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Memorandum

To: John Cordes, Jesse Funches, Trip Rothchild, Leo Slaggie, and NRC Staff
From: Stephen J.K. Walters, Ph.D.
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Date: January 4, 1994
Re: Restoration of the Generic Exemption from Annual Fees for Nonprofit Educational Institutions

Since our initial meeting of Dec. 12, 1993, I have (a) carefully reviewed selected comments on the proposed exemption for nonprofit educational institutions, (b) read the medical petition to conduct a rulemaking, and (c) conducted a literature survey related to the issues of "positive externalities" and "public goods."

Based on this endeavor and on prior research and analysis, I would make the following observations:

(1) The Commission's proposal to reinstate the annual fee exemption for nonprofit educational institutions is, from the standpoint of economic analysis, fundamentally sound.

(2) The Commission's stated rationale for this exemption--the existence of "external benefits" resulting from use of university research reactors--is, however, somewhat vague, and needs to be specified in greater detail.

(3) What has been missing, thus far, in the discussion of reasons why an exemption might be socially desirable is an understanding of the concept of the "public goods" which research and educational facilities provide. Market provision of these peculiar but important goods is problematic in some cases, and it is for this reason that unique consideration is due educational institutions.

In this memorandum, I will discuss each of these points in more depth and provide references to literature where interested readers may find more detailed information. I hope I am not *too* long-winded, but my hope is to provide you with a resource you will find useful in drafting a final rule.

The "External Benefits" of Education and Research

Those who invest in education derive tangible private benefits: by acquiring knowledge or training, they make themselves more valuable to employers, and capture this value in the form of higher wages. In fact, this *knowledge-based earnings premium* has been growing lately: in the mid-'70s, the median income of college graduates exceeded that of high school graduates by about 35%, while by the late '80s this premium exceeded 70%.[1]

[1]See: Erica L. Groshen and Colin Drozdowski, "The Recent Rise in the Value of Education: Market Forces at Work," *Economic Commentary*, Federal Reserve Bank of

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It is widely--though by no means universally--held in the economics literature, however, that investing in education also yields certain "social" or "external" benefits.[1] These are benefits which are not wholly captured by the individual acquiring more education, but which flow to society at large or to bystanders (i.e., those "external" to the act of investing in education).

For example, education at all levels is thought to strengthen the social fabric by fostering notions of mutual respect and cooperation among individuals, and to persuade citizens to observe certain practices necessary to preserve public health and safety. Investment in *higher* education is thought to involve one particularly important external benefit: the generation of new ideas, or technological advance. In this view, education is an input to research and development; an externality arises because inventors sometimes will be unable to capture all the benefits of their innovative activity. In particular, some intellectual achievements (e.g., mathematical theorems, which are an important input into engineering) cannot be patented or otherwise protected from "copycats"; these imitators could then appropriate some or all of the benefits flowing from the inventions.

Comments on the NRC's proposed exemption contained ample and satisfactory evidence that nuclear facilities and materials are an important element in educational programs that generate such external benefits. Just about all the commenting institutions documented that they not only train significant numbers of enrolled students in the proper handling of nuclear materials; many also offer seminars, study tours, and other informational programs aimed at introducing a wider public to the principles of nuclear safety. More important, all the commenters stressed that the training these facilities make possible is indeed a crucial input to the production of new technologies in a variety of fields, from archaeology to medicine to physics.

The problem here (which economists tend to refer to as "the externality problem") is this: Since consumers tend to weigh only the *private* costs and benefits of purchasing more education, and fail to consider the external benefits, they will tend to under-consume this good. E.g., Suppose I could buy one more year of education at a cost of $10,000. Suppose further that this would raise my lifetime earnings stream by $9,900 and generate external benefits of $1,000 (in the form of extra public health or safety enjoyed by others), for total social benefits of $10,900. On net, society would be $900 better off if I bought the extra year of education, but I would be $100 poorer, and will decline to buy. This provides a rationale for public subsidies aimed at

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Cleveland, August 15, 1992.

[1]For a critical survey on this point, see: Jack High, "State Education: Have Economists Made a Case?" *Cato Journal*, v. 5, no. 1 (Spring/Summer 1985), pp. 305-23; more generally, see Burton Weisbrod, *External Benefits of Public Education*, Princeton: Princeton University Press (1964).

increasing the amount of education which will be produced and consumed. In this example, a voucher or scholarship for $100 or more (up to $1,000) would make the investment in education worthwhile both personally and socially.

There is, frankly, scant evidence on the magnitude of the externality problem in education. Discussion of the matter tends to be superficial; most treatments simply point out that public subsidy of education has tended to increase supply.[3] No one, to my knowledge, has precisely quantified the extent to which individuals acting without subsidy in ordinary markets will under-produce and -consume education, especially higher education.[4] Several researchers, however, have presented convincing evidence that countries which invest more in education (or, in the jargon, invest more in "human capital formation") enjoy significantly higher rates of economic growth.[5]

Of course, it is possible to argue that quantification of the externality problem in education is unimportant; the problem appears to be so widely acknowledged that subsidies for education, including higher education, are the rule rather than the exception. For example, the comments on the NRC's proposed rules included information that (in-state) students at the University of Virginia pay only one-half the true cost of their education; at Cornell, students pay a mere 29% of this cost. What is more, staff and equipment costs usually are far higher in, say, nuclear engineering programs than in English literature; if tuitions are uniform across programs, then, the nuclear engineering student receives a far greater subsidy than the English lit student. But the existence of such subsidies makes the absence of quantification more, not less, troubling. It certainly seems reasonable to ask: Is not the present level of subsidy adequate to overcome the problem of under-consumption? Are additional subsidies from the NRC truly necessary for this purpose?

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[3]See the volume by Weisbrod, cited earlier, and also: Elchanan Cohn, *The Economics of Education*, Cambridge: Ballinger (1979); Walter Garms, *et al.*, *The Economics and Politics of Public Education*, Englewood Cliffs, NJ: Prentice-Hall (1978).

[4]And some researchers argue that the externality problem is not quantitatively significant in education; see, e.g., Jack High and Jerome Ellig, "The Private Supply of Education: Some Historical Evidence," in Tyler Cowen, ed., *The Theory of Market Failure*, Fairfax, VA: George Mason University Press (1988).

[5]See: Costas Azariadis and Allen Drazen, "Threshold Externalities in Economic Development," *Quarterly Journal of Economics*, v. 105, no. 2 (May 1990), pp. 501-26; Robert J. Barro, "Economic Growth in a Cross Section of Countries," *Quarterly Journal of Economics*, v. 106, no. 2 (May 1991), pp. 407-43; Robert E. Lucas, Jr., "On the Mechanics of Economic Development," *Journal of Monetary Economics*, v. 22, no. 1 (July 1988), pp. 3-42; Paul M. Romer, "Increasing Returns and Long Run Growth," *Journal of Political Economy*, v. 94, no. 5 (October 1986), pp. 1002-37.

Given the present level of empirical research on the matter, it is impossible to answer these questions with assurance. We *suspect* that a generic exemption will get us closer to the "optimum" number of, say, nuclear engineering majors, but we can't prove it. In my view, then, it would be unwise to focus solely on the external benefits resulting from the use of reactors (and other nuclear material) in education when we assess the desirability of granting a fee exemption; if we are to be reasonably sure that such an exemption would enhance welfare, we need "something more." I believe we need to consider the role of such an exemption in assuring the production of adequate amounts of new knowledge, which is an example of a "pure public good."

New Knowledge as a Public Good

Economists use the phrase "public good" to describe a good that has two peculiar properties: nondepletability and nonexcludability. (Sadly, this phrase was not chosen wisely: there are lots of goods that somehow involve the word "public," e.g., public phones, that are *not* public goods.)

A good is nondepletable[6] when my consumption of it leaves no less of it available for you to consume. Most goods, therefore, are not "public" (we refer to them as "private goods"). When, for example, I pour myself a cup of coffee from the office pot, there is less coffee available for you. But when I turn on my radio to "All Things Considered" as I drive home, that does not reduce the amount of that program available to you; the radio signal is a public good. When a good is nondepletable, it is generally undesirable to exclude anyone from consuming it—even if this were technologically feasible.[7] The reason is simple: Given its nondepletability, letting one more consumer enjoy a public good involves no added cost to society; if she values the good at all, then allowing her to consume it will yield a social benefit in excess of cost, i.e., will make society better off.

Economists have long held that it will be difficult or impossible for free, unfettered markets to produce goods possessing these properties—or, at the least, to produce them and

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[6]Sometimes the phrase "nonrival in consumption" is used to describe this characteristic. In addition, you will sometimes see public goods referred to as "social goods" or "collective goods."

[7]Most early writers on the subject tended to say that it was difficult or impossible to exclude individuals who hadn't paid for a public good from consuming it. After several authors pointed out that excludability problems could be solved in many cases, the discussion tended to focus on the idea that such exclusion was undesirable rather than impractical.

distribute them to all comers at a price equal to zero, as is desirable.[4] There are several problems. First and most obvious is the fact that private producers will be unable to recoup the initial costs of creating the public good if they give it away; but if they charge a positive price, some consumers who value the good in excess of its incremental consumption costs (i.e., zero) will be denied it. More subtly, it will be very hard for producers to gauge potential consumers' true demand for a public good: Consumers, aware that it may be infeasible or undesirable to exclude those who have not contributed to the creation of the good from enjoying it *after* it has been produced, may misstate their preference for the good *before* it is created in the hope they can free ride on the payments of those who ante up for the good's production. The result will be an inadequate private supply of public goods.

Many researchers have documented that, despite these concerns, there are many historical examples of privately supplied public goods; other authors have suggested pricing strategies in which private sellers might make the optimum amount of a public good available.[5] Nevertheless, there seems to be a reasonably broad agreement in the economics profession that private provision of public goods is problematic. There is simply no assurance that the requisite conditions (e.g., perfect information, zero costs of transacting or enforcing agreements) exist for optimal private production of public goods. Thus, there is a general consensus that public subsidies are often--though not always--necessary and desirable for the production of such goods.

This consensus is especially strong with respect to public financing of one particularly important public good--pure research aimed at creating new knowledge. It is obvious that a great deal of research (i.e., proprietary research) goes on--and will continue to go on--without governmental subsidy. In areas where intellectual property rights are secure (e.g., because of patents), the creation of new knowledge often pays handsomely, and private entrepreneurs rush to supply this good. But often it is either impossible to secure intellectual property--as in the case of the aforementioned mathematical theorems--or undesirable to do so.

As an example of the latter, consider a research project (described in the comment submitted by the University of Michigan) underway at Wayne State University. There researchers (under the supervision of Dr. J.M. Saxe) are using neutron activation analysis to try

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[4]The classic references here are: Paul A. Samuelson, "The Pure Theory of Public Expenditure," *Review of Economics and Statistics*, v. 36 (November 1954), pp. 387-89; Francis M. Bator, "The Anatomy of Market Failure," *Quarterly Journal of Economics*, v. 72 (August 1958), pp. 351-79.

[5]The classic references here are: Ronald H. Coase, "The Lighthouse in Economics," *Journal of Law & Economics*, v. 17 (October 1974), pp. 357-76; Harold Demsetz, "The Private Production of Public Goods," *Journal of Law & Economics*, v. 13 (October 1970), pp. 293-306. For a review of other papers on these topics, see Cowan, *The Theory of Market Failure* (cited earlier in note 4), pp. 1-26.

to find the most effective of four currently-favored methods of resuscitation following shock. This project is aimed at producing an absolutely pure public good, both nondepletable and nonexcludable. Once the most effective resuscitation method is determined (assuming the project can be concluded successfully), this knowledge *should be given away* to all hospitals or other potential users; to attempt to sell this knowledge--even if this were feasible[10]--would clearly be inefficient. Other hospitals (and their patients!) likely attach significant value to the knowledge, and can consume it at no incremental cost to society. There is no reason to withhold the knowledge from anyone.

The comments on the NRC's proposed rule contain copious similar examples of how nuclear facilities and materials are being used to support the production of pure public goods. These examples span a broad array of disciplines, from nuclear engineering and physics to cancer treatment to art history. In all cases, the commenters stressed that their research facilities are used to support non-proprietary research; i.e., they are not trying to do what entrepreneurs might do, but instead are rushing in where entrepreneurs fear to tread, conducting research in areas where the potential value to consumers is difficult to gauge or where the costs of such research would (perhaps because of property rights problems) be difficult to recoup. Further, the research supported in this way is distributed in precisely the manner required by the theory of public goods, i.e., it is "given away" in the form of articles in scholarly journals, presentations at professional meetings, and as lectures to enrolled undergraduate and graduate students.

This activity, it seems to me, suggests strongly that a generic exemption for educational institutions will enhance welfare. But, naturally, some questions remain:

1. The public good rationale looks an awful lot like the "external benefits" rationale. What's the difference? There's not always a clear difference, even to economists.[11] I would focus on the nonexcludability characteristic of public goods, and point out that while private goods which generate external benefits may be under-produced and -consumed, public goods may not be produced at all--absent some subsidy or other arrangement to ensure that costs are recouped.

2. As already noted, educational institutions already receive significant subsidies. Why must the NRC add its own? The key here is the difficulty of accurately gauging demand, or

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[10]And selling this knowledge would not be feasible: the first person to buy the answer to the question of what is the most effective resuscitation method would pass the word to others, destroying any attempt to exclude non-payers.

[11]For a monograph partly devoted to untangling the differences, see J. Ronnie Davis and Joe R. Hulett, *An Analysis of Market Failure: Externalities, Public Goods, and Mixed Goods*, Gainesville, FL: Univ. of Florida Press (1977).

value. The possibility of free riding means that there may be legions of eager consumers of a particular piece of new knowledge, but none may step forward and offer to pay to get the job done. Therefore, we endow various grants committees with resources, and trust them to allocate these resources wisely, i.e., to make sure that projects with the highest expected value per dollar of cost are funded. But there is no guarantee these committees will not act like free riders. Specifically, it is conceivable that grants committees will view proposals in their area of interest and expertise more favorably than proposals in areas that are relatively "foreign" to them. In short, if the NRC does *not* grant an exemption, there is no assurance that other agencies will step forward and fill the resulting research-funding void in a neutral manner; research requiring nuclear materials or facilities is likely to suffer a *relative* decline.

3. Do all educational institutions produce public goods of the kind described? What criteria should be used for exemption? Not all educational institutions actually produce pure public goods, but all *try* to do so. In this day and age, even the humblest liberal arts college requires its faculty to perform some sort of research. Given the unpredictable nature of the enterprise, not all succeed. But sometimes we need to cast our net widely if we are to catch fish. Accordingly, I would grant an exemption to all educational institutions who claim that some nontrivial fraction of their nuclear facilities or materials are used for non-proprietary research. (Clearly, the public good rationale also suggests that institutions that are not primarily educational, e.g., research entities like the Marine Biological Laboratory in Woods Hole, MA, might qualify for exemption.) The key criterion for determining whether research qualifies as non-proprietary is whether findings are disseminated widely and at a zero price, e.g., at professional meetings, in scholarly journals, or in other public presentations.

Concluding Remarks

I hope you will find the foregoing useful in formulating a final rule. I would make one final point: Expanding the discussion of the external benefits provided by the activities of educational institutions to include their production of public goods not only makes it clearer why an educational exemption is desirable, but makes it easier to distinguish worthy from unworthy appeals for exemption. Consider, for example, the Petition for Rulemaking submitted by the American College of Nuclear Physicians (ACNP). Throughout this petition, ACNP refers to the "unique contributions to society" and "unique social benefits" generated by its members; at one point, ACNP argues that the services of its members "serve at least an equally worthy purpose as is served by the non-profit educational institutions."

Such rhetoric points up the risks of vague, unfocused statements about "external benefits" as the sole rationale for a fee exemption. Since such benefits are often unquantifiable, it is easy for groups to claim they generate such benefits—and, sometimes, impossible to prove that they don't. But it is generally quite clear when someone is producing a public good requiring subsidy. Quite simply, ACNP members are not: they use radioactive materials for diagnostic and therapeutic purposes, i.e., they produce *private* goods. The optimal production of such

goods generally does not require subsidy, and the ACNP members should not qualify for a fee exemption.

Additional References

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