trist Democrats who supported the
sful North American Free Trade Ag
position of sugar and textile industri
ned. But increasing numbers of po
e United States to mitigate the costs
ntries that are not required to adh
dards. Economist Robert J. Samuel
t globalization is destined to triu
cs do matter.[13] As we have seen, the
"open systems" is as much a product
e of the national "psychology" and po
trial wealth. How effectively, and h
g decades, remains to be seen.

APPENDIX: ESSAY ON SOURCES

Whether one explores issues in U.S. science and technology policy for academic or for practical reasons, the first step is to learn "the lay of the land." However, because an individual's interest in this subject is rarely neutral, the danger is great at the outset of becoming captive to special pleading (or one's own biases). Policy advocates as well as academic scholars will be more effective if they fully appreciate every salient position on the controversy at hand. Thanks to the developments discussed in chapter 6, Internet access to congressional deliberations and policy development in the executive branch is substantial. Readers should start with the following websites (most of which have site maps with links to more specific sources of information or opinion): <http://www.house.gov/science>, website for the U.S. House of Representatives Committee on Science; <http://www.senate.gov>, for links to the U.S. Senate committees on commerce, science, transportation, and energy and natural resources; and then <http://www.ostp.gov/index.html>, the Office of Science and Technology Policy (OSTP) for links to White House policy position papers (many of which can be in the form of speeches made by the president's science advisor or reports by the National Science and Technology Council and President's Council of Advisors on Science and Technology).

Links on White House, OSTP, and Office of Management and Budget (OMB) website home pages vary somewhat from administration to administration. The OMB's website at <www.whitehouse.gov/omb>, which tends to be the most consistent over time, is an essential tool for students of federal science and technology policy. Currently (during the second George W. Bush administration) OMB's home page has direct links to White House policy on energy, environment, transportation, health, science, and space policy issues. There are also direct links to current budget documents and executive branch testimony before and reports to Congress. The page's search feature allows readers to see administration statements and reports from federal agencies involved in science and technology, by entering in their acronyms, e.g., NASA, EPA (Environmental Protection Agency), and NSF (National Science Foundation). Meanwhile, each executive branch agency has a website that can be accessed by entering its name into a browser's search field, and virtually all executive

branch agency websites have links to their internal policy development organizations and publications. Also an essential bookmark for Internet users is the federal government's web portal, "FirstGov" (<www.firstgov.gov>), which has an excellent reference section with links to federal data, statistics, libraries, laws, and regulations.

The largest challenge facing first-time researchers is the surfeit of policy-relevant information. A good screening rule is to limit one's initial searches to organizations that have gained some traction in the policy-making process. Some of the many organizations and interest groups that cluster around science and technology policy agendas carry more weight than others in the White House and the Congress, whether for substantive or financial reasons. A good way to identify those organizations and individuals is to scan the hearing calendar of the pertinent congressional committees to determine the organizational affiliations of scheduled witnesses; having done so, visit the organizations' websites for more information about them and their policy views.

For the executive branch, from the OSTP website use the site map and outreach/reports links to reach a list of reports on various subjects, most of which name the participating individuals and organizations. Among the biggest non-government players are the National Academy of Sciences/National Research Council, the National Academy of Engineering, and the American Association for the Advancement of Science, at <http://nationalacademies.org> and <http://www.aaas.org/pp>. For more critical views visit the websites of Public Citizen (<http://www.citizen.org>), the Center for Science in the Public Interest at <http://www.cspinet.org>, and the Center for Responsive Politics, which collects and publishes information on campaign contributions and lobbying at its website, <http://www.opensecrets.org>.

In addition, federal agencies responsible for promoting U.S. research and development publish annual or periodic surveys which, when consulted together, can provide a necessary anchor for the generalizations we rely on to frame valid policy questions or proposals. These are the National Science Board's annual *Scientific and Engineering Indicators*, published by the National Science Foundation in both print and online versions (Washington, D.C.: National Science Board, annually); the Office of Management and Budget's annual "Analytical Perspectives, Budget of the United States Government" most readily accessed online at <http://www.whitehouse.gov/omb/budget/>; and the U.S. Department of Commerce (DOC), Office of the Secretary annual "Summary Report on Federal Laboratory Technology Transfer [calendar year]: Report to the President and the Congress Under the Technology Transfer and Commercialization Act," available online at <http://www.technology.gov/Reports.htm>.

In using these reports, which rely almost entirely on quantitative data, researchers must be mindful not only of the limits of quantitative data in economic and social policy development, but of their comparative context. For

examples, see Will Lepkowski, "Science and Engineering Indicators—Of What?" *Science and Policy Perspectives*, Vol. 2 (Center for Science, Policy and Outcomes, <www.cspo.org> [2001]); National Research Council, *Quantitative Assessments of the Physical and Mathematical Sciences, A Summary of Lessons Learned* (Washington, D.C.: National Academy Press, 1994); National Research Council, "Measuring the Science and Engineering Enterprise" (Washington, D.C.: National Academy Press, 2002); Organisation for Economic Co-operation and Development (OECD), "Fiscal Measures to Promote R&D and Innovation" (Paris, 1996) and "Research and Development in Industry: Expenditure and Researchers, Scientists and Engineers 1976–97" (Paris, 1999). The OECD offers numerous statistical reports pertinent to comparative energy, health, environmental, and information policy issues that can be accessed from links at <http://www.oecd.org/home>.

HAVING SKETCHED OUT a topographical map of the science and technology policy issues that interest one the most, researchers can begin to burrow down and make some geological observations of those issues' political, institutional, and historical terrain. Any list of sources must necessarily be somewhat idiosyncratic, for the simple reason that the quantity of publications, from good journalism to the most obscure doctoral dissertation, is so great that to include them all would consume the pages of another book. Therefore no reader is likely to find the following suggestions complete, but this author has found the following published resources especially valuable.

For general historical frameworks and survey treatments, see Don K. Price, *Government and Science* (New York: New York University Press, 1954); A. Hunter Dupree, *Science in the Federal Government: A History of Policies and Activities* (Cambridge, Mass.: Harvard University Press, 1957, 1986); Michael Polanyi, "The Republic of Science: Its Political and Economic Theory," *Minerva*, Vol. 1 (1962); Don K. Price, *The Scientific Estate* (Cambridge, Mass.: Harvard University Press, 1965); Daniel Greenberg, *The Politics of Pure Science* (New York, N.Y.: Penguin, 1967); Harvey Brooks, *The Government of Science* (Cambridge, Mass.: The MIT Press, 1968); W. Henry Lambright, *Governing Science and Technology* (New York, N.Y.: Oxford University Press, 1976); Derek de Solla Price, *Little Science, Big Science . . . and Beyond* (New York, N.Y.: Columbia University Press, 1986); Bruce L. R. Smith, *American Science Policy Since World War II* (Washington, D.C.: The Brookings Institution Press, 1990); Daniel Kleinman, *Politics on the Endless Frontier* (Durham, N.C.: Duke University Press, 1995); Bruce L. R. Smith and Claude Barfield, eds. *Technology, R&D and the Economy* (Washington, D.C.: The Brookings Institution Press, 1996); and Daniel Kleinman, *Science, Technology, and Democracy* (Albany, N.Y.: State University Press of New York, 2000). See also Michael Crow and Barry Bozeman, *Limited by Design: R&D Laboratories and the U.S. National Innovation System* (New York, N.Y.: Columbia University Press,

1998), and U.S. Library of Congress, Congressional Research Service, *Linkages Between Federal Research and Development Funding and Economic Growth*, Report No. 92-211 SPR (Washington, D.C.: U.S. Library of Congress, 1992).

To the extent that science policy decisions have been premised on the relationship between science and government posited in 1945 by Vannevar Bush's report to the president, *Science—the Endless Frontier* (New York, N.Y.: American Council of Learned Societies-ACLS History E-Book Project, 2001)—or the Bush paradigm—the principal issue in science policy has been providing sufficient funding for university-based (academic) research while allowing federally funded researchers maximum programmatic and administrative latitude. A good overview of issues in federally funded university research can be found in David H. Guston and Kenneth Keniston, eds. *The Fragile Contract: University Science and the Federal Government* (Cambridge, Mass.: The MIT Press, 1994). See also Claude E. Barfield, ed. *Science for the Twenty-First Century: The Bush Report Revisited* (Washington, D.C.: The American Enterprise Institute Press, 1997). For critical treatments of the linear model of the influence of scientific research on technological advance and subsequence economic growth see Daniel Sarewitz, *Frontiers of Illusion* (Philadelphia, Pa.: Temple University Press, 1996) and Donald Stokes, *Pasteur's Quadrant* (Washington, D.C.: The Brookings Institution Press, 1997).

The tension between scientific and political authority is as old as modern science itself. Those wishing to dig more deeply into the ideological foundations of contemporary "science v. politics" controversies should become familiar with the notion of "scientific revolution" as the leading force for change in modern life. Begin with Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago, Ill.: University of Chicago Press, 1962) and John Henry, Roy Porter, and John Breuilly, *The Scientific Revolution and the Origins of Modern Science* (New York, N.Y.: St. Martin's Press, 1997). Roy Porter, in *Enlightenment* (New York, N.Y.: Palgrave Macmillan, 2001), provides good European intellectual context for the ideas that would flourish and migrate to the new republic in the early nineteenth century. Daniel J. Kevles's *The Physicists: The History of a Scientific Community in Modern America* (Cambridge, Mass.: Harvard University Press, 1971) offers an unparalleled, intimate look at the way questions of authority and political influence operated among the professional aspirations and successes of the arguably most important community of scientists in the United States in the twentieth century.

A good sampling of commentary on the varied ways in which scientific and cultural authority have competed in twentieth-century America can be found in Ronald G. Walters, ed. *Scientific Authority in Twentieth-Century America* (Baltimore, Md.: The Johns Hopkins University Press, 1997). See also Kleinman's, *Politics on the Endless Frontier*; Sheila Jasanoff, *The Fifth Branch: Science Advisers as Policy Makers* (Cambridge, Mass.: The MIT Press, 1990); Bruce L. R. Smith, *The*

Advisers: Scientists in the Policy Process (Washington, D.C.: The Brookings Institution Press, 1992); and Gordon Adams, *The Iron Triangle: The Politics of Defense Contracting* (New York, N.Y.: Council on Economic Priorities, 1981). While Adams's study is now over twenty years old, its observations and conclusions are as valid today as they were in the early Reagan administration.

An old joke among lawyers about *pro se* litigants warns that "he who represents himself has a fool for a client." That may be so, but the survival of constitutional government requires that ordinary citizens have a general familiarity with constitutional principles so that they can recognize when those principles may be in jeopardy. Moreover, constitutional law sets both the boundaries and possibilities of creative and constructive policy making in the arena of science and technology policy no less than in any other policy arena—as we have attempted to illustrate in the preceding chapters. For an overview of the relations of science, technology, and law, see Sheila Jasanoff, *Science at the Bar: Law, Science and Technology in America* (Cambridge, Mass.: Harvard University Press, 1997). Three sources in particular are invaluable in offering general discussions of constitutional issues and the significance of critical decisions by the federal judiciary. For historical Supreme Court cases into the 1950s the best summaries can be found in the first edition of Robert E. and Robert F. Cushman's *Cases in Constitutional Law* (New York, N.Y.: Appleton-Century-Crofts, 1958). What generations of law and political science students know as "Cushman and Cushman" has been updated several times, most recently with the ninth edition published in 2000 by Robert F. Cushman and Brian Stuart Koukoutchos with Susan P. Koniak, *Cases in Constitutional Law* (Upper Saddle River, N.J.: Prentice Hall, 2000), but the discussions of cases, while more current, are not nearly as extensive as in the first edition.

For First Amendment decisions, which govern the extension of federal telecommunications power into the content of what is communicated, the place to begin is with Zechariah Chafee, Jr., *Free Speech in the United States* (New York, N.Y.: Atheneum, 1969), while Floyd Abrams's *Speaking Freely: Trials of the First Amendment* (New York, N.Y.: Viking, 2005) offers a more recent treatment. Discussions of more recent cases can be found in the new "Annotated Constitution" offered over the Internet by the Legal Information Institute (LII) of the Cornell University Law School, at <http://chrome.law.cornell.edu/ancon>. Meanwhile the federal judiciary's interpretations and applications of the "commerce clause" (Article I, Section 8) have set the legal framework in which the adoption of technologies spreads into the national and global market place. When the LII Annotated Constitution (online) is completed, one can consult it for contemporary discussions of critical cases in the interpretation of constitutional grants of (or restrictions on) federal power over commerce. For discussions of the use of expert testimony (science and engineering) by the federal judiciary, see Donald Kennedy and Robert A. Merrell, "Issues in Focus:

Science and the Law," Stephen Breyer, "Science in the Courtroom," and Margaret A. Berger, "Expert Testimony: The Supreme Court's Rules," in *Issues in Science and Technology* (Washington, D.C.: National Academy of Sciences, Summer 2000).

Public administration—what federal and state bureaucracies do—is one of the most maligned and least appreciated functions of government. A succession of would-be presidents on the campaign trail has promised to "reduce" or "rid" the country of too much government and bureaucratic red tape, only to discover shortly after entering office that how they carry out their campaign promises (i.e., the administrative tools they use) can make or break the success of their policies. Unfortunately, the public administration literature rarely makes for light reading. Nonetheless the topic must be mastered to a modest extent to understand why, for example, the mandatory setting of emissions restrictions may, in the long run, prove less effective for environmental purposes than allowing firms to trade emissions "allowances."

Useful additional reading to learn more about how the U.S. policy toolkit for distributing and managing federal funds shapes the outcomes of federal support for scientific research and development includes Linda R. Cohen and Roger G. Noll, *The Technology Pork Barrel* (Washington, D.C.: The Brookings Institution Press, 1991); Hedrick Smith, "Pentagon Games: The Politics of Pork and Turf," in *The Power Game: How Washington Works* (New York, N.Y.: Random House, 1988); and Daniel S. Greenberg, *Science, Money and Politics: Political Triumph and Ethical Erosion* (Chicago, Ill.: University of Chicago Press, 2001). Two studies of federal efforts by the Department of Defense to "push" and shape computer technology provide an exceptionally close view of the intersection in the federal government of organizational politics with the challenges of technological innovation: Arthur L. Norberg and Judy E. O'Neill, *Transforming Computer Technology: Information Processing for the Pentagon, 1962–1986* (Baltimore, Md.: The Johns Hopkins University Press, 1996, 2000) and Alex Roland and Philip Shiman, *Strategic Computing: DARPA and the Quest for Machine Intelligence, 1983–1993* (Cambridge, Mass.: The MIT Press, 2002).

A major watershed was reached during the 1980s' presidency of Ronald Reagan, whose eagerness to turn federal programs over to the private sector (manifest in the intellectual property policies of the 1980s) were not reversed during the centrist presidency of his Democratic successor, Bill Clinton. A good sketch of the Reagan redesign of federal policy tools can be found in Haynes Johnson's chapters "Privatizing" and "Deregulation" in his *Sleepwalking Through History: America in the Reagan Years* (New York, N.Y.: W. W. Norton & Co., 1991). See also W. H. Schacht, "Patent Ownership and Federal Research and Development: A Discussion on the Bayh-Dole Act and the Stevenson-Wydler Act" (U.S. Congressional Research Service Report RL30320, 2002); Barry Bozeman, "Technology Transfer and Public Policy: A Review of Research and Theory, *Research*

Policy (2002); B. Hall and J. Van Reenen, "How Effective are Fiscal Incentives for R&D? A Review of the Evidence," *Research Policy* (2002); and Nathan Rosenberg and R. R. Nelson, "American Universities and Technical Advance in Industry," *Research Policy* (1994).

The distribution of federal funds for scientific (academic) research is dominated by the process of peer review by largely non-federal scientists. A good summary of this process and the policy issues it raises can be found in Richard C. Atkinson and William A. Blanpied, "Peer Review and the Public Interest," *Issues in Science and Technology*, Vol. 1, No. 4 (Washington, D.C.: National Academy of Sciences, 1985). See also H. Zuckerman and Robert Merton, "Institutionalized Patterns of Evaluation in Science," in Robert K. Merton and Norman W. Storer, eds., *The Sociology of Science: Theoretical and Empirical Investigations* (Chicago, Ill.: University of Chicago Press, 1973); Daryl Chubin and E. J. Hackett, *Peerless Science: Peer Review and U.S. Science Policy* (Albany, N.Y.: State University of New York Press, 1990); Roy Rustom, "Funding Science: The Real Defects of Peer Review and an Alternative to It" and Sheila Jasanoff, "Peer Review in the Regulatory Process," both in *Science, Technology and Human Values*, Vol. 10, No. 3 (1985); Robert K. Merton, "The Matthew Effect in Science," *Science*, Vol. 159, No. 3810 (January 5, 1968); and Charles W. McCutchen, "Peer Review: Treacherous Servant, Disastrous Master," *Technology Review* (October 1991).

For international comparisons with the administration of science and technology policy in the United States see David Mowery, "The Practice of Technology Policy," in Paul Stoneman, ed., *Handbook of the Economics of Innovation and Technological Change* (Oxford, UK: Blackwell Publishers, 1995). Set in the broader context of economic policies which today have technology at their center, such comparisons are richly explored in Daniel Yergin and Joseph Stanislaw, *The Commanding Heights: The Battle Between Government and the Marketplace That is Remaking the Modern World* (New York, N.Y.: Simon & Schuster, 1998). The international Organisation for Economic Cooperation and Development (OECD) maintains an excellent website that has numerous links to aggregate as well as country-specific information about such topics as science and innovation, science and technology policy, energy, environment, biotechnology, and information and communication technologies. See <www.oecd.org>.

THE LITERATURE ON the science and technology policy issues highlighted in chapters 6 through 9 does not observe any principle of parity. Some issues have inspired more publications (not necessarily a measure of quality) than others. That said, the following studies can be especially valuable in filling out the historical or political backdrop against which communications, health, biotechnology, space, energy, and environmental policy decisions must be assessed. For space policy, see R. Cargill Hall's essay, "Origins of U.S. Space Policy: Eisenhower, Open Skies, and Freedom of Space," in John M. Logsdon,

ed., *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program, Vol. I, Organizing for Exploration* (Washington, D.C.: National Aeronautics and Space Administration, 1995); Nathan C. Goldman, *American Space Law: International and Domestic* (San Diego, Calif.: Univelt, Inc., 1996); Robert A. Divine's essay, "Lyndon B. Johnson and the Politics of Space," in Robert A. Divine, ed., *The Johnson Years, Vol. II: Vietnam, the Environment, and Science* (Lawrence, Kans.: University Press of Kansas, 1987); Walter A. McDougall, . . . *The Heavens and The Earth: A Political History of the Space Age* (Lawrence, Kans.: University of Kansas Press, 1985); W. Henry Lambright, *Powering Apollo: James E. Webb of NASA* (Washington, D.C.: National Aeronautics and Space Administration, 1995); and Sylvia D. Fries, "2001 to 1994: Political Environment and the Design of NASA's Space Station System," *Technology and Culture,* Vol. 29, No. 3 (July 1988).

For health policy questions—which occasion as much heat as light, thanks to their many-faceted complexity—see David Culter and Alan Garber, *A Disease Based Comparison of Health Systems* (Paris, France: OECD, 2003); Judith W. Leavitt and Ronald L. Numbers, *Sickness and Health in America: Readings in the History of Medicine and Public Health* (Madison, Wisc.: University of Wisconsin Press, 1997); Roy Porter, *The Greatest Benefit to Mankind: A Medical History of Humanity* (New York, N.Y.: W. W. Norton & Co., 1997), David J. Rothman, *Beginnings Count: The Technological Imperative in American Health Care* (New York, N.Y.: Oxford University Press, 1997) and *Strangers at the Bedside: A History of How Law and Bioethics Transformed Medical Decision-making* (New York, N.Y.: Basic Books, 1991); Paul Starr, *The Social Transformation of American Medicine* (New York, N.Y.: Basic Books, 1983); and M. L. Tina Stevens, *Bioethics in America: Origins and Cultural Politics* (Baltimore, Md.: The Johns Hopkins University Press, 2000).

Among the best introductions to the digital age are Paul E. Ceruzzi's *A History of Modern Computing* (Cambridge, Mass.: The MIT Press, 2000) and Janet Abbate's *Inventing the Internet* (Cambridge, Mass.: The MIT Press, 2000). For broader perspectives, see Alfred D. Chandler and James W. Cortada, eds., *A Nation Transformed by Information* (New York, N.Y.: Oxford University Press, 2000); Michael E. Hobart and Zachary S. Schiffman, eds. *Information Ages: Literacy, Numeracy, and the Computer Revolution* (Baltimore, Md.: The Johns Hopkins University Press, 1998); and James E. Katz and Ronald E. Rice, *Social Consequences of Internet Use: Access, Involvement, and Interaction* (Cambridge, Mass.: The MIT Press, 2002). And for thoroughly engaging writing, see Tracy Kidder's now classic and intimate look at the early hours of the digital age, *The Soul of a New Machine* (New York, N.Y.: Little, Brown and Company, 1981); and Ken Auletta's *World War 3.0: Microsoft vs. the U.S. Government, and the Battle to Rule the Digital Age* (New York, N.Y.: Broadway Books, 2001).

More than any other area of science and technology policy, issues in en-

ergy and environmental policy are driven by quantitative questions of "how much" and "for how long?" Thus anyone venturing into this area should be familiar with the following widely consulted, though not always consistent, data sources. Among government sources, see the Energy Information Administration (<http://www.eia.doe.gov>), International Energy Agency (<www.iea.org>), Nuclear Regulatory Commission Information Digest (<http://www.nrc.gov/reading-rm/>), and the Federal Energy Regulation Commission (<http://www.ferc.gov>) websites. Among organizational and commercial sources, see the American Petroleum Institute's website's (<http://api-ec.api.org/>) link to "Industry Statistics," and the American Automobile Association's "Daily Fuel Gauge Report" (<www.fuelgaugereport.com>). Data on motor vehicles use and other forms of transportation can be found at the Department of Transportation's Bureau of Transportation Statistics' website (<www.bts.dot. gov>). The most credible sources of information and policy discussions at the crossroads of energy and environmental issues are the websites of the U.S. Environmental Protection Agency (<http://www.epa.giv>), which have links to pertinent laws and policy documents, as well as data on a broad range of environmental issues; the Natural Resources Defense Council (<www.nrdc.org>) and Resources for the Future (<http://www.rff.org>).

Good introductions to both energy and environmental policy issues are David H. Guston, ed., *Science, Technology and the Environment* (Washington, D.C.: The Policy Studies Organization, 1997) and Otis L. Graham, Jr., *Environmental Politics and Policy, 1960s–1990s* (University Park, Pa.: Pennsylvania State University Press, 2000). A nearly complete education in the role of carbon-based fuels in the U.S. economy and politics can be had from Daniel Yergin's, *The Prize: The Epic Quest for Oil, Money, and Power* (New York, N.Y.: The Free Press, 1991). Also valuable for its comparably rich discussion of the post–World War II origins of U.S. energy policy is Richard K. Vietor's *Energy Policy in America Since 1945: A Study of Business-Government Relations* (New York, N.Y.: Cambridge University Press, 1984, 1987). For a forward look, see Howard Geller, *Energy Revolution: Policies for a Sustainable Future* (Washington, D.C.: Island Press, 2002).