CHAPTER TWO

The Limits of Government-Funded Research: What Should They Be?

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INTRODUCTION

The United States government today funds a wide range of research, research that serves many ends. Government-funded research seeks to find the limits of the universe, to understand human health, to discover cures for all known diseases, to know the smallest constituents of matter, to improve crops, to develop new sources of energy, to maintain control of our nuclear weapons, and to develop new systems for conventional defense. This, of course, is a tiny sample of (in 1998[1]) a 67-billion-dollar enterprise. Our task here is to ask, from a classical-liberal political perspective, just how broad government support of research should be.

In recent decades libertarians and conservatives have had some success in their efforts to limit the scope of government. They have made substantial progress in deregulating some industries and in freeing some markets, but the scope of federal

1. National Science Board, *Science and Engineering Indicators—2000* (Arlington, Va.: National Science Foundation, 2000), chap. 2.

research funding has been almost unchanged. Many traditional conservatives are content to see the government play a substantial role in research and are often willing to support any research that does not immediately produce a profitable product. Their guiding principle, in effect, is that government must not compete with business, but can do things that support future business activity. Such conservatives would support the General Welfare clause in the U.S. Constitution.

In contrast, libertarians oppose the General Welfare clause, and do not consider it proper for the government to support future business activity. They often state their blanket opposition to government support of research. Emotional fuel for this position can be found in the work of the author Ayn Rand who, in her influential novel *Atlas Shrugged*, makes an emotionally powerful case against state control of science. She shows how the decision of a brilliant physicist to support such control leads to the destruction of his integrity, and eventually of his life, when he must progressively compromise his principles to placate those who control funding for his research. There has been a small libertarian assault on the idea that research must and should be funded by government, usually in response to arguments by prominent scientists that such funding is essential to continued economic progress and to intellectual well-being. Here again, what is at issue is the role of government in supporting the general welfare.[2]

What has been missing, however, is an analysis of government support of research that considers the purposes of government within a classical-liberal political context. In this con-

2. Since one does not see legal challenges to the support of research by the U.S. government, it is somewhat speculative to ground such support exclusively in the General Welfare clause. For some research, in particular as it relates to regulatory actions, the Interstate Commerce clause might also be used.

text, government exists for certain fundamental purposes, and must act to achieve these purposes. In principle, it might or might not prove necessary for the government to support research in order to achieve these fundamental purposes. We will see that it does, or can, prove necessary and this will lead us to ask what the limits of such government support should be. This question, it turns out, does not have a simple answer, but we can and will make progress toward answering it. As we explore these issues, we will review some of the relevant history and consider specific cases.

ACHIEVING FUNDAMENTAL PURPOSES OF GOVERNMENT

We will consider research from the perspective of a classical-liberal, or libertarian,[3] view of politics, and will evaluate government actions from this perspective. The classical liberal holds that the fundamental purpose of government is to defend the natural rights of citizens. One can specify these rights, on a general level, as the rights to life, liberty, and property. These rights imply other, more specific rights, such as freedom of speech, but we will not concern ourselves here with their elucidation. The question is what the government must do in order to defend such rights. One can readily identify the need for a national defense, to protect the citizens from the potential actions of other countries, and for a police and criminal court system, to protect the citizens from criminals.

3. It would not be productive to engage in the largely semantic discussion regarding any differences between "classical-liberal" and "libertarian" politics. There are, for example, anarchists who consider themselves to be "libertarians" politically. The text defines the political context that will form the basis of the present discussion. Those who would develop an alternative discussion, in an alternative context, are welcome to do so.

Beyond this, the government must do other things to protect the rights of citizens and to allow citizens to exercise their rights. Here we cite a few examples but do not provide an exhaustive list. Government must protect citizens from the inadvertent violation of their rights, which might occur, for example, through the underground seeping of sewage from one property to another. It must also define the rights associated with new technologies and with intellectual property. Maintaining a patent office and patent law is one example of this. It must provide a framework for the exercise of the rights of citizens, such as for the exchange of goods and services among people. This occurs, for example, through the definition and enforcement of law regarding contracts.

One sees here that government has a number of valid purposes, but these do not imply anything about the methods through which it is to achieve them. There is a basic logical requirement that government must not achieve these purposes by routinely violating those rights of the citizens that government exists to defend. For example, the use of slave labor would not be a legitimate method by which to achieve the proper purposes of government. There are also the challenging issues of funding a government that violates no rights, and the thorny quagmire of special emergencies, which lie outside our focus here. The important point for our purposes is that there are no fundamental restrictions on the employment of individuals in order to achieve the legitimate purposes of government.

Thus, employing soldiers or policemen is valid, but so is hiring a construction company to build a jail. If a courthouse or a jail is needed, it is legitimate for the government to build it. If the government needs a steady effort in the construction of facilities, it is equally legitimate for the government to establish an internal construction organization to carry out such

work. However, this is not wise, as it is very well established by political science that governmental organizations tend to be inefficient or incompetent in carrying out such activities. The wave of privatization that has been sweeping the world during the past two decades reflects an increasing recognition of this fact. The distinction drawn here will also be important for our discussion of research. I will argue that although it is legitimate for the government to pursue a wide range of research through many methods of support, it is only wise to pursue a narrower range of research and to employ specific methods of support.

There is another point worth making here. In the context of government support, there is nothing special about scientific research. Scientific research is no more and no less than one type of human activity. In some contexts, in the face of severe crises that can only be met by new knowledge, scientific research may be a very important human activity, but there are other important human activities. Those fundamental considerations that apply to government support of scientific research apply equally well to government support of any other human activity, which makes our analysis a bit easier, as we can draw examples from other areas.

From the above, one can conclude that it would be legitimate for the government to support any research required to achieve the valid purposes of government. One can ask: Is scientific research necessary for the government to achieve its proper ends? The answer is clearly yes, it can be. The easiest examples are from wartime. In the course of World War II the U.S. government supported a great deal of research that had enormous consequences for the war. Here are two of many examples. The development of radar provided advance warning

of airborne attacks.[4] The development of nuclear weapons saved an enormous number of American (and Japanese) lives.[5]

Some examples from the Cold War are also compelling. Continued research in nuclear weapons and related sciences, in the face of the threat from the Soviet Union, was obviously called for by the mission of national defense. It was essential to be as capable as, if not more capable than, a nation whose explicit political philosophy involved seeking worldwide domination. For the same reasons, research that led to the development of improved technologies for spying was important. In addition, the initial steps into outer space were essential to the national defense.

The Cold War provides other cases, though, which are more difficult to evaluate. Research in the universities is a good example. From 1958 to 1968, federal support of university research increased fivefold, from $1 billion to $5 billion (in 1988 dollars).[6] On the one hand, perhaps this expansion was part of the general expansion of government involvement in life and in the economy during the 1960s. On the other hand, there were very real national-defense motivations for it. There was a need for the United States to be strong and capable in the face of the Soviet threat. Our question about this explosion of university research will be whether it was legitimate, and, if so, whether it was wise, but we are not quite ready to answer this. We first need to return to the fundamental line of argument.

4. Robert Buderi, *The Invention That Changed the World: How a Small Group of Radar Pioneers Won the Second World War and Launched a Technological Revolution* (New York: Simon and Schuster, 1996).

5. Richard Rhodes, *The Making of the Atomic Bomb* (New York: Simon and Schuster, 1986), 687.

6. Hugh Davis Graham and Nancy Diamond, *The Rise of American Research Universities* (Baltimore: Johns Hopkins University Press, 1997), 83.

CAN WE FIND LIMITS OF LEGITIMACY?

We have established that scientific research can be necessary for the government to achieve its proper ends. Such research is then legitimate. Next one would like to understand the limits of legitimacy. In particular, it would be convenient if there were a simple principle that could identify some research as legitimate and other research as not legitimate. In pursuit of this, let us examine some limiting cases. For this purpose, we can draw a useful distinction between research that directly supports actions necessary to achieve the purposes of government and research that indirectly supports such actions. Examples of research that directly supports valid governmental actions include research into the properties of high explosives and research to improve fingerprint detection. It is fairly easy to establish whether such a direct connection exists. This defines a restrictive limiting case; we will examine it first by considering this proposed simple rule: the only scientific research for which government support is legitimate is research that directly supports actions necessary to achieve the valid purposes of government. Such research would support national defense activities such as the development of weapons, or would serve a similarly narrow function with regard to other valid purposes of government. This simple rule, unfortunately, does not stand up to scrutiny. It is not hard to find cases in which much more than this would clearly be legitimate, by the standard we specified above.

One such example, which might involve some support for research but primarily involves education, is the case of a newly free third-world country. Imagine such a country, now devoted to the protection of the rights of its citizens, ready to let the magic of the market make its citizens rich. The country in question would have a substantial national defense problem.

As it became wealthier, it would become a tempting target for the poorer countries around it. Such a country would have an immediate crucial need to produce educated, technically trained individuals to support its national defense. This need would be similar to, but would go far beyond, the need for soldiers. It would clearly be legitimate for this country to provide extensive support for the general and technical education of the people it needs. This could legitimately and sensibly include establishing schools as well as sending people to Western universities. The wise pursuit of these methods might involve a delimited way for those educated to repay the government, similar to the Reserve Officer Training Corps in the United States. It might also involve a plan to phase out the government involvement in the universities as the populace became better-educated and more naturally able to provide the required support for the national defense. But the legitimate actions of government in this case, necessary for the national defense, would unquestionably include support for activities that only indirectly support national defense.

We can draw another example from the present situation of the United States. The world includes many countries with nuclear weapons, and their number will only increase with time. All such countries pose a potential threat of nuclear damage to the United States, whether deliberately or through terrorist intervention. Certain countries have the potential to become a strategic threat to the United States. The United States itself has a large number of aging nuclear weapons. For all of these reasons, the United States needs to sustain technical expertise in nuclear weapons and related areas of science and technology. However, this involves arcane subjects such as the behavior of matter at extremely high pressures and the behavior of radiation in highly ionized metals. The U.S. economy does not naturally produce experts in these areas. Moreover,

within the context of science in the United States, the only way to attract sufficiently capable people into this area is to have a basic research presence in the universities. (Basic research in the universities is most often supported, not for the knowledge it produces, but for the people trained through it.) This combination of circumstances makes it legitimate and appropriate for the U.S. government to support basic research in technically relevant areas, in the universities as part of its effort to sustain technical excellence in nuclear weapons. It is worth noting that a significant fraction of astrophysics research can be justified in this way.

Thus, a narrow principle claiming that legitimate support for scientific research must directly support valid governmental action is inadequate. There are cases in which indirect needs must be met in order to achieve the valid purposes of government. However, having opened the door to indirect needs, it is unclear how far one can go. A very wide range of research activity can serve to indirectly support the valid actions of government. Examples whose connection to such valid actions is close include research aimed at developing useful technologies and research conducted to train people. Examples whose connection is real but more distant include research in improved computer architectures and basic research in any area, as history shows that one cannot predict which basic research will produce an important breakthrough for defense.

There is no reason to stop at this point in drawing indirect connections. An example whose connection is even more distant would be research into the sources of happiness (happy people are more productive, and a more productive society is more defensible). This is specific to research, but one could make similar arguments relating to a very wide range of human activity. A productive society of happy individuals can more readily defend itself. In effect, one could drive all the activity

justified by the entire General Welfare clause through the tunnel created by the national defense mission. This might be an improvement as compared to the present situation, in which promoting the general welfare is explicitly identified as a purpose of government, but it is not at all where a classical liberal argument would be expected to lead.

Returning to research, in the discussion above our effort to find a simple principle that sets the limits of legitimacy has failed. There appears to be no inherent limit to the range of scientific research that the government could legitimately support beyond those that apply to all government action. Having failed to find such simple rules, we must seek wisdom. More formally, we should try to identify the contextual limits to government support of scientific research that are required by the practice of good government. This is a much harder task, and we will not come close to completing it. In particular, much of the necessary analysis in political science probably has yet to be undertaken. We can, however, make some progress.

THE PRINCIPLES OF WISDOM

Our goal here is to identify principles that provide a guide to wise government action. These will not be the sort of nearly inviolable principles that state the fundamental purposes and limitations of governmental actions but rather will be "rules of thumb," identifying the best course in the absence of compelling reasons to do otherwise. Technically, such principles can be described as *ceteris paribus* principles, which are principles that apply with "other things constant," and thus are subject to context. Though they are not absolute, these principles are tremendously important. Failing to adhere to them opens the door to many kinds of corruption and to the growth

of vast, unmanageable bureaucracies that are very hard to kill. The consequences can be much greater than those involved in correcting a modest error regarding the proper limits of government action. Here is the list of principles that we will discuss and apply below.

1. Minimize government action.
2. Avoid governmental competition with private efforts.
3. Avoid sinecures.
4. Privatize as much as possible.
5. Avoid political control in awarding government funds.
6. Avoid political influence on research outcomes.
7. Specify only deliverables; avoid government involvement in process.

I make no claim that this list is complete, and some important principles may not be included. Indeed, my own view is that there is a severe need for thorough, scholarly work in classical-liberal political science. While there is substantial agreement regarding the fundamental natural rights, and that "to secure these rights, governments are instituted among men," there is a staggering absence of fundamental work regarding how government really ought to function. All we can do here is to briefly elucidate the significance of the principles listed above.

Minimize government action. This principle reflects the fact that it should be the actions of the citizens and not of government that secure the general welfare. Government has a fundamentally defensive and reactive role. It is quite clear, historically, that attempts by government to undertake organized human activities, from subways to social work, tend to produce politically driven, inefficient bureaucracies. The fact that

only political action, and not profitability, can restrain such efforts allows many such organizations to continue indefinitely, consuming resources far in excess of any value they produce.

Avoid governmental competition with private efforts. This principle reflects the fact that the government exists to protect private action, not to supplant it. If the government sells some product or service to the public, from research to rocket launches to lunch, this interferes with the potential for a private individual or group to form a business that provides that same product or service. In this regard, the government can act improperly in several ways. These include (a) production by the government of a needed item that is already being produced privately, (b) entering into direct competition with an existing business, and (c) selling something at below cost, since this practically precludes the development of private alternatives.

Avoid sinecures. The principle reflects the fact that the government can, but should not, create inherently unproductive circumstances. The government can place an individual or an organization in a position that is so secure that there is no motivation for productivity or efficiency. Some organizations staffed by civil service employees are of this type, since such employees effectively cannot be laid off. In science, there are several motivations beyond tomorrow's paycheck that provide an incentive toward productivity, including the competition for supplemental funding for research projects. Nonetheless, providing indefinite funding for a research program conducted by government employees within a government laboratory is a recipe for lack of focus and low productivity, because lack of focus and inefficiency will have no adverse consequences.

Privatize as much as possible. This principle could be viewed as a consequence of the first three. It reflects the fact that any activity done in a competitive market tends to be more efficient,

and vastly more innovative, than it would be if done by government. As we said above, recognition of this has led to the wave of privatization that has been sweeping the world during the past two decades.

Avoid political control in awarding government funds. This principle reflects the fact that one must work to prevent political incentives from taking precedence over the accomplishment of valid ends of the government. While political action is inherent in deciding which type of research to support and how much, just as it is inherent in deciding when to build a new courthouse, it is important in all such cases to award government funds using objective standards whose purpose is to obtain quality results. The classic examples of unwise action involve Congressmen who seek big federal construction projects for their districts. In recent years, however, scientific and academic pork have become common.[7] Each year, Congress earmarks an increasing fraction of the federal scientific budget for specific institutions. This practice, discussed further below, is most definitely not wise. The opponents of earmarking typically call for the use of peer review, which has been the traditional method. Peer review is often the best approach but has limitations, although we will not examine this issue here. A more general statement of wise policy is the following: in awarding government funds, use competitive methods with review mechanisms that employ objective evaluation processes.

Avoid political influence on research outcomes. This principle reflects the fact that the only worthwhile research outcomes are objective, but that governmental officials very often have political reasons to desire specific results. Vice President

7. James D. Savage, *Funding Science in America* (Cambridge: Cambridge University Press, 1999).

Gore very much desired anthropogenic global warming to be a certain, looming catastrophe while President Bush would prefer that it be small or absent. This principle complements the previous one. It is necessary, but not sufficient, to keep politics out of funding decisions. Beyond this, it is essential to the integrity of the scientific process that researchers do not feel that their conclusions will impact their future viability. Regulatory agencies routinely violate this principle—as we will discuss at length later.

Specify only deliverables; avoid government involvement in process. This principle reflects the fact that government should treat those it supports as independent contractors, not as government agents. The public has a right to know a great deal about its government agents, so there is merit in close monitoring of government agents by both the government itself and the press. The result is the emergence of a bureaucracy to monitor and regulate the actions of government agents. However, suppliers of goods or services, including research, are properly treated as independent trading partners in an open market. If they are treated instead as government agents, then the result will be (and has been) large bureaucracies that stifle their efforts at substantial cost to the taxpayers.

This completes our identification and survey of the principles of wise government that are relevant to government support of research. Each of them, and doubtless others, could be the subject of a chapter-length or book-length exposition. I hope that someone will undertake this and look forward to seeing the results.

At this point we have set the stage for a more specific discussion and will begin with a discussion of basic research and university research (these are closely coupled). This will return us to discussion of the Cold War expansion in the 1960s, in the following section. Uunfortunately, we will have to ignore

funding for health research, although this is an interesting issue. The degree to which government action is appropriate, in response to disease, deserves a serious analysis. On the one hand, the bubonic plague killed a large fraction of the population of Europe[8] and the potential for a similar disaster certainly exists today. This would seem to justify some level of government activity. On the other hand, the common cold seems pretty clearly beyond the classical liberal province of government. Beyond this, there are complications in this topic related to government support and government regulation of the health industry. Overall, health research and related issues is too large a can of worms for us to open here. We will leave this to others.

HISTORICAL BASIC AND UNIVERSITY RESEARCH

In the area of basic and university research, two developments prior to World War II are worth examining. The first is government funding of research during this period.[9] Before the war, the primary justifications for government-funded research in the United States were defense and commerce, although health was also significant. From our classical-liberal perspective, we approve of defense as a motivation but not of

8. Norman F. Cantor, *In the Wake of the Plague: The Black Death and the World it Made* (New York: Free Press, 2001).

9. Daniel J. Kevles, *The Physicists* (Cambridge, Mass.: Harvard University Press, 1987); James D. Savage, *Funding Science in America* (Cambridge: Cambridge University Press, 1999); A. Hunter Dupree, *Science in the Federal Government* (Baltimore: Johns Hopkins University Press, 1986); Bruce L. R. Smith, *American Science Policy Since World War II* (Washington D.C.: Brookings Institution, 1990); Harold Orlans, ed., *Science Policy and the University* (Washington, D.C.: Brookings Institution, 1968).

commerce, viewing this as outside the proper role of government. However, the methods of accomplishing funded research during this period were distinctly unwise. There was little and reluctant funding of research by nongovernment employees. By World War II, organizations such as the Weather Service, the Geological Survey, and the National Bureau of Standards had long histories. It would have been wiser to privatize these efforts in ways that were consistent with our other principles.

Beyond the direct federal effort, much of the other funding that did exist was institutional in nature. The Hatch Act of 1887 and the Smith-Lever Act of 1914 established agricultural research and agricultural extension services that involved long-term support of politically distributed institutions.[10] If you have reminisced with farmers who were active in the mid-twentieth century, you probably know that the extension services did a lot of good work. However, from a classical-liberal perspective these efforts were wrong in two respects. First, they were undertaken to support the general welfare, rather than for a purpose connected with the rights of the citizens. Second, the way they were supported was unwise. It prevented the development of private alternatives and the innovations that would have resulted.

Meanwhile, certain U.S. universities were inadvertently preparing themselves to play a much larger role in research for the nation. "On the eve of World War II, the unplanned evolution of higher education in the United States had produced a loose, sprawling, largely unregulated system that was decentralized, pluralistic, competitive, and vast."[11] This was a direct

10. James D. Savage, *Funding Science in America* (Cambridge: Cambridge University Press, 1999), 33.

11. Hugh Davis Graham and Nancy Diamond, *The Rise of American Research Universities* (Baltimore: Johns Hopkins University Press, 1997), 24.

result of decentralized market competition. Private institutions had always played a major role, and the institutions that were publicly funded by the states competed with the private institutions and one another. This remains true today. This market in higher education differed sharply from the centralized and nationally controlled system in place in Europe, where the fraction of students advancing to the universities was three times smaller at the outbreak of World War II.

Two consequences were important. First, the best U.S. institutions (about three dozen out of more than 600) resulting from this brisk competition were extremely capable. These institutions became the research-oriented graduate schools, and there was a need for them. "The sheer size of American higher education created huge communities of scientists in every discipline and field. Although much of the instruction given at American colleges and universities took place at less than an advanced level, teaching itself created secure professional employment for thousands of scientists and scholars; and training these cadres gave work of a higher order to the graduate schools."[12]

With the advent World War II, the government needed far more research than its captive scientists could provide. The federal government was forced to rely upon project grants to support the research it needed. Christian Arnold[13] reports: "At the beginning of our involvement in the war, our military technology and machinery were almost hopelessly inadequate and obsolete. Therefore the military agencies did what they had to do—they bought the information, engineering, and 'hardware' they needed by negotiating contracts with organi-

12. Roger L. Geiger, "Organized Research Units—Their Role in the Development of University Research," *Journal of Higher Education* 61 (1990): 2.

13. Christian K. Arnold, in *Science Policy and the University*, ed. Harold Orlans (Washington D.C.: Brookings Institution, 1968), 89–90, 91.

zations and individuals that seemed likely to do the best job for them." Our response is that this was wise, and was the approach that should have been used previously. Although the top universities had the intellectual resources to undertake the needed research, in the university arena this approach led to political problems after the war. The most competent institutions won the lion's share of the work, and these institutions were concentrated in only a few states.

After World War II, the relation of government to research did not return to the prewar condition. Graham and Diamond summarize the change in perspective as follows.[14] "World War II convinced American society . . . that . . . the link between research universities and the nation's economic strength and national security was too vital for the national government to leave unattended." From a classical-liberal perspective, one would challenge this assertion with regard to the nation's economic strength, which is typically hurt by federal efforts to improve it, but one would agree that national security is the responsibility of the national government. World War II provided very clear evidence that research plays a key role in national security and in the ability to win wars. Those who analyze such matters believe that "any power that lags significantly in military technology, no matter how large its military budget or how efficiently it allocates resources, is likely to be at the mercy of a more progressive enemy."[15] The experience of the Gulf War provides recent evidence in support of this statement from 1960.

There ensued a five-year battle over the method by which

14. Hugh Davis Graham and Nancy Diamond, *The Rise of American Research Universities* (Baltimore: Johns Hopkins University Press, 1997), 25.

15. Charles J. Hitch and Roland N. McKeon, *The Economics of Defense in the Nuclear Age* (Santa Monica, Calif.: RAND, 1960), 243.

the federal government should support research.[16] One group, led by Senator Kilgore from West Virginia, favored a geographically distributed approach modeled on the agricultural extension service. They were opposed by another group, led by Vannevar Bush, who was the director of the Office of Scientific Research and Development both during and after the war. Through his wartime experience, Bush[17] "grew leery of what might happen to the independence of university research if, after the war, government directly managed the conduct of academic science." He advocated the competitive distribution of research funds by individual contracts and grants. After five years, Bush and his colleagues finally won this battle, and President Truman signed legislation creating the National Science Foundation.

Equally important, though, was what happened in the interim. Several other federal agencies had filled the policy void by beginning to support research that they needed, seeking to meet their needs from the (academic and other) research marketplace, and not by means of geographic or institutional formulae. This continued through the 1960s, so that "what emerged from the 1950s and 1960s is a relatively decentralized federal science establishment, although one dominated by national security interests, in which academic research support comes in the form of project grants awarded to individual university researchers."[18] We can see here that during this period, and from the point of view of the wise conduct of government, the good guys won. Using private resources and

16. James D. Savage, *Funding Science in America* (Cambridge: Cambridge University Press, 1999), 334–35; Hugh Davis Graham and Nancy Diamond, *The Rise of American Research Universities* (Baltimore: Johns Hopkins University Press, 1997), 28–30.

17. Ibid., 35.

18. Ibid., 36.

methods that minimized political influence was a wise way to support the research that the nation chose to undertake.

THE COLD WAR AND BEYOND

This returns us to the beginning of the Cold War and to the massive expansion of federal support for scientific research during the 1960s. This expansion has been characterized as part of the general expansion of proactive government involvement in society during this period. I believe, however, that this viewpoint is incorrect. This immense expansion, with the associated increase in facilities and in number of students, was driven in large measure by the perceived need for the United States to be strong and capable in the face of the Soviet threat. This need went far beyond the need to develop specific weapons or related technologies; it reflected the need to be ready to respond to any discovery that mattered for defense, in any area of human endeavor. Research progress in psychology was potentially as important as research in explosive chemistry. In a real sense the United States was at war, and the battleground was war-related technical capability. The Soviets understood this and spoke of it. Soviet Chairman Leonid Brezhnev pointed out in the late 1970s that the "center of gravity in the competition between the two systems [U.S. and U.S.S.R.] is now to be found precisely in [the field of science and technology]."[19] Of course, such research also can be (and was) justified for the sake of the general welfare. But this was a case where the general welfare and the needs of national defense walked hand

19. Quoted in Amos A. Jordan, William J. Taylor, and Michael J. Mazarr, *American National Security* (Baltimore: Johns Hopkins University Press, 1998), 321.

in hand. It is not surprising, in this light, that the U.S. Congress found it easy to support these efforts.

Politicians will give every reason that has a constituency as grounds for their actions, but one can sometimes find the compelling reasons by seeing which events lead to changes in their actions. It is very informative to trace the parallel evolution of national security concerns[20] and of university research.[21] During the 1950s and 1960s the Soviet threat was viewed as severe and immediate. In weapons (such as hydrogen bombs) and technology (Sputnik) they appeared to be even with or ahead of the United States. It is no coincidence that the 1960s are described as the Golden Decade for university research. By the late 1960s to early 1970s, there was a consensus among U.S. security experts that the Soviet threat had been exaggerated. The congressional response with regard to university research in the 1970s caused it to be called the Stagnant Decade. The United States de-emphasized defense in many ways during this decade, while the Soviet Union used this period to accomplish a massive buildup of its military establishment. "By the early 1980s, the enormous momentum of the Soviet buildup yielded some clear elements of Soviet superiority."[22] Again the U.S. responded, with the "Reagan buildup" of the 1980s, including the Strategic Defense Initiative. It should not be a surprise that the 1980s are characterized as a second golden age for university research.

Our focus in the above discussion has been on the United

20. Ibid., chap. 16.

21. Hugh Davis Graham and Nancy Diamond, *The Rise of American Research Universities* (Baltimore: Johns Hopkins University Press, 1997).

22. Amos A. Jordan, William J. Taylor, and Michael J. Mazarr, *American National Security* (Baltimore: Johns Hopkins University Press, 1998), 345.

States. At least one analyst of worldwide research funding (Terence Kealey) believes[23] that "governments fund education, science, universities, and technology for military, not humanitarian, reasons." He and I might differ, however, over the legitimacy of this. My view is that in many cases research funding by the U.S. government, and likely by other Western governments, has been justified and reasonable for defense reasons. Even so, much of this support has been carried out unwisely, and the needs of defense are smaller now than they were through the end of the Cold War.[24]

In the United States, things changed in the early 1990s. After the collapse of the Berlin wall and the fall of the Soviet Union, broad congressional support for university research collapsed. There was a period of substantial confusion and large fluctuations as Congress wrestled with the question of whether the "peace dividend" should include a large reduction in federal support for such research. Since that time, congressional support for science has been much less certain and far more contentious. As an active scientist, I have seen an enormous increase in the level of lobbying activity by scientific organizations and in appeals to me to contact Congress in support of some objective. Science, once coddled as essential to the national defense, has become just another interest group.

23. Terence Kealy, *The Economic Laws of Scientific Research* (New York: St. Martin's Press, 1996), 118.

24. Kealy also argues, with statistical supporting evidence, that government funding of research disproportionately displaces private research funding, leading to a net decrease in research progress. Even if he were correct in this, though, there are times when the real needs of defense would be worth the cost. However, I am skeptical of his conclusion for two reasons. First, like many scientists I am skeptical of studies that turn out to support a conclusion which the author knows in advance. Second, Kealey's analysis does not allow for whether the research is funded and managed wisely. In my view this will make a difference.

Meanwhile, Congress, perceiving various kinds of value in scientific efforts, is evolving toward a system of support in which the general welfare is a much larger motivation. Simultaneously science is increasingly part of federal "pork." Earmarking of academic and other research funds so that they go to specific institutions in specific congressional districts is steadily on the increase. Such funds have increased from $17 million in 1980 to $328 million in 1996.[25] This is not surprising. As it becomes less urgent to make research progress for the sake of defense, science funding becomes more like any other goody that Congress hands out. The classical liberal assessment of this is rather negative. Science funding is becoming less legitimate as its connection with the national defense weakens, and less wise, as earmarking becomes more significant. In this context there are many examples of programs with a plausible defense justification during the Cold War for which such a justification is much harder to support now. The Internet is an excellent example. In the early 1960s, long before Al Gore "invented" the Internet, the agency then known as ARPA (the Advanced Research Projects Agency, which later added Defense to become DARPA) focused on the problem of improving the military use of computer technology.[26] Defense laboratories and the military had a serious, unmet need for what would now be known as broadband communication. At that time, there were no commercial enterprises devoted to broadband communication. The leader of this ARPA program, Dr. J.C.R. Licklider, decided that this need could most effectively be met by work within the universities. He supported the foundation of the ARPANET, which initially connected a

25. James D. Savage, *Funding Science in America* (Cambridge: Cambridge University Press, 1999), 3.

26. This history is described at *www.netvalley.com/intval.html.*

number of universities. The great breakthrough came when researchers using a computer at UCLA tried to log in to a computer at Stanford. The system crashed after two letters were transferred, but nonetheless "a revolution had begun."[27] We can be pleased that this work laid the foundations for today's Internet, which is of great benefit and commercial importance despite the recent (as of 2001) dot.com madness. Nonetheless, at the time, it made sense for the federal government to support this work.

Today there is a follow-on project, the Internet-II, through which a number of universities are receiving support to create a next-generation Internet. One probably could justify such a project for defense reasons because everybody needs more bandwidth, including the military. But today there is a vast, commercially driven, telecommunications industry. This industry is also starving for bandwidth. I do not see why, from a classical-liberal perspective, there remains a strong justification for further federal funding of Internet development.

The space program provides another example, but with a different, more nuanced outcome. In my view, there is no question that the early space program was fully justified by defense needs. The conquest of space and development of the ability to put weapons and humans in space was essential in response to Soviet activities. Even now, there are still defense-related reasons for some space activity by the government. For example, flying and improving spy satellites remains important. In addition, as mentioned above, sustaining some astrophysics research contributes to the manpower-training and basic science needs of nuclear defense activities. However, the United States and NASA have violated our principles of wisdom in several respects. As one example, NASA should have

27. *Sacramento Bee*, May 1, 1996, D1.

encouraged the development of a private launch industry, in appropriate ways, instead of developing the space shuttle.

The reader should not conclude, however, that Congress adopted a strict, classical-liberal approach to research funding throughout the Cold War, and that this has now changed. Congress has always supported the General Welfare clause (and most definitely its local welfare corollary). Support for research in agriculture, for example, has endured since the nineteenth century.

Before leaving this subject, we should discuss the funding of research in settings other than universities, such as private laboratories. From the standpoint of validity and of wisdom, there is no general reason to prefer one over the other. In practice, much of research funding (and nearly all funding of basic research) has been supported primarily for the purpose of training students. Basic research only produces results of immediate and substantial value unpredictably and sporadically, but it produces trained scientists with high reliability when it is done in a university. This is a legitimate motivation for using universities for basic research. However, whenever this motivation is not important, it would be perfectly reasonable to support such research within other organizations.

LABORATORIES FOR LARGE-SCALE RESEARCH

We have discussed research funded in universities, and similar research funded in private laboratory environments. In addition there is a category of research projects for which universities are ill-suited. These are projects that are of a substantial size (involving more than about ten people) or are strongly interdisciplinary (involving in an essential way more than three or four scientific disciplines). They are our subject here, be-

cause a need for them can arise in many areas of research, and because the United States has handled them quite poorly. Such projects are very difficult to accomplish in a university environment and are not very appropriate for universities, as they require tight management and a programmatic focus inconsistent with the educational context of a university. It might make sense for a university to set up a laboratory that can accomplish such projects, especially if the projects tie in to the scientific and educational purposes of the university—in fact, I now run such a laboratory. But such situations are exceptional, and the need for large-scale, interdisciplinary research projects is not.

The need for such projects led to the emergence of numerous large research laboratories during the 1950s and 1960s. The motivation for their research was the same as that for research in universities, so our above conclusions apply to the legitimacy of their research. Unfortunately, the advent and growth of these laboratories was not handled wisely. Most of them are of two types, both of which are very strongly controlled by the federal government. Some, notably including most of the NASA centers and the military laboratories (some of which are much older) are federal laboratories. In these labs, all of the property is government property and all of the employees are Civil Service employees. Other laboratories, including NASA's Jet Propulsion Laboratory (JPL) and all of the Department of Energy (DOE) labs such as Lawrence Livermore, are Federally Funded Research and Development Centers (FFRDCs). In FFRDCs, nearly all of the funding is federal, but some other organization hires the employees and manages the laboratory under a contract with the federal government. The University of California, for example, manages Livermore while Cal Tech manages JPL. The managing organization is not always a university; for example, the Sandia Laboratories are managed by Lockheed Martin. A few private research

centers are large enough to qualify as laboratories in this sense, including SouthWest Research Institute (which builds space hardware and conducts space missions), but these are the exception.

Both the federal laboratories and the FFRDCs embody the worst features of a bureaucratic environment. Specifically, as there are no constraints related to profit, the only fundamental motivation of any individual involved in monitoring these laboratories, or in performing support functions within them, is to avoid adverse publicity. The most secure way to accomplish this is to *do nothing* and *prevent the scientists from doing anything*. Bureaucrats and rules proliferate without limit in such an environment. As I know from personal experience and from many discussions with employees of these institutions, the scientists working there end up facing a terrible choice. On the one hand, they can try to follow the rules. They won't succeed, but they absolutely will not accomplish anything. On the other hand, they can try to do meaningful work for the country. This requires that they routinely break the bureaucratic rules. In such an environment, it becomes very difficult to retain good judgment regarding which rules matter. In my own view, both the Wen Ho Lee incident and the missing tapes incident at Los Alamos in the late 1990s were consequences of this fundamental problem.

One specific example of bureaucratic irrationality was provided when a colleague of mine was responsible for shipping some hazardous waste from the Livermore Lab to a safe disposal site. He had three choices. He could follow DOE rules in doing so, which would require violating both federal and state laws. Or he could follow federal law, which would require violating state law and DOE rules. Or he could follow state law, which would require violating federal law and DOE

rules. His situation was in addition a "Catch-22." Doing nothing would have violated the laws and rules as well.

My interactions with a few Russians illustrated more generally just how irrational the environment within such laboratories has become. During the early 1990s there was a substantial migration of Russian scientists to the United States. Some of them became affiliated with the Livermore Lab, as was I at the time. These individuals, experienced with the Soviet state, often had a great deal of difficulty understanding American culture and society. In contrast, they found it very easy to understand the workings of the DOE labs. It is truly ironic that we developed a Soviet-style environment in our attempt to counter the Soviet nuclear threat.

A more chilling example of the adverse consequences of direct federal control was provided during the Clinton administration. Vice President Gore would ask leading climate scientists, such as James Hansen and Tom Wigley, to share the stage with him while he made ludicrous statements about global warming. What the press did not report, however, was that these scientists held leadership positions in federally controlled laboratories. They had no choice but to attend this event. When the boss (or the vice boss) calls, one must go. This is the one thing I have seen, in more than twenty years of involvement with federally funded science, that reminded me of the State Science Institute as it was portrayed in *Atlas Shrugged*.

It should be clear that the development of federally controlled research laboratories was extremely unwise. It violates numbers 1 through 4 and 7 of our principles of wisdom, and sometimes also 5 and 6. Any large-scale research that is legitimately required by the nation should be undertaken by private laboratories, which should work under competitively awarded contracts, requiring no more than that they accomplish the

research and obey the relevant laws while doing so. In my opinion, the federally controlled laboratories should be phased out and their assets should be sold.

RESEARCH, REGULATION, AND THE UNKNOWN

Our discussion so far has focused principally upon research whose purpose is national defense. Much of what we have said, however, would apply equally well to research conducted for other purposes. For example, police agencies might choose to support research aimed at computerizing fingerprint detection or research aimed at developing psychological profiles of terrorists. These would be legitimate, as they both support the valid purposes of government, and both could be done wisely. Beyond these defense and police functions, government might need to support research for other reasons related to the other valid purposes of government discussed above in the second section. It is unfortunate that we do not have space to explore this as a general subject here, because the specific subject of regulation is of great practical importance.

It is unclear to me whether regulation is a necessary component of a classical-liberal government. Many classical liberals advocate the use of the courts to deal with all circumstances in which citizens can harm one another. Some would allow statutory law to play a role as well. However, what is now known as the environment is in many respects a natural commons. Problems such as air pollution, ocean pollution, and harmful-insect propagation do harm citizens and their property but do not obviously lend themselves to strict judicial solutions. Much work in political science is needed here. It is very unclear in what sense and to what extent a citizen has a right to clean air or a right to the present climate. It is even

more uncertain whether and to what extent regulation will be needed to secure these rights.

It is very clear, however, that governments will be using regulatory mechanisms for the foreseeable future. Because of this, work is also needed on how regulation can be done wisely. Libertarian think tanks are doing some of this today, for specific applications. We can hope that someone is undertaking (or soon will) a more general analysis of how to regulate wisely, which is outside our scope here. A related and interesting question is whether the government ever should engage in regulation of some activity when research about its effects has not yet produced certain results. The answer here might be yes, if the plausible or probable consequences are large enough. In any event, governments today routinely implement regulations under such uncertain circumstances. As a result, the implications of this situation for research deserve our attention.

In considering the interplay of research and regulation, it is crucial to note that the mindset and the incentives for these two activities are completely different. The mindset of the researcher is to discover how reality works. This includes the need to identify and focus on areas of uncertainty, and to continually question what seems to be well known. The mindset of the regulator is to devise a practical means of restricting human action, to achieve some simply stated goal. The goal often reflects scientific work, but cannot respect scientific uncertainty. For example, the decision to regulate often requires that an acceptable concentration or rate of emission of some pollutant must be established. For two reasons, the established limit very often will be based on uncertain science. First, the question, "how small is small enough?" is often difficult for science to answer. Second, the political process produces a drive to act NOW, in response to whatever threat is perceived. The incentive for the regulator is to specify some standard and

to implement a regulation. Politically, it matters much less whether the regulation is soundly based.

There are two implications for research. First, research will very often be needed and important *after* a regulation is enacted. The continued development of scientific knowledge will often show that the decisions made when enacting the regulation should be revisited. The science will sometimes show that the regulation is very wrong. Yet there has been a clear trend for government agencies to cease supporting research as soon as a regulation is in place. The Department of Transportation stopped its support of stratospheric ozone research as soon as regulations were in place regarding chlorofluorocarbons. The interagency acid rain program was terminated as soon as emission controls, intended as a response to acid rain, were in place. After the EPA proposed regulating hydrocarbons to control ground-based ozone, research at Georgia Tech showed that this is often impossible. The conclusion to draw here is that *regulation requires research*. The government should assure that there is continued development of the science in any area in which it chooses to regulate. This may mean that the government should fund such research, if it will not be accomplished by other means. It should do so in order to assure that the regulation is achieving its stated goal of protecting the citizens in some way and to assure that the freedom of action of the citizens is not being restricted unnecessarily.

Second, the incentive of the regulator is to oppose such further research. It makes the regulator look bad when the regulation needs to be changed. Dealing with such issues also distracts the regulator from the process of developing other needed regulations. An example from California illustrates the incompatibility of regulation and research. California gave the problems of both regulating air pollution and supporting research to its California Air Resources Board. The board estab-

lished an advisory committee of scientists to advise it on research directions, and then proceeded to blatantly ignore the advice of the committee. The committee felt that its advice was not taken seriously, and disbanded in protest.

One can conclude from the above that *one must separate research and regulation.* Only this can provide a system of checks and balances that will dampen the tendency to regulate excessively and unreasonably. If one establishes a regulatory agency, one should also establish independent research within some other agency. The task of the independent research agency should be to advance the science related to the regulations without regard for the political consequences. (This will be politically practical only if the research agency supports research by others, through grants and contracts, but does no research itself.) The United States combines research and regulation in several cases, notably including the Environmental Protection Agency and the Food and Drug Administration. Based on the above discussion, this is a colossal mistake directly responsible for many of the bad regulator decisions that one hears about from these agencies. One does not hear about many other cases, in which further research, never undertaken, would have shown that some regulation ought to be amended or scrapped.

CONCLUSIONS

We have seen that the General Welfare clause in the U.S. Constitution is the underlying principle that justifies government support of research today. Some of this research is done wisely; some of it is not. However, once we reject the General Welfare clause, and seek a government based on the defense of individual rights, we still find that the government should support research. Unfortunately, it does not prove trivial to place limits

on which research should be supported, and we end with the problem of needing to proceed wisely in the face of complex trade-offs. A historical review suggests that much of the research supported during the twentieth century was appropriate for defense reasons, although only some of the methods of support were wise. In particular, both federal labs with Civil Service employees and Federally Funded Research and Development Centers ought to be phased out and replaced by private alternatives. We have also seen that regulation and research are conflicting missions. In consequence, a government that would regulate wisely must separate regulation and research.[28]

28. The author acknowledges useful discussions with David Kelley, Joyce Penner, Patrick Stephens, and Roger Donway.