for private industry by purchasing certain products or technologies that it deems worthy. While the government has used procurement policies for energy-efficient products since 1976,[294] recently, the government has been active with environmentally friendly procurement measures, such as preferences for recycled products.[295] Instead of focusing on whether the government should be an active consumer, we think critics should instead focus on whether this approach has been successful. We do, however, agree that government procurement efforts can have a negligible impact on the market. To address this concern, we suggest that government procurement efforts be focused. Typically, this involves using government

---

[292] Donald B. Marrow, *Buying Green: Government Procurement as an Instrument of Environmental Policy*, 25 PUB. FIN. REV. 285 (1997).

[293] In certain circumstances government may intervene on the supply side of procurement to ensure competition and innovation among producers. For example, the military has successfully utilized a number of strategies to ensure a viable military supplier community. These strategies include awarding contracts to new firms as well as established ones, ensuring technical information was widely disseminated across industry, and the use of second sourcing. However, these approaches seem most successful when limited to circumstances when government purchasing dominates in a specific market with few producers. If government spending is not significant its policies will likely be ineffective in affecting suppliers. Similarly, if there are a plethora of suppliers there is no need for the government use procurement strategies to create competition and innovation. *See* Charles Edquist & Leiff Hommen, *Government Technology Procurement and Innovation Theory*, *available at* www.tema.liu.se/tema-t/sirp/pdf/322_1.pdf (1998) (discussing various procurement strategies the military uses).

[294] Exec. Order No. 11,912, 41 Fed. Reg. 15,825 (Apr. 13, 1976) (calling for several measures to improve energy efficiency).

[295] Jennifer McCadney, *The Green Society? Leveraging The Government's Buying Powers to Create Markets for Recycled Products*, 29 PUB. CONT. L.J. 135 (1999). *See generally* ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, GREENER PUBLIC PURCHASING: ISSUES AND PRACTICAL SOLUTIONS (2000).

procurement to provide the early demand for a product using new technologies.[296] It is at this crucial stage that government can most effectively shape the development of technologies for commercial use.[297]

Even in markets where government demand is influential, procurement efforts may fail.[298] Consider the scenario of two goods that are substitutes, green and brown. Government procurement of green goods would crowd out the availability of green goods to private industry. This would lead to private industry procuring more brown goods as a substitute for green goods. Thus, the net effect of the government's and private industry's actions would be offsetting.[299] Moreover, this could be seen as negatively impacting the development of new products or technologies because government would be crowding out private purchasers of green goods. However, this analysis is based on the assumption that the products are close substitutes. Moreover, if marginal costs are decreasing, government intervention can lower the price for green goods for all consumers through economies of scale. This analysis indicates that economies of scale are an important element in the success of government procurement for shaping technologies.[300]

Finally, we understand the criticisms that additional procurement policies would raise the cost of procurement and deter agencies from following these rules. While procurement guidelines require agencies to purchase equipment that meets the EPA's Energy

---

[296] MICHAEL E. PORTER, THE COMPETITIVE ADVANTAGE OF NATIONS 645-46 (1990). Government can also serve as a positive force to improve technologies and the competitiveness of producers through the following actions. The government can use stringent product specifications rather than just purchasing what domestic firms produce. These product requirements should also consider international needs, as that is where future markets will lie. Government also must not be afraid to procure competitively. This provides domestic firms an incentive to innovate.

[297] Another related criticism is that government efforts will be neutered by the lack of cooperation by private industry. There are a number of examples of private industry fighting procurement policies. *See* Nader, *supra* note 286 (noting how contractors have successfully fought off requirements that would hold construction companies liable for the quality of roads). McCadney, *supra* note 295, at 147 (discussing how Lexmark used contract conditions for toner cartridges that conflicted with the government's procurement efforts to recycle toner cartridges)

[298] Marrow, *supra* note 292.

[299] *Id.*

[300] *Id.* Furthermore, this leads to the conclusion that government procurement can produce significant benefits if the government is a particularly large buyer of a specific product, supply is particularly elastic, and/or private demand is particularly inelastic.

Star requirements,[301] agencies are also supposed to purchase products that rank in the top twenty-five percent for efficiency for product groups without Energy Star labels.[302] One report suggests that there is a low level of compliance with these rules for a number of reasons including a lack of enforcement, no requirement to justify inefficient purchases, and agencies already having too many procurement requirements to consider.[303] However, there is no compelling reason to believe that these issues could not be addressed, if needed.[304]

One example of the influence of procurement power is the government's support of energy efficient computer equipment. An Executive Order in 1993 mandated that computers purchased by federal agencies must meet the EPA's Energy Star requirements.[305] In 1999, it was estimated that the Energy Star requirements on computers and monitors saved over one billion dollars.[306] Moreover, the entire Energy Star program for labeling consumer products has prevented emissions of 5.7 million metric tons of carbon equivalent and saved over two billion dollars on energy bills in 1999 alone.[307] These savings are the result of a voluntary government standard supported by a procurement policy. Furthermore, these results suggest that the EPA's Energy Star labeling and the federal procurement guidelines have led the private sector to purchase energy efficient equipment. Moreover, there is no evidence that the purchase of energy efficient products by the government has led private industry to shift consumption toward inefficient products.

Another contemporary example of the government's procurement power is the requirement that the government comply with section 508 of the Rehabilitation Act. The Act states that any federal purchases of computers, software, and electronic equipment

---

[301] Exec. Order No. 13,123, 64 Fed. Reg. 30,851 (June 3, 1999).
[302] *Id.*
[303] ALLIANCE TO SAVE ENERGY & FEDERAL ENERGY PRODUCTIVITY TASK FORCE, LEADING BY EXAMPLE: IMPROVING ENERGY PRODUCTIVITY IN FEDERAL GOVERNMENT FACILITIES 18-19 (1998).
[304] Recently a federal judge ordered fifteen federal agencies to increase their purchases of alternative fuel vehicles as required by existing law. *Agencies Ordered to Obey Alternative Vehicle Law*, ENVTL. NEWS SERVICE, Aug. 8, 2002, *available at* http://ens-news.com/ens/aug2002/2002-08-08-06.asp.
[305] Exec. Order No. 12,845, 58 Fed. Reg. 21,887 (Apr. 21, 1993).
[306] EPA Climate Protection Division, *The Power To Make a Difference: ENERGY STAR and Other Partnership Programs*, EPA 430-R-00-006, July 2000, at 12 (calculating 15 billion-kilowatt hours at $0.08 a kWh).
[307] *Id.*

used to disseminate information, including telephones, copiers, and facsimile machines, must be accessible to persons with disabilities.[308] This has prompted firms such as Microsoft, Macromedia, and Adobe to modify their products to ensure they are capable of producing accessible web sites and content.[309] The above examples illustrate that the government values societal concerns such as reducing carbon emissions and ensuring that disabled people have access to information technologies. In both of these examples, critics ask: what is the cost of administering these programs? Moreover, what are the additional procurement costs to the government as a result of these requirements? This is a much harder question. First, there is no clear data on how much extra, if any, the government has spent. Unless this data showed that the government spent significantly more money, it would seem irrelevant. This is because the government's procurement decision takes into account various externalities and necessarily implies the government's willingness to pay more. The hope here is that government efforts will prompt others to also take into account these values, and perhaps make it economically attractive for them to do so.

The aforementioned analysis suggests several recommendations for government procurement decisions regarding code. The efficiency rationale suggests that government should consider how to save money in making procurement decisions. In keeping with this idea, the U.S. General Services Administration (GSA) already buys information technology products in volume. This approach is a reasonable way to save government resources. The efficiency rationale also suggests the government should consider standards for product quality as well as open standards that promote interoperability. Both of these types of standards have the potential to reduce costs. For example, recently the United Kingdom put forth a policy seeking to use open standards that promote interoperability while avoiding products that lock-in to proprietary code.[310] To conclude, the efficiency rationale suggests that government should consider the total cost of ownership and not just

---

[308] Section 504 of the Rehabilitation Act, 29 U.S.C. § 794d. *See also supra* note 91 (noting that the Telecommunications Act requires code to be accessible when it is easily achievable).

[309] Ann Moynihan, *Creating Web pages That Are Accessible To the Disabled Is Good Business*, BUSINESS REV., Mar. 29, 2002, *available at* http://www.bizjournals.com/albany/stories/2002/04/01/focus5.html.

[310] Office of Government Commerce, *Open Source Software: Use Within UK Government, (*July 15, 2002), *available at* http://www.ogc.gov.uk/ index.asp?id=2190.

the initial purchase price when buying products. This rationale could lead government to support open source code if there was evidence that its total cost of ownership was less than proprietary code. However, there is a need for more data on the costs of open source code as compared with proprietary code before government can justify its use of open source code on efficiency grounds.

In procuring custom-made code, not available off-the-shelf, the government should consider placing its source code in the public domain.[311] While this is not current practice, there is no reason why the government cannot bargain for the source code in its contracts.[312] Once government has access to the source code, duplication for the public costs nothing because the software component of source code is nonrivalrous.[313] If the government built a building, it could not simultaneously keep its offices there while allowing the public to use this building. However, software code is different, since it can be easily reproduced.[314]

The government may go farther by placing its source code in the public domain, thereby keeping parties with access to the source code from having to "reinvent the wheel." Critics would argue that this approach is wrong for two reasons. First, access to the source code could allow hackers to gain control of vital systems. We agree with this criticism and believe that the source code should not be placed into the public domain, if there are national security concerns;

---

[311] The government may require the development of custom-made code. This is usually to fulfill the requirements of law or the mission of a government agency. For example, the Federal Bureau of Investigation developed Carnivore, an electronic surveillance tool. It differs from commercially available surveillance tools, because it can distinguish between communications that can be lawfully intercepted and those that may not. For example, Carnivore can distinguish between email and online shopping activities. *See* Federal Bureau of Investigation, *Carnivore Diagnostic Tool*, *available at* http://www.fbi.gov/hq/lab/carnivore/carnivore2.htm (last visited Mar. 16, 2002).

[312] Typically when the government contracts out the development of code it does not have the right to distribute the code. U.S GENERAL ACCOUNTING OFFICE, *supra* note 385, at 27.

[313] The UK Government is considering placing the source code into the public domain for custom made code. *See* Office of Government Commerce, *supra* note 310.

[314] The Environmental Protection Agency (EPA) and the Department of Energy (DOE) developed software for the remote evaluation and control of energy conservation features of networked computers. Their goal was to save money on energy costs, but the nonrivalrous nature of code meant it was relatively costless to make this code publicly available in the interest of energy conservation. For more information on the EPA's Enabling Monitor Power Management software. *See* www.energystar.gov/powermanagement.

e.g., it may not be appropriate for code governing military satellite communications to be accessible by anyone. Nevertheless, there may be portions of the code that could be placed into the public domain for society's benefit. Secondly, critics argue that placing code into the public domain will result in the code just languishing there. Instead, what is needed for further development is the ability for a party to have exclusive property rights. While this may be true in some instances, we do not think this is true in very many cases. Rather, in the later section on the transfer of intellectual property rights to the private sector, we argue that property rights are not necessarily required for further improvement of code.[315]

Government procurement decisions regarding code could also consider certain externalities such as the support of innovation, protection of privacy, and ensuring security. The government could use its procurement decisions to favor certain products. In the case of innovation, the government can ensure that the products it buys support open standards and modularity, keys to code innovation. In the case of security, the government could ensure its products meet standards for security, such as the Common Criteria.[316] These decisions may be more costly, but can benefit the public in ways that that the market does not capture.

Relying on the efficiency and externalities rationales has led to proposals that government use its procurement power to adopt open source code instead of commercial, off-the-shelf products.[317]

---

[315] *See infra* Part III.D.

[316] *See supra* note 277.

[317] *See* ROBERT W. HAHN, GOVERNMENT POLICY TOWARD OPEN SOURCE SOFTWARE (2002), *available at* http://www.aei.brookings.org/admin/authorpdfs/page.php?id=210 (providing several articles on possible approaches toward open source procurement by government). *See also* President Information Technology Advisory Committee, *Developing Open Source Software to Advance High End Computing*, Oct. 2000, *available at* http://www.ccic.gov/ac/letters/pitac_ltr_sep11.html (encouraging the U.S. Government to use open source software in high end computing); Mitch Stoltz, *The Case for Government Promotion of Open Source Software*, NETACTION, *available at* http://www.netaction.org/opensrc/oss-whole.html (last visited Jan. 28, 2002); Shawn W. Potter, *Opening Up to Open Source*, 6 RICHMOND J. L. & TECH. 24 (2000) (arguing that besides procurement, the government needs to amend the UCC to enhance adoption of open source); *Should Public Policy Support Open-Source Software?*, AM. PROSPECT, *available at* http://www.prospect.org/controversy/open_source/ (organizing a debate on this issue); David Bollier, *The Power of Openness: Why Citizens, Education, Government and Business Should Care About the Coming Revolution in Open Source Code Software: A Critique and a Proposal for The H20 Project*, *available at* http://www.openresources.com/documents/power-openness/main.html (Mar. 10, 1999) (suggesting the use of

From an efficiency standpoint, it is well-established that the quality of open source code, such as Apache, can be comparable to that produced by private firms.[318] However, the cost of open source code is significantly lower, especially when the nonrivalrous nature of open source code is considered.[319]

From an externalities standpoint, there are several reasons for the government to prefer open source code over proprietary code. First, government use of open source code can lead to public benefits through free access to this code. For example, once the government develops or purchases open source code for one agency, department, or school, it can then be used by the rest of government for free. Additionally, this code can be freely adopted by the general public and would serve as an infrastructure others could use and build upon. A second externality to consider is the more innovative nature of open source code resulting from the fewer restrictions on its use as compared to proprietary code.[320] Third, the open source movement's

---

government spending to support open source code). *Contra* David S. Evans & Bernard Reddy, *Government Preferences for Promoting Open-Source Software: A Solution in Search of a Problem, available at* http://ssrn.com/abstract id=313202 (May 21, 2002); Klaus M. Schmidt & Monika Schnitzer, *Public Subsidies for Open Source? Some Economic Policy Issues of the Software Market, available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=319081 (last modified Nov. 2002) (arguing that government should generally not favor open source software over commercial software).

[318] *See* A. Mockus et al., *A Case Study of Open Source Software Development: The Apache Server*, PROCEEDINGS OF INTERNATIONAL COMPUTER SOFTWARE ENGINEERING 263, 265 (2000), *available at* http://www.bell-labs.com/user/audris/papers/apache.pdf. Another popular example is the Linux operating system. It is considered more secure and bug free than code produced by Microsoft. The explanation is that the open source movement's public review process is much better and faster than that used by firms. However, the claim of the open source movement's high quality code is backed more by anecdotal evidence that empirical research.

[319] From an efficiency standpoint, open source code can also lead to less red tape because of the lack of licensing requirements that typically govern proprietary code. For example, there is no need to worry about whether there is a license for code running on each computer. This is a real concern for those who use proprietary software.

[320] Steven Mann extends this idea by arguing that government should not let itself be subject to any proprietary code. Instead the government should only support code that is open. The rationale is that government should create and use an electronic architecture that is available to everyone. For example, he suggests that all publicly funded institutions be required to use file formats and standards that are in the public domain. Steve Mann, *Free Source as Free Thought: Architecting Free Standards*, FIRST MONDAY, Jan. 2000, *available at* http://www.firstmonday.dk/issues/issue5_1/mann/.

public development process allows for a plurality of influences because it is not dominated by any one firm or country.[321] Finally, open source code is transparent. This allows government and society to easily examine code.[322]

The "political" property of code is analogous to the transparency we require in government legislation.[323] For example, transparency in filtering software allows the public to determine the rules for excluding sites.[324] Already, governments such as China, France, Germany, the United Kingdom and the United States are beginning to adopt open source code.[325] For example, the ministries of culture, defense, and education in France are switching to Linux from Microsoft, Sun, and Lotus.[326] Their reasons are that open source code is politically palatable, technically superior, and cheaper. The political reasons include concerns about the influence of the United States on their domestic software industry, national pride, and the well-known security flaws in Microsoft's products. The objections to this proposal are largely that government is interfering

---

[321] The public development process can lead to new features that support societal values, which may not be present in commercial code. This includes values such as privacy, security, and support for multiple languages, which are all in the interest of government to promote.

[322] Transparency ensures the law of cyberspace is open to public examination. LESSIG, *supra* note 1, at 224.

[323] The public's expectations regarding transparency are also supported by the Freedom of Information Act (FOIA) and the Sunshine Act. The FOIA provides for a general right to examine government documents. 5 U.S.C. § 552 (1994). The Sunshine Act strives to provide the public with information on the decision-making processes of federal agencies. 5 U.S.C. § 552b (1994).

[324] Benjamin Edelman is seeking a declaratory judgment that will allow him to decrypt and publish portions of N2H2's list of blocked sites. By viewing the list, the public can determine what content N2H2 blocks. Edelman argues that this information is important, because it allows the public to evaluate N2H2's effectiveness in blocking content. *See* Ross Kerber, *ACLU Sues Firm Over Filtering Software,* B. GLOBE, July 26, 2002, *available at* http://www.globe.com/dailyglobe2/207/business/ACLU_sues_firm_over_its_filtering_software+.shtml; Benjamin Edelman, *Edelman v. N2H2, Inc. - Case Summary & Documents, available at* http://cyber.law.harvard.edu/people/edelman/edelman-v-n2h2/ (last modified Jul. 30, 2002).

[325] Paul Festa, *Governments Push Open-Source Software*, CNET NEWS.COM, Aug. 29, 2001, *available at* http://news.cnet.com/news/0-1003-200-6996393.html; Office of Government Commerce, *supra* note 310; Evans & Reddy, *supra* note 317 (providing a good summary of various governmental efforts in promoting open source code); Steve Lohr, *An Alternative to Microsoft Gains Support in High Places*, N.Y. TIMES, Sep. 5, 2002, *available at* http://www.nytimes.com/2002/09/05/technology/05CODE.html.

[326] Krane, *supra* note 325.

in private markets and that government is taking money away from private industry. The criticisms are both legitimate, but society is better off if this code is freely provided than by purchasing the code. By providing this code, the government is creating an infrastructure that others can build upon, thereby creating new innovative forms of code. In the end, the government's effort will create more innovative applications, instead of perhaps wasting money on duplicative code.

C. Using Tax Expenditures

The government's power of taxation is another tool for shaping code. In using its power of taxation, government can reduce or increase an individual's or firm's tax burden to create incentives for certain behavior. This section discusses how a reduction of the tax burden through tax expenditures can induce certain behavior thereby allowing the government to both support the development of code generally and shape code in a particular fashion.

The government can reduce the tax liability for individuals or firms to encourage an activity or use of a product. This reduction in tax liability is effectively a substitute for government spending and is termed a tax expenditure.[327] The term tax expenditure highlights that the loss of tax revenue is equivalent to government spending.[328] Tax expenditures are commonly thought of as tax incentives or loopholes.[329] They serve many purposes, but are a popular method for addressing societal concerns.[330]

---

[327] *See* STANLEY S. SURREY & PAUL R. MCDANIEL, TAX EXPENDITURES (1985) (providing the authoritative work on tax expenditures). *See also* TAX INSTITUTE OF AMERICA, TAX INCENTIVES (1971) (providing a number of articles on tax expenditures); Eric J. Toder, *Tax Incentives for Social Policy: The Only Game in Town?*, Burns Academy of Leadership, University of Maryland, *available at* http://www.academy.umd.edu/scholarship/DLS/WorkingPapers/Toder.pdf (last visited Jun. 28, 2002); Eric Toder, *Tax Cuts or Spending – Does it Make a Difference?*, Urban Institute, *available at* http://www.taxpolicycenter.org/research/author.cfm?PubID=410261 (June 8, 2000).

[328] Tax incentives can lead to a great deal of lost tax revenue. For example, the tax expenditures for energy conservation and alternative fuels to mitigate global warming were estimated as $10.6 billion between 1998 to 2002. This is three times as much as budgeted federal spending on addressing climate change. Chris Edwards et al., *supra* note 125, at 467 (noting that funding for the Climate Change Technology Initiative was about $3.5 billion between 1998 to 2002).

[329] SURREY & MCDANIEL, *supra* note 327, at 1.

[330] *See* Eric J. Toder, *The Changing Composition of Tax Incentives: 1980-99*, National Tax Association Proceedings, *available at* http://www.urban.org/tax/austin/austin_toder.html (Mar. 1999) (documenting that tax expenditures have

The use of tax expenditures to shape code is analogous to direct spending by the federal government. It follows that the same justification for using a tax expenditure also supports the establishment of a direct funded government program.[331] Commonly, this justification of government intervention is based on a form of market failure. Different reasons exist as to why government may choose to use tax expenditures instead of direct spending to shape code for a particular purpose. First, there are jurisdictional differences between tax expenditures and direct spending. This refers to differences in the responsibility over the measure within the executive branch.[332] When government uses a tax expenditure, the responsibility falls to the Treasury Department and the Internal Revenue Service for its administration.[333] In contrast, direct spending requires an agency within the executive branch to administer the program. This suggests that tax expenditures are best used when the administrative costs of establishing and maintaining a spending program are high.[334] Additionally, administration of a program by the Treasury and IRS usually results in strict eligibility requirements because they tend to limit deductions.[335] Moreover, the Treasury and IRS usually do not have the expertise or the interest in the effectiveness of the program.[336] Therefore, a tax expenditure is appropriate when a program does not require continued administrative oversight and discretion.[337]

---

increasingly been used to promote social policy goals instead of business investment). The total tax expenditures for fiscal year 2002 will be over six hundred billion dollars. *See* Office of Management and Budget, *Table 22-4. Tax Expenditures by Function, available at* http://www.whitehouse.gov/omb/budget/fy2002/bud22_4.html (last visited Jun. 27, 2002).

[331] SURREY & MCDANIEL, *supra* note 327, at 112.

[332] There are also jurisdictional differences in Congress. Legislators with little expertise on the issue at hand often write tax expenditure provisions, because they sit on the tax writing committee rather than the committee dedicated to the issue. *See* SURREY & MCDANIEL, *supra* note 327, at 106-07.

[333] SURREY & MCDANIEL, *supra* note 327, at 106.

[334] Edwards, *supra* note 328, at 476.

[335] SURREY & MCDANIEL, *supra* note 327, at 106.

[336] *Id.*

[337] One of the problems with the use of tax expenditures is that they may turn into tax shelters and lose their initial intent by subsidizing middlemen. In the 1970s many tax shelters were used by well off persons and not their intended recipients, because investment professionals used techniques such as partnerships to gain tax advantages. In contrast, a direct grant program by an agency can ensure that funds go directly to the intended recipients. SURREY & MCDANIEL, *supra* note 327, at 105.

Another reason for government's choice of tax expenditures is that using them produces psychological and political benefits. In contrast to a direct spending program, a tax expenditure has much lower visibility.[338] It is not represented by a government agency, rather it is hidden in the tax code. A tax expenditure is not viewed as government rewarding a few firms, but is instead seen as encouraging private decision-making.[339] As a result, many politicians who regard themselves as fiscally conservative would rather use a tax expenditure than support another "big government spending program". This is a key component to the popularity of tax expenditures.[340] Nevertheless, a tax expenditure is still government spending. Essentially, virtually any tax expenditure provision could be rewritten as a direct spending program.[341]

There are several objections to using tax expenditures. First, critics argue that tax expenditures are not equitable. They are of little use to firms or individuals with low tax liability. A related objection is that the benefits of tax expenditures unfairly go to those with the highest tax liability.[342] For individuals and firms with little tax liability or firms subject to the alternative minimum tax (AMT), a tax expenditure would be of no value. However, in these cases, legislators can utilize a refundable, taxable credit, which is effectively a direct grant.[343] Thus, this type of tax expenditure does not discriminate against those with little tax liability. Secondly, the benefits of tax expenditures accrue to those with the highest tax liability.[344] In some cases, this can serve as a stimulus to change practices to gain the full benefit of the tax expenditure. If it is considered unfair that some beneficiaries with high tax liability are reaping the lion's share of the benefits, the tax expenditure program can be limited. Limits still provide incentives for behavior, but allow the government to ensure that a few taxpayers are not unjustly rewarded. An additional objection is that tax expenditures are not

---

[338] *Id.* at 104-05.
[339] *Id.* at 100.
[340] *See* CHRISTOPHER HOWARD, THE HIDDEN WELFARE STATE: TAX EXPENDITURES AND SOCIAL POLICY IN THE UNITED STATES (1997) (documenting how four major tax expenditures, including the home mortgage interest deduction and the work opportunity credit are the result of political forces that differ from forces supporting direct spending programs).
[341] *Id.* at 105.
[342] *Id.* at 71-72 (noting that tax expenditures disproportionately favor those with high incomes).
[343] *Id.* at 109-11.
[344] *Id.* at 71-82 (noting that tax expenditures favored those with high incomes).

efficient, but rather merely reward behavior that would have resulted anyway. Therefore, tax expenditures produce a windfall.[345] This objection also targets direct spending, which is the alternative to a tax expenditure. However, it is possible to limit the windfall by making the tax expenditure incremental in structure. For example, by requiring that a taxpayer's activities exceed that of previous years to prevent a windfall, only marginal improvements would be rewarded.[346] Critics also object that further tax expenditures will place too high of an administrative burden on the IRS.[347] This seems unlikely given that the IRS already handles hundreds of billions of dollars in tax expenditures involving numerous subjects such as energy, natural resources, agriculture, housing, and transportation etc. . ..[348] Moreover, instead of creating a new agency or department for a direct spending program, tax expenditures are likely to result in lower overall administrative costs by placing the burden on the IRS which already administers tax policy.

The final objection is that the tax code should not be used for social policy even when supporting technological development. Instead, the government should look toward direct funding.[349] Stated another way, the tax code focuses on raising revenue and not on social policy. These incentives are likely to further complicate the tax code and lead people to lose faith in it. While this argument is valid, the reality is that the tax code has long been an instrument of social policy. Moreover, society supports this approach.[350] In fact,

---

[345] *Id.* at 102.

[346] *Id.*

[347] Edwards, *supra* note 328, at 476. *But see* Edward A. Zelinsky, *Efficiency and Income Taxes: The Rehabilitation of Tax Incentives*, 64 TEX. L. REV. 973, 975-76 (1986) (arguing that tax expenditures can be more efficient than direct government spending because of lower transactional costs); Martin Feldstein, *A Contribution to the Theory of Tax Expenditures: The Case of Charitable Giving*, *in* THE ECONOMICS OF TAXATION 99 (Henry J. Aaron & Michael J. Boskin eds., 1980) (arguing that in some cases a tax subsidy provides society with a better outcome than direct spending).

[348] *See supra* note 330 (providing a more complete listing of all tax expenditures).

[349] This is not new. *See* Bernard Wolfman, *Federal Tax Policy and the Support of Science*, 114 U. PA. L. REV. 171 (1965) (arguing that we need to question some of the favorable tax incentives given to encourage the development of technologies and ask whether they are needed or whether they are better off being direct subsidies).

[350] While tax scholars do not like the tax system used for social policy, economists see tax policy as an effective method to address societal concerns. Taxes are seen as a way to address externalities. *See* Maureen B. Cavanaugh, *On the Road to Incoherence: Congress, Economics and Taxes*, 49 UCLA L. REV. 685 (2002). *See*

according to Zelinsky, tax expenditures are a better way of communicating social policy to middle-income individuals and small businesses than direct spending. This is true because the existing information networks of tax professionals will communicate information regarding tax expenditure.[351] In contrast, the transaction costs are high for individuals and firms who try to find and utilize direct spending programs set up by the government.

Tax expenditures have long been used to support technological development, e.g., tax credits for research and development as well as proposed legislation to provide tax credit for the acquisition of information technologies.[352] Other tax credits attempt to shape specific technologies. For example, tax expenditures support alternative fuels, hazardous waste facilities, electric vehicles, and even research and development activities.[353] Consider the Orphan Drug Act, which seeks to stimulate the research and development of drugs for rare diseases through both tax expenditures and direct research grants.[354] This intervention is justified because rare diseases are seen as unprofitable by the pharmaceutical industry; therefore, industry requires an incentive for research and development.[355] Moreover, direct grants are used to fund clinical testing programs for orphan drugs. The FDA administers this program. In contrast, the tax expenditures allow a tax credit equal to fifty percent of the qualified clinical testing expenses for the taxable year.[356] However, the drug must first be

---

generally A.C. PIGOU, WEALTH AND WELFARE 164 (1912); F.P. Ramsey, *A Contribution to the Theory of Taxation*, 37 ECON. J. 47 (1927).

[351] Zelinsky, *supra* note 347, at 1036.

[352] The government's Research and Experimentation Tax Credit is one example of this. It costs the government billions of dollars, but subsidizes research and development by firms. *See* OFFICE OF TECHNOLOGY ASSESSMENT, THE EFFECTIVENESS OF RESEARCH AND EXPERIMENTATION TAX CREDITS (1995). Kenneth C. Whang, *Fixing the Research Credit*, ISSUES SCI. & TECH., Winter 1998, *available at* http://www.nap.edu/issues/15.2/whang.htm. Senator Lieberman has proposed this tax credit as a stimulus for the economy. *See* Joe Lieberman, *U.S. Needs Policies That Encourage Tech Investment*, MERCURY NEWS, Nov. 6, 2002, *available at* http://www.siliconvalley.com/mld/siliconvalley/4456934.htm.

[353] *See* Internal Revenue Service, Qualified Electric Vehicle Credit, Form 8834 (providing a tax credit to purchasers of electric vehicles).

[354] Orphan Drug Act of 1985, Pub. L. 97-414, 96 Stat. 2049 (2001). For more information see the FDA page *at* http://www.fda.gov/orphan/index.htm.

[355] Andrew Duffy, *Rare Diseases' Troubling Questions*, OTTAWA CITIZEN, Jan. 21, 2002 (discussing legislative activity in the United States and Canada on providing incentives for research and development into rare diseases).

[356] Orphan Drug Act of 1985, Pub. L. 97-414.

designated as an orphan drug by the FDA.[357] Here, the tax expenditure requires a modest amount of cooperation between the applicable federal agency with the expertise, the FDA, and the Treasury department to meet the goal of stimulating research.

The government could use tax expenditures to shape the development of code.[358] For example, government could encourage the development of code to protect minors online, e.g., filtering software, which prevents minors from gaining access to inappropriate content. Government intervention into this market is justified because the current products, including PICS, are expensive, difficult to use, and not very effective.[359] Moreover, there is a demand by parents for a code-based solution to the problem of minors gaining access to indecent material.

The justification for tax expenditures over a direct spending program rests largely on three reasons. First, tax expenditures would not appear to be interfering in the market for the current products. Moreover, the problems of favoritism and picking "winners" for direct funding could be avoided. Second, the administrative cost for this program would be modest, as there are only a few firms that would be eligible for this expenditure. Finally, tax expenditures are much more politically palatable because they are not viewed as tax and spend. The consequences of this proposal would be subsidizing vendors. This could overcome the current stalemate, where parents don't buy the code because it's overpriced, and developers cannot

---

[357] Orphan Drug Regulations, 21 C.F.R. PART § 316.20.

[358] Another proposal calls for tax expenditures or direct funding for firms and public organizations that manage key parts of the Internet known as Domain Name System (DNS) servers. Currently, these are operated as free services. Government funding would provide an incentive to improve the security of such systems. Such an incentive is needed because of the poor state of security and the threat of attacks on the DNS servers. *See* Paul Roberts, *Major Net Backbone Attack Could Be First of Many*, IDG NEWS SERVICE, Oct. 23, 2002.

[359] Larry Buchanan, *Surfing in Shark-Infested Waters: Filtering Access to the Internet*, MULTIMEDIA SCH., March 1996, *available at* http://www.infotoday.com/MMSchools/MarMMS/networks3.html (noting the high prices of filtering software); COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD, NATIONAL ACADEMY OF SCIENCES, TECHNICAL, BUSINESS, AND LEGAL DIMENSIONS OF PROTECTING CHILDREN FROM PORNOGRAPHY ON THE INTERNET: PROCEEDINGS OF A WORKSHOP 36-47 (2002) (providing a critique of the effectiveness of existing filtering software products); Leslie Gornstein, *Locking Kids Out: Web Filters*, ORANGE COUNTY REG., Sep. 27, 1998, *available at* http://archives.seattletimes.nwsource.com/cgi-bin/texis.cgi/web/vortex/display?slug=safe&date=19980927 (quoting Family PC's editor Joe Panepinto, "(Filters) are difficult to use, relatively expensive to maintain and difficult to configure").

earn enough revenue to improve their code, because of their low acceptance. Thus, tax expenditures could lead to a reduction in cost for users while providing financial incentives for developers to improve their products.[360]

D. Funding Education and Training

The purpose of government funding can vary from providing information about an activity or product to proactively attempting to change behavior. Such intervention is justified because of the lack of information on the part of the general public.[361] In this section, we show how educational campaigns can shape code. After discussing the criticisms of funding educational campaigns, we show how government can shape code through educational campaigns. We focus on two such campaigns. The first type of campaign is a by-product of government's employee training, while the second approach involves direct funding of educational campaigns.

Criticism of government funded educational campaigns largely centers on the effectiveness of these programs. Critics argue that millions of dollars are spent on educational programs that provide no tangible benefits.[362] One notable article on educational campaigns identified three problems with their effectiveness. First, not all behaviors can be corrected by educational campaigns. "Given human frailties, some accidents simply cannot be prevented."[363]

---

[360] Another example of the use of tax expenditure to support code is to encourage the adoption of computers by individuals. Instead of operating a direct funded program to provide people with computers, the government could opt for a refundable tax credit. However, for tax expenditure to operate properly and to prevent fraud, it must be simple for the IRS and Treasury to administer the program. In this case, the IRS could limit the deduction to new computers purchased from merchants registered as computer sellers with the IRS. Although this would limit fraud, it would also not allow the purchase of computers from garage sales or eBay whose prices would be lower. The tax expenditure would likely be a refundable tax credit to ensure that taxpayers with low tax liability can take advantage of this provision.

[361] For example, the European Union partially funds the Internet Content Rating Association, which is educating parents and web sites about using content filtering technology, such as PICS. Internet Content Rating Association, *Internet Industry Leaders Gather for Launch of ICRAfilter*, (Mar. 21, 2002) *available at* http://www.icra.org/press/p19.shtml.

[362] Robert S. Alder & R. David Pittle, *Cajolery or Command: Are Education Campaigns an Adequate Substitute for Regulation*, 1 YALE J. REG. 159, 192 (1984).

[363] *Id.* at 191.

Second, campaigns should focus on one-time actions instead of trying to alter patterns of behavior. Third, changes come "slowly, modestly, and often expensively." While these criticisms are valid, newer and more sophisticated approaches to educational campaigns have been shown to be more effective.

One way to raise the effectiveness of a campaign is to make it less costly. An example of this is the use of educational campaigns that are by-products of the government's efforts to educate its own employees.[364] This occurs because of the ease of diffusing information through the Internet, essentially a low-cost educational campaign. An excellent example of this is the web site usability.gov. Its original purpose was to assist people working with the National Cancer Institute's (NCI) web pages, which provided a methodology for how to improve the design of web sites based on NCI's experience. NCI recognized that its web site was useful to people outside of NCI and proceeded to make it available to both other federal agencies and the general public. The cost of making this information available to others via the Internet was extremely low. As a result, usability.gov is now an important resource for web designers on how to make web sites more usable, useful, and accessible. This example shows how effective educational campaigns can flow from the government's efforts to educate its employees.[365]

The effectiveness of educational campaigns can vary depending upon whether the government is seeking to merely inform consumers about risks or attempting to change the behavior of people.[366] While informing consumers is a straightforward process, changing behavior is much more difficult. After all, firms have long tried to persuade consumers to purchase their products with mixed success. Nevertheless, there is ample evidence that educational campaigns can in fact change behavior where other forms of regulation would fail.[367] Today's educational campaigns use much more sophisticated

---

[364] For example, the government strives to ensure that its employees consider energy efficiency through educational campaigns. ALLIANCE TO SAVE ENERGY AND FEDERAL ENERGY PRODUCTIVITY TASK FORCE, *supra* note 303, at 31-34.

[365] *See* http://usability.gov; Sanjay Koyani, *The Story Behind Usability.gov*, *available at* http://www.boxesandarrows.com/archives/002319.php (Apr. 1, 2002) (providing a history of usability.gov); William Matthews, *Dot-gov by Design*, FED. COMPUTER WK., Dec. 10, 2001 (discussing how usability.gov helps to improve government web sites).

[366] Alan R. Andreasen, *Challenges for the Science and Practice of Social Marketing*, *in* SOCIAL MARKETING 3, 5 (Marvin E. Goldberg et al. eds, 1997).

[367] PHILIP KOTLER & EDUARDO L. ROBERTO, SOCIAL MARKETING 8 (1989).

marketing techniques. The same principles and practices firms used for marketing are now being adapted to bring about social change, such as public health or safety. This approach is aptly named social marketing. It has been applied to a variety of social issues including health, education, safety, and the environment.[368] Despite these new tools, the effectiveness of social marketing depends on the problem it is trying to solve. Clearly, changing fundamental behaviors, attitudes, and values is much more difficult than altering a single behavior. Nevertheless, in some cases, social marketing has proven successful in changing behavior.[369]

The government currently operates educational campaigns for code which provide information to help with consumer decisions.[370] The Federal Trade Commission (FTC) maintains information for consumers on e-commerce and the Internet. This includes information on buying low cost computers, protecting minors online, and the many types of online scams.[371] One notable example is the Securities and Exchange Commission's use of fake web sites to teach investors about potential scams.[372] The fake web sites promoted financial opportunities with the potential for tremendous financial gains. But once an investor tries to invest, they are led to a page that says, "[i]f you responded to an investment idea like this … you could get scammed!"[373] The page also provides further information how to research investment offers and what to do if you are scammed. Another example of an educational campaign is the Energy Star specifications that allow consumers to identify energy-efficient

---

[368] *Id.* at 6.

[369] *Id.* at 8-10 (noting the success of the Stanford Heart Disease Prevention Program and Sweden's campaign to change the rules of the road). A few other examples that Kotler and Roberto cite are as follows: M. T. O'Keefe, *The Anti-Smoking Commercials: A Study of Television's Impact on Behavior*, 35 PUB. OPINION Q. 242 (1972 (smoking); Harold Mendelsohn, *Some Reasons Why Information Campaigns Can Succeed*, 37 PUB. OPINION Q. 50 (1973) (drinking); R. I. Evans, *Planning Public Service Advertising Messages: An Application of the Fishbein Model and Path Analysis*, 7 J. ADVERTISING 28 (1979) (littering).

[370] Similarly, NIST provides the public with information on how to improve security. *See* NIST Computer Security Publications *at* http://csrc.nist.gov/publications/nistpubs/.

[371] Federal Trade Commission, *Consumer Protection: E-Commerce & the Internet*, *available at* http://www.ftc.gov/bcp/menu-internet.htm (last modified Apr. 25, 2002).

[372] Securities and Exchange Commission, *Regulators Launch Fake Scam Websites To Warn Investors About Fraud*, *available at* http://www.sec.gov/news/headlines/scamsites.htm (last modified Jan. 30, 2002).

[373] *Id.*

products. This program has led to substantial purchases of energy efficient products.[374]

One example of a proposed code-based government education campaign concerns the common security problem, which occurs when people do not update their computers and properly utilize code-based solutions such as firewalls and anti-virus software. To persuade people to use these tools, the government is preparing to develop an educational campaign directed at home and small business users.[375] Another similar campaign could focus on limiting the use of social engineering. This approach does not focus on the code, but instead gains information to bypass the security of computer users.[376] Such an approach may involve tricking people into revealing passwords by pretending to be a technician. The best countermeasure here is an education campaign, which would likely require social marketing techniques.[377] However, it could result in fewer security problems with code. Examples of basic security precautions that could be addressed include using strong passwords with a mixture of alphanumeric characters, changing passwords frequently, and educating employees about the risks of email attachments.[378]

IV. SHAPING CODE THROUGH INTELLECTUAL PROPERTY RIGHTS

Government can use intellectual property rights, such as patents and copyright, to shape code. In this first section, we note briefly that the government may modify intellectual property (IP) rights to further innovation and preserve dissemination in code. A detailed study of how the scope of IP rights can be modified in order to shape the development of code is a vast and important topic that is

---

[374] Kevin Heslin, *EPA's Energy Star Program Pays Dividends*, ENERGY USER NEWS, Jan. 23, 2001, *available at* http://www.energyusernews.com/CDA/ArticleInformation/features/BNP__Features__Item/0,2584,19253,00.html.

[375] Brian Kerbs, *U.S. Gov't Plans Internet Security Ads*, WASH. POST, Oct. 23, 2003.

[376] KEVIN MITNICK, THE ART OF DECEPTION: CONTROLLING THE HUMAN ELEMENT OF SECURITY (2002).

[377] *See* Malcolm Allen, *The Use of Social Engineering as a Means of Violating Computer Systems*, SANS Institute, *available at* http://rr.sans.org/social/violating.php (Oct. 12, 2001); Rick Nelson, *Methods of Hacking: Social Engineering*, *available at* http://www.isr.umd.edu/gemstone/infosec/ver2/papers/socialeng.html (last visited Mar. 26, 2001).

[378] Cisco Systems, *10 Basic Cyber Security Tips for Small Businesses*, *available at http://www.cisco.com/warp/public/cc/so/neso/sqso/secsol/cybsc_ov.pdf* (Apr. 2000).

beyond the scope of this work. In keeping this our brief foray into IP rights and the development of code, the second section focuses on the use of patent pools and compulsory licensing to foster the dissemination of code or content. The third section focuses on the appropriate policy for transferring government created code to the private sector; this can have a significant impact on the development of code.

A. Revising Intellectual Property Rights

Intellectual property rights differ from conventional property rights in one aspect: significant society benefits accrue from intellectual property that is not privatized. Free flowing information allows people to build upon the intellectual efforts of others. This is understood at the outset from Art. I, sec. 8, cl. 8 in the U.S. Constitution, which only permits limited protection for intellectual property rights in order to foster both creation and dissemination thereby promot[ing] "the Progress of Science and Useful Arts."[379] Thus, the government's limited protection of intellectual property plays an important role in stimulating innovation, preserving dissemination and fostering cumulative innovation.[380]

Intellectual property rights for code have historically been different for hardware and software. Patent law has traditionally protected the hardware components, and has recently joined copyright law in protecting software. This change has occurred, not because of the actions of legislators, but because of judges.[381] Recent decisions by the Supreme Court and the Court of Appeals for the Federal Circuit, now allow the patenting of software.[382]

---

[379] U.S. CONST. art.. I, § 8, cl. 8.

[380] Robert P. Merges, *Commercial Success and Patents Standards: Economic Perspectives on Innovation*, 76 CALIF. L. REV. 803 (1988) (noting how the patent system should directly reward innovation).

[381] The Supreme Court played a role in changing intellectual property rights for biotechnology. Diamond v. Chakrabarty, 447 U.S. 303 (1980) (allowing the patenting of genetically engineered life forms).

[382] Diamond v. Diehr, 450 U.S. 175 (1981) (finding that a software related invention was patentable); State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, (Fed. Cir. 1998) (holding that a computer software program that produces a useful result is patentable subject matter). *See also* Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CALIF. L. REV. 1, 8-11 (2001) (providing a brief history of software patents); Steven G. Steger, *The Long and Winding Road to Greater Certainty in Software Patents*, CBA RECORD, Apr. 2000, at 46 (providing a brief history of software patents); John T. Soma et al., *Software Patents: A U.S. and E.U. Comparison*, 8 U.

However, copyright protection of code has not decreased. In fact, legislators have increased the duration of copyright protection with the Sonny Bono Copyright Term Extension Act of 1998.[383] This act retroactively extended the duration of copyrights an additional twenty years.[384] Proponents argued that this extension would encourage investment in existing copyright works as well as encouraging the creation of new works, because of the longer exclusivity period.[385]

A number of scholars have argued that current intellectual property rights are too strong and actually discourage innovation.[386] They believe that intellectual property laws need to facilitate the sharing of information to further innovation. In keeping with this idea, Lessig proposes limiting the duration of copyright protection and requiring renewal every five years.[387] If the copyright is not renewed, the work falls into the public domain. He also proposes that, in order to gain copyright protection for software, the author must provide the source code so it may enter the public domain upon

---

BALT. INTELL. PROP. L.J. 1, 5-29 (2000) (providing a history of software patents for the United States as well as European countries. The paper describes how patent protection for software has changed over time).

[383] *See* Sonny Bono Copyright Term Extension Act, Pub. L. No. 105-298, 112 Stat. 2827 (1998) (to be codified at 17 U.S.C. §§ 108, 203, 301-304).

[384] This ensured that no new copyright works, such as Walt Disney's Mickey Mouse character, would enter the public domain in the United States until 2019, when all works created in 1923 will enter into the public domain. Christina N. Gifford, *The Sonny Bono Copyright Term Extension Act*, 30 U. MEM. L. REV. 363, 385 (2000). This legislation is currently being challenged in Eldred v. Reno, 537 U.S. __ (2003). *See also* Lawrence Lessig, *Copyright's First Amendment*, 48 UCLA L. REV. 1057 (2001); Neil Weinstock Netanel, *Locating Copyright within the First Amendment Skein*, 54 STAN. L. REV. 1 (2001).

[385] Copyright Extension, *The Sonny Bono Copyright Term Extension Act, available at* http://www.copyrightextension.com/page01.html (last visited Jul. 16, 2002). Similarly, there have been calls for government to be allowed to copyright and grant partially exclusive and exclusive licenses for computer software by amending copyright law. U.S GENERAL ACCOUNTING OFFICE, TECHNOLOGY TRANSFER: CONSTRAINTS PERCEIVED BY FEDERAL LABORATORY AND AGENCY OFFICIALS 37 (1988).

[386] LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD (2001); SIVA VAIDHYANATHAN, COPYRIGHTS AND COPYWRONGS: THE RISE OF INTELLECTUAL PROPERTY AND HOW IT THREATENS CREATIVITY (2001); Neil Weinstock Netanel, *Copyright and a Democratic Civil Society*, 106 YALE L.J. 283 (1996).

[387] LESSIG, *supra* note 386, at 251. *See also* Mark A. Haynes, *Black Holes of Innovation in the Software Arts*, 14 BERKELEY TECH. L.J. 503 (1999) (arguing for limiting copyright protection, because it is slowing down innovation in code).

expiration of the copyright.[388] The net effect would be to place more content and code into the public domain for other to build on.

Evaluating and justifying the revision of intellectual property rights is difficult for two main reasons. First, it is difficult to empirically ascertain whether intellectual property protection is too strong or too weak. Concepts such as innovation or a public commons for knowledge are difficult to compare as to their costs and benefits. Second, the modification of intellectual property rights affects a fundamental social and economic characteristic of society.[389] Individuals and firms rely on these notions and definitions of property in their actions. Therefore, any change undermines these assumptions.[390] Nevertheless, for political economy reasons, the long-term trend in copyright law toward more protection has not slowed down.[391]

B. Patent Pools and Compulsory Licensing

A second, more tangible and immediate method of shaping code is by using patent pools and compulsory licensing, which allows the government to force a party to license their copyright or patent. As a result, another party or the government can make, use, and sell the affected content or technology. This allows government to expand the dissemination of intellectual property. In the United States, the government has required compulsory licensing of

---

[388] Lemley and O'Brien put forth another example of property rights affecting innovation. They argue that the existing model of copyright law discourages the use of modular components in code. Current copyright law favors new developers recreating portions of code, rather than copying the code for incorporation. They believe that the principles of patent law, which encourage incorporation rather than recreation, may allow for greater use of modularity in code. Mark A. Lemley & David W. O'Brien, *Encouraging Software Reuse*, 49 STAN. L. REV. 255 (1997).

[389] Carol M. Rose, *Property and Expropriation: Themes and Variations in American Law*, 2000 UTAH L. REV 1.
(noting the traditional justifications for the stability of property).

[390] We reject the argument that copyright terms are meaningless. For example, Adkinson has argued that lengthening the terms of copyright is "unlikely to interfere with creativity or confer power over consumers. Recall that copyrighted works are not monopolies in the antitrust sense—they lack monopoly power—and the ideas contained in them are in the public domain from the outset." William F. Adkinson, *Creativity & Control Part 2*, AM. SPECTATOR, May 2002, *available at* http://www.gilder.com/AmericanSpectatorArticles/AdkinsonMay-June.htm.

[391] JESSICA LITMAN, DIGITAL COPYRIGHT (2001) (noting the trend toward more protection).

copyrights, but generally not patents.[392] The prevailing justifications for the use of patent pools and/or compulsory licensing are high transactions costs, public interest, and the need to continue to promote downstream innovation. These types of licensing schemes are used to reduce transactions costs.[393] In some industries, there are large numbers of intellectual property rights holders that must be contracted with to develop or use their property rights. These large numbers result in high transaction costs and reduce the incentive to use intellectual property.

Government intervention seeks to address high transaction costs by using patent pools or compulsory licensing, which reduces the costs of haggling over individual transactions as well as providing an administrative method to ensure the proper parties are compensated. For instance, the government requires compulsory licensing of the retransmission of broadcast signals by cable. The rationale is that transaction costs would make it impractical for the cable company to pay royalties to each individual copyright owner of a broadcast signal.[394] Through compulsory licensing, the government reduces the transaction costs for all parties and promotes the growth of new technology by ensuring an adequate supply of content.[395] The objection to using compulsory licensing rests largely on the costs of government action as compared with private action. Opponents of government mandated compulsory licensing prefer privately established organizations that lower transactions costs, such

---

[392] The 1976 Copyright Act provides for a number of compulsory licenses, such as for cable television, jukeboxes, and for public radio and public television. *See* 17 U.S.C. 111, 116, 118. Patents can also be the subject of compulsory licensing. *See* Joseph A. Yosick, *Compulsory Patent Licensing for Efficient Use of Inventions*, 2001 U. ILL. L. REV. 1275, 1277 (discussing the use of compulsory licensing for patents); Kenneth J. Nunnenkamp, *Compulsory Licensing of Critical Patents Under CERCLA*, 9 J. NAT'L RESOURCES & ENVTL. L. 397 (reviewing compulsory licensing of patents for cleanup of hazardous waste). *See also* Consumer Project on Technology, *Examples of Compulsory Licensing of Intellectual Property in the United States*, *available at* http://www.cptech.org/ip/health/cl/us-cl.html (last visited July 22, 2002).

[393] Robert P. Merges, *Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations*, 84 CAL. L. REV. 1293, 1295 (1996) (noting how compulsory licensing can reduce transactions costs, but argues that privately established organizations are preferable to compulsory licensing). Darlene A. Cote, *Chipping Away at the Copyright Owner's Rights: Congress' Continued Reliance on Compulsory License*, 2 J. INTELL. PROP. L. 219, 230 (noting that high transactions costs were a motivating factor in congressional action for compulsory licensing).

[394] Cote, *supra* note 393, at 228-232.

[395] *Id.* at 242.

as the American Society of Composers, Authors, and Publishers (ASCAP).[396] These groups argue that private organizations have more flexibility in their licensing decisions.[397] Additionally, government action is subject to interested parties that may manipulate the rules for their own benefits.[398]

The existence of technology vital to the public interest, examples of which include public safety, national defense, agriculture, environment, and antitrust, is the second rationale for compulsory licensing.[399] The justification for compulsory licensing is that the public interests are so great as to make it necessary to ensure public access to the products through compulsory licensing. A classic example is a life-saving drug that is sold at a high price.[400] A host country may choose to use compulsory licensing to bring down the price of a drug. The objection to this approach is that a compulsory license leads to a loss of monopoly power, which is an essential condition for an intellectual property right, resulting in lower revenue for the producer. More generally, the government's use of this power will reduce a firm's incentive to innovate. Consequently, if firms believe they will be subject to compulsory licensing for a product, they will not develop it.[401] In effect, the overuse of this method could actually lead to fewer technologies that address various public interests.[402]

A final objection to compulsory licensing is its administrative costs. The necessary legislative and regulatory proceedings can take time because government does not move quickly. Conversely, in the area of code, technological development is rapid. As a result,

---

[396] Merges, *supra* note 393 (arguing that compulsory licensing is inferior to privately established collective rights organizations that address the problem of high transaction costs).
[397] *Id.* at 1295.
[398] *Id.*
[399] Cole M. Fauver, *Compulsory Patent Licensing in the United States: An Idea Whose Time Has Come*, 8 NW. J. INT'L L. & BUS. 666, 670 (1988); Yosik, *supra* note 392, at 1279-84.
[400] Tracy Collins, *The Pharmaceutical Companies Versus Aids Victims: A Classic Case of Bad Versus Good? A Look at the Struggle Between International Intellectual Property Rights and Access to Treatment*, 29 SYRACUSE J. INT'L L. & COM. 159 (2001).
[401] Fauver, *supra* note 399, at 676-77.
[402] *Id.* at 670-71. *See also* Theodore C. Bailey, *Innovation and Access: The Role of Compulsory Licensing in the Development and Distribution of HIV/AIDS Drugs*, 2001 J. L. TECH. & POL'Y 193, 210-14 (arguing that while compulsory licensing may reduce the level of innovation, the reduction may actually be the socially optimal level for research activity).

compulsory licensing may reduce the incentive for firms to develop new business models that touch upon public interests because of the risk that they may be subject to compulsory licensing.[403]

There are a number of possible uses for compulsory licensing for code. For example, to reduce transactions costs and promote the growth of new digital music technologies, the government could require compulsory licensing of music in a digital format.[404] The critical issue is whether government intervention is really needed because of the lack of private action in permitting transactions of digitally formatted music. In addition, compulsory licensing could be used in a variety of ways for the public interest. As an example, one potential remedy in the Microsoft antitrust trial was the licensing of Microsoft Windows.[405] This licensing could be justified by the unique and important nature of the Windows operating system to society. Proponents would have to show how this licensing would increase innovation in the software industry. Yet another compelling reason for compulsory licensing, besides innovation and competition, would be for code that protects privacy, national security, or minors. In this case, a compulsory licensing scheme could be justified to ensure that the product was widely disseminated. However, in using such a scheme, the government would have to consider the administrative costs as well as the potential adverse effects on innovation – if firms are not adequately compensated by such licensing schemes, they may avoid developing code that addresses societal concerns.

C. Transferring Intellectual Property to the Private Sector

The government is capable of creating very innovative code. However, government is generally not the ideal institution to provide technical support, maintenance, and further enhancement of code.

---

[403] Adkinson, *supra* note 390.

[404] *Lawrence Lessig: The "Dinosaurs" Are Taking Over*, BUS. WK., May 13, 2002, *available at* http://www.businessweek.com/magazine/content/02_19/b3782610.htm; Neil W. Netanel, *Impose a Noncommercial Use Levy to Allow Free Peer-to-Peer File Sharing*, 17 HARV. J.L. & TECH. (forthcoming); William Fisher, TECHNOLOGY, LAW, AND THE FUTURE OF ENTERTAINMENT (2004).

[405] James V. Grimaldi, *States Want Microsoft to Auction Off Windows Coding*, SEATTLE TIMES, Mar. 28, 1999, *available at* http://seattletimes.nwsource.com/news/local/html98/micx_19990328.html. *See generally* Consumer Project on Technology, *Compulsory Licensing as Remedy to Anticompetitive Practices*, *available at* http://www.cptech.org/ip/health/cl/us-at.html (last visited July 22, 2002).

Instead, this activity is better accomplished by other institutions such as firms, consortia, or the open source movement.[406] For very innovative code to become useful to society, it is often necessary to transfer it to the private sector.[407] Consequently, there are a number of laws that require government and public universities to support the transfer of its technology to the private sector. Additionally, federal agencies, such as the NSF, seek to have their sponsored research commercialized.[408]

To promote technology transfer, the government has enacted laws that allow for the transfer of intellectual property rights to the private sector.[409] The first notable law was the Stevenson-Wylder Technology Innovation Act, which made technology transfer an integral activity for federal laboratories.[410] This was followed by the Bayh-Dole Act, which today allows universities and firms to patent and license the results of government-sponsored research.[411] These laws represented a shift from public ownership of government-sponsored research toward private appropriation,[412] and has meant

---

[406] *See* Rajiv C. Shah & Jay P. Kesan, *Incorporating Societal Concerns into Communication Technologies*, IEEE TECH. & SOC'Y MAG., (2003), at 28 (noting the competencies of other social institutions).

[407] J.S. Metcalfe & L. Georghiou, *Equilibrium and Evolutionary Foundations of Technology Policy*, 22 SCI. TECH. & INDUS. REV. 75 (1998) (arguing that effective innovation is dependent upon knowledge transfers between universities and the private sector). This is known as a systemic approach in the study of innovation systems. *See* Jukka-Pekka Salmenkaita & Ahti A. Salo, *Rationales for Government Intervention in the Commercialization of New Technologies*, Systems Analysis Laboratory Research Report, Sep. 8, 2001.

[408] Rita R. Colwell, Director, National Science Foundation, *Remarks Before the Senate Appropriations Subcommittee on VA/HUD and Independent Agencies*, May 4, 2000, *available at* http://www.nsf.gov/od/lpa/congress/106/rc00504sapprop.htm ("This example is really just the latest in a string of NSF successes. The underlying technology for nearly all major search engines found on the web today - including Lycos, Excite, Infoseek, Inktomi and specialized search engines like Congress's own THOMAS - all were begun [and] created through NSF-funded research at universities.")

[409] Bhaven N. Sampat & Richard R. Nelson, *The Emergence and Standardization of University Technology Transfer Offices: A Case Study of Institutional Change*, ADVANCES STRATEGIC MGMT. (forthcoming) (providing a history of university patent policy).

[410] Stevenson-Wylder Technology Innovation Act of 1980, Pub. L. No. 96-480, 94 Stat. 2311-2320 (codified as amended at 15 U.S.C. §§ 3701-3714 (1994)).

[411] Bayh-Dole Act, Pub. L. No. 96-517, 94 Stat. 3018 (1980) (codified as amended at 35 U.S.C. § 200-12 (1994).

[412] *See* Rebecca Eisenberg, *Public Research and Private Development: Patents and Technology Transfer in Government-Sponsored Research*, 82 VA. L. REV.

that inventions, previously in the public domain for anyone to use, may now be patented with arguably limited use.[413]

The standard justification for technology transfer laws is promoting commercialization. These laws provide firms with the necessary intellectual property protection to support the eventual commercial development of a technology. Firms argue that technologies developed by the public sector or government are immature and in need of further refining and testing before entering the marketplace. However, such further development is risky. Therefore, firms need the protection of intellectual property rights through technology transfer laws which encourage them to accept risk in the development process.[414] Without intellectual property protection, firms argue that government-sponsored technologies would languish in the public domain in their unrefined form.

The history of the NCSA Mosaic web server and web browser highlighted two different approaches the government could take in transferring its technology. In one instance, the government licensed the technology to the private sector, and in the other instance, the government placed the technology in the public domain. In the case of the NCSA Mosaic web browser, the University of Illinois licensed out the code for several million dollars.[415] The dominant web browser today, Microsoft's Internet Explorer, is built upon the NCSA Mosaic web browser source code.[416] The second method of technology transfer consisted of placing the NCSA Mosaic web server into the public domain. This method earned the university zero dollars. However, the most popular web server today, Apache, available for free to the public, had its origins in the NCSA Mosaic web server source code.[417]

The Apache example challenges the prevailing view that intellectual property protection is needed to encourage the

---

1663, 1663 (1996) (providing an historical overview of the government's technology transfer policy).

[413] *Id*.

[414] Rebecca Eisenberg, *Public Research and Private Development: Patents and Technology Transfer in Government-Sponsored Research*, 82 VA. L. REV. 1663, 1669 (1996); U.S GENERAL ACCOUNTING OFFICE, *supra* note 385, at 14.

[415] University of Illinois, Research & Technology Management Office, *Fiscal Year 1999 Annual Report*, *available at* http://www.otm.uiuc.edu/Publications/Annual Report/annreport.htm (Oct. 1999)

[416] Netscape chose to forgo licensing and instead hired the NCSA programmers. They sought the knowledge of the developers of NCSA Mosaic, rather than the intellectual property rights.

[417] GLYN MOODY, REBEL CODE 125 (2001).

commercialization of government-sponsored research.[418] By placing the NCSA Mosaic web server into the public domain, the government encouraged the dissemination and continued innovation of the web server. From this, individuals and firms incrementally and cumulatively improved the original source code created by NCSA. On the whole, generalizing and passing on the efficacy of placing all government-sponsored innovations in the public domain is unsupported by our two case studies. However, it is clear that definitive conclusions, either for or against intellectual property protection for government-sponsored research, are not currently possible. Moreover, there is limited empirical evidence on this subject.[419] It is clear which scenario benefits the University of Illinois. However, it is not as clear which scenario benefits society.[420] Perhaps society would have been better off if the NCSA Mosaic web browser was placed into the public domain instead of being licensed.[421] This could have encouraged a larger number of entities to build upon the NCSA Mosaic web browser.

---

[418] *See* Colyvas et al., *How Do University Inventions Get Into Practice*, 48 MGMT. SCI. 61 (2001) (arguing on the basis of case studies that firms do not need the assurance of intellectual property protection to commercialize university technology).

[419] David C. Mowery et al., *The Growth of Patenting and Licensing by U.S Universities: An Assessment of the Effects of the Bayh-Dole Act of 1980*, 30 RES. POL'Y 99, 117-18 (2001) (noting the lack of empirical evidence, but worried that the emphasis on patenting and licensing could hamper technological innovation, because it limits researchers access to technologies used in the process of conducting research); Sampat & Nelson, *supra* note 409 (commenting on the lack of evidence on the social benefits of existing technology transfer policy).

[420] *See* Eisenberg, *supra* note 412, at 1712 (arguing that intellectual property protection by universities is more likely to retard product development than promote development).

[421] There is evidence that the primary outcome technology managers and university administrators are interested in are revenues. While licensing revenues are easily quantifiable and a measure of success, they are not necessarily equivalent with the public interest. Richard Jensen & Marie Thursby, *Proofs and Prototypes for Sale: The Tale of University Licensing*, NBER Working Paper 7 (1998) (conducting a survey of technology managers and university administrators on licensing). The public interest is to ensure that technologies are transferred to the private sector. In this manner other methods are just as important. These methods include publication, conferences, informal information channels, and consulting. Similarly, a report for the National Institute of Health pointed out that a university's principal obligation should not be maximization of revenues but the utilization of technologies, "technology transfer need not be a revenue source to be successful." Report of the National Institutes of Health (NIH) Working Group, *Research Tools*, June 4, 1998, *available at* http://www.nih.gov/news/researchtools/index.htm.

The Apache case study also challenges the assumption that firms are the only entity capable of commercializing code. The prevailing logic for technology transfer laws assumes that only firms are capable of turning government sponsored research into useful products. However, there is another institution that is capable of producing useful code, the open source movement. The open source movement's reliance on both individual volunteers as well as firms to develop useful code has been validated in many projects including Apache. These products are not niche products, but rather products around which the computing industry is increasingly being based. Accordingly, the government's efforts at technology transfer must recognize the value and strength of the open source movement. To further innovation and dissemination of code, the government should ensure the open source movement has access to government-sponsored code. We propose, as a general rule, that government funded research should place its code in the public domain.[422] Placing code in the public domain is the least restrictive method for both preserving access while permitting downstream intellectual property protection.[423] This allows both firms and the open source movement to build upon the government's code. Moreover, firms can still seek intellectual property protection for any code that they have spent effort on improving or refining.[424] This policy is

[422] Our proposal focuses on the public domain, because it is much less restrictive than the GPL. The GPL requires any derivative code to be licensed under the GPL. While some people don't want their work privatized, this is largely a personal decision. Government should focus on creating the building blocks of code, no matter who the end users are. *See* Evans & Reddy, *supra* note 317 (arguing that the government should favor the public domain or BSD style of licenses over the GPL. Free Software Foundation, *GNU General Public License, available at* http://www.gnu.org/copyleft/gpl.html (last modified June 1991); David McGowan, *Legal Implications of Open-Source Software*, 2001 U. ILL. L. REV. 241 (discussing social, economic, and legal implication of open source software and the GPL); Richard Stallman, President, Free Software Foundation, *Letter to the Editor: Public Money, Private Code*, SALON, Jan. 29, 2002, *at* http://www.salon.com/tech/letters/2002/01/29/stallman_on_universities/index.html (providing practical advice for university researchers on getting university code released with the GPL).

[423] To ensure that government places code into the public domain it may be necessary to amend portions of the Bayh-Dole Act and the Federal Technology Transfer Act. An exception to government's encouragement and support of intellectual property rights during technology transfer would be needed for software.

[424] Firms would still have an incentive to make code user friendly, add documentation, and provide training because they could profit from these activities.

consistent with technology transfer laws, such as the Bayh-Dole Act, which seeks to further the utilization of government-sponsored research.[425] The main objection to this proposal is that all parties are treated equally, including foreign competitors to American companies.

One use of intellectual property protection during technology transfer is allowing the government to provide preferential treatment to American firms. This is one of the many stated rationales for the Bayh-Dole Act.[426] In response, we argue that preferential treatment is just one of the many underlying rationales for technology transfer. The main rationale behind technology transfer is ensuring the utilization of government research. Moreover, the rise of the open source movement, which is based upon volunteers around the world, complicates any preferential treatment for American firms. As an example, the development of Apache relied on developers from around the world.[427] The effect of preferential treatment toward American firms is to ensure code is not available to the open source movement. For example, American software firms have criticized the National Security Agency (NSA) for developing an enhanced secure version of the open source operating system Linux. [428] Nevertheless, NSA has decided to continue working on its secure version of Linux as part of its mission to understand and improve

---

[425] 35 U.S.C. § 200 ("It is the policy and objective of the Congress to use the patent system to promote the utilization of inventions arising from federally supported research or development"). *See also Report of the National Institutes of Health (NIH) Working Group on Research Tools*, June 4, 1998, *available at* http://www.nih.gov/news/researchtools/index.htm (noting that technology transfer is not about financial returns to the government from licensing).

[426] 35 U.S.C. § 200 (2002) ("It is the policy and objective of the Congress to use the patent system to promote the utilization of inventions arising from federally supported research or development; to encourage maximum participation of small business firms in federally supported research and development efforts; to promote collaboration between commercial concerns and nonprofit organizations, including universities; to ensure that inventions made by nonprofit organizations and small business firms are used in a manner to promote free competition and enterprise; to promote the commercialization and public availability of inventions made in the United States by United States industry and labor; to ensure that the Government obtains sufficient rights in federally supported inventions to meet the needs of the Government and protect the public against nonuse or unreasonable use of inventions; and to minimize the costs of administering policies in this area.").

[427] Roy T. Fielding, *Shared Leadership in the Apache Project*, COMM. ACM, Apr. 1999, at 42.

[428] Robert Lemos, *Linux Makes a Run for Government*, CNET NEWS.COM, Aug. 16, 2002, *available at* http://news.com.com/2100-1001-950083.html.

computer security.[429] The open source community has applauded the NSA's work and has begun utilizing their code.[430]

The policy of placing code into the public domain may be difficult for universities to pursue because licensing brings universities much needed revenue. Therefore, it is difficult to turn away that money, and instead, place code into the public domain. In fact, the University of Illinois had a number of companies seeking to license the NCSA Mosaic web browser. Abandoning that potential licensing opportunity would go against the nature and mission of a university technology transfer office. Thus, for this policy to become widely used, it will be necessary to change the mindset in technology transfer offices.[431] Currently, universities are not "distinguishing between times when it's important to have a patent in place to get something disseminated and times when it's not. They're just looking to see if they can make money," according to Eisenberg.[432] As the NCSA Mosaic web server example shows, the benefits of placing code into the public domain may not flow directly to the

---

[429] Drew Clark, *Defense, NSA Move on 'Open Source' Software Development*, GOV'T EXECUTIVE MAG., Mar. 17, 2003, *available at* http://www.govexec.com/dailyfed/0303/031703td2.htm.

[430] Jim Krane, *World Governments Choosing Linux for National Security*, GOV'T TECH, Dec. 3, 2001, *available at* http://www.govtech.net/news/news.phtml?docid=2001.12.03-3030000000003951. *See also* Robert Lemos, *U.S. Helps Fund FreeBSD Security Project*, CNET NEWS.COM, July 9, 2001, *available at* http://news.com.com/2100-1001-269644.html (discussing the U.S. Department of Defense's work on improving the security of FreeBSD, an open source variant of Unix).

[431] Licensing offices often derive their budgets from licensing revenue. This gives them an incentive to favor short-term revenue from licensing, instead of ensuring the long-term development of their products. This is especially relevant since many licensing offices are losing money. Eyal Press & Jennifer Washburn, *The Kept University*, ATLANTIC MONTHLY, March 2000, *available at* http://www.theatlantic.com/issues/2000/03/press.htm.

[432] Jeffrey Benner, *Public Money, Private Code*, SALON, Jan. 4, 2002, *at* http://salon.com/tech/feature/2002/01/04/university_open_source/print.html.

There are a few cases where is appears that technology transfer offices are placing a university's private gain over the benefits to the public. For example, Michigan State University is an example of a university that chose its own private profits over the public good. The university received a patent for a widely prescribed cancer drug, cisplatin, in 1979. Since then, the patent has generated over $160 million for the university. In 1996 Michigan State University applied for a new slightly altered patent to protect its revenue stream. As a result, generic drug manufacturers are unable to develop cheaper versions of cisplatin. Press and Washburn, *supra* note 431.

university, and it may take a long time for the benefits to accrue to society.[433]

Already, the government is slowly beginning to support the open source movement as an institution capable of developing code. While the open source movement has developed a significant amount of the code for the Internet, it also is playing a role in biotechnology.[434] This has led the National Institute of Health (NIH) to begin studying the appropriate level of intellectual property protection needed for its research tools. One such research tool is bioinformatics code. A working group of the NIH has recommended that the NIH should promote the free distribution of research tools.[435] Other researchers have been more aggressive in calling for the use of open source code.[436]

IV. CONCLUSION

This Article has taken a very different approach than traditional scholarship which focuses on how code affects a particular societal concern. Our goal was to show the many methods available to government to influence the development of code. To this end, we analyzed a number of different regulatory and fiscal actions government can take to shape code. For each possible action, we discussed potential regulatory and technological issues that could affect the success of the action. We believe our analysis will be invaluable to scholars and policymakers seeking to shape the development of code.

---

[433] Larry Smarr, former director of NCSA during the period when NCSA Mosaic was created and now a professor of computer science at U.C. San Diego does not believe that "universities should be in the money making business. They ought to be in the changing-the-world business and open source is a great vehicle for changing the world." Benner, *supra* note 432.

[434] *See* Bruce Stewart, *Ewan Birney's Keynote: A Case for Open Source Bioinformatics*, *available at* http://www.oreillynet.com/lpt/a//network/2002/01/28/bioday1.html (Jan. 29, 2002); Bruce Stewart, *Lincoln Stein's Keynote: Building a Bioinformatics Nation*, *available at* http://www.oreillynet.com/pub/a/network/2002/01/29/bioday2.html (Jan. 30, 2002).

[435] *See Report of the National Institutes of Health (NIH) Working Group on Research Tools*, June 4, 1998, *available at* http://www.nih.gov/news/researchtools/index.htm.

[436] Harry Mangalam of TACG Informatics has called on the NIH to require research scientists who receive federal funding to make their code freely available for other researchers. *Computer Scientists Push to Publish Code Powering Genetic Research*, SAN JOSE MERCURY NEWS, Nov. 24, 2001, *available at* http://www.siliconvalley.com/docs/news/svfront/015842.htm.

In considering regulatory actions we noted that prohibitions can be an effective method of regulation, but current export prohibitions on encryption code are impractical.[437] Similarly, we discussed the regulatory trade-offs with technology-forcing regulation and illustrated this by analyzing the CDA as a technology-forcing regulation.[438] Our analysis led us to criticize the current policy of mandating digital broadcasting technologies, because of their vague benefits.[439] Our discussion of liability led us to conclude that modification of liability systems can result in more secure and safer code.[440] However, we identified flaws in a proposed government policy to create a more secure code by attempting to develop an insurance system for cybersecurity.[441] A final key point was the need for a comprehensive regulatory strategy for code. Just as other regulatory objects, such as biotechnology and automobiles, have a regulatory framework, the same approach is needed for code.[442]

Our consideration of government's fiscal approaches led us to offer a number of policy recommendations. We discussed how government can shape code by funding its research and development.[443] We also suggest that government should use its procurement power to favor open standards and open source code.[444] Such a policy is consistent with the government's goals of spending its resources efficiently while considering social and environmental externalities. Finally, we argue that government can further innovation by promoting technology transfer by placing its code into the public domain.[445] This allows a wide variety of parties to build upon and refine the work accomplished by government on the behalf of its citizens.

Future scholarship will more fully examine each of the measures discussed in this article. We encourage and look forward to this, because it is our belief that code can serve as a beneficial regulatory mechanism. To this end, we have attempted to analyze the various methods that policymakers may use to guide and promote the development of code that contributes to our society.

---

[437] *See supra* text accompanying notes 44-51.
[438] *See supra* Part II.B.1.
[439] *See supra* text accompanying note 94.
[440] *See supra* Part II.D.1.
[441] *See supra* Part II.D.3.
[442] *See supra* Part II.F.
[443] *See supra* Part III.A.1.
[444] *See supra* Part III.B.
[445] *See supra* Part IV.C.