Research Paper Commerce

Climate Change and Public Policy Responses

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ABSTRACT

This paper asserts that a significant increase in public funding for climate change research and development is needed. While additional public R&D funding alone is unlikely to provide a sufficient policy response to climate change, it is critical policy component in an effective long-run strategy. Different possibilities for generating additional public revenues for R&D funding are considered. The analysis demonstrates that quite modest taxes on carbon emissions or gasoline could fund a significant increase in public R&D funding for clean energy. An alternative to tax instruments, the paper considers a program of voluntary retirement contributions to a clean energy fund. These clean energy retirement accounts would allow individuals to directly contribute to a fund used exclusively to support climate change-related R&D.

Specifically, the paper suggests that CERA funds be used to offer low-interest loans to private firms and to form private-public partnerships pursuing the long-term development of clean energy technologies.

KEYWORDS

INTRODUCTION

Global emissions of carbon dioxide, the primary greenhouse gas, have risen about 30 percent since 1990. Projections indicate that in the absence of effective climate change policies global CO2 emissions could increase a further 60 to 70 percent by 2030, with continued growth in emissions beyond that (US Department of Energy, 2006a; International Energy Agency, 2005). It is becoming increasingly clear that the global growth of CO2 emissions needs to be halted and eventually reversed during the 21st century in order to avoid potentially catastrophic effects from global climate change. The recent much-publicized *Stern Review on the Economics of Climate Change* notes that climate stabilization at an atmospheric concentration of 550 parts per million CO2-equivalent would require global emissions to peak in the next ten to twenty years and then fall to 25 percent below current levels by 2050, with further declines thereafter (Stern, 2006). Climate stabilization even at this level could result in significant negative effects including reduced crop yields, increased water shortages, and ecological damages.

Public Policy Responses to Climate Change

Two types of market failure prevent an adequate response to climate change from unregulated private markets (US Congressional Budget Office, 2006). First, the negative externalities associated with carbon emissions are not reflected in market prices. The most common proposal to address this market failure is carbon taxation at a level that reflects the social costs of carbon emissions, or a cap-and-trade system with comparable effects on carbon pricing. The second market failure is an insufficient level of private research and development on clean energy technologies because the benefits of such innovations cannot be fully captured by the innovating firm. This market failure suggests the need to supplement private R&D with public R&D funding for technologies that could potentially promote climate stabilization.

The emphasis of most policy proposals to address climate change is on carbon pricing. Economic models estimating the relative effectiveness of carbon taxation and R&D subsidies suggest that pricing policies alone are much more cost effective than R&D subsidies alone but that overall cost effectiveness is achieved by a combination of both policies (US Congressional Budget Office, 2006). While public R&D funds promote the development of new technologies, in the absence of higher carbon prices there may not exist any incentive to adopt those technologies (Popp, 2004).

Even in the presence of a socially optimal price for carbon, private R&D on clean energy technology will still be undersupplied. One problem is that in the case of climate change the benefits of private investment may accrue outside of the short-term planning horizon of most firms. Thus many technologies that could make a significant contribution to carbon mitigation in the long term may fail to be commercialized without determined policy intervention (International Energy Agency, 2006b).

Second, the benefits of innovations do not fully accrue to the innovating firm. Beneficiaries also include other firms and society as a whole. Research suggests that the social rates of return on R&D investments can be in the range of 30 to 50 percent while private rates of return fall in the range of 7 to 15 percent (Popp, 2004). The gap between social and private rates of return is likely to be greatest in the case of basic research:

Federal support would probably be most cost-effective if it went toward basic research on technologies that are in the early stages of development. Such research is more likely to be underfunded in the absence of government support because it is more likely to create knowledge that is beneficial to other firms but that does not generate profits for the firm conducting the research. (US Congressional Budget Office, 2006, p. 2)

A third problem is that there exists considerable uncertainty regarding which technologies will prevail in a low-carbon society. Given that some technologies will fail for technical or economic reasons, a portfolio approach to clean energy investment is required. Directed public R&D investments could ensure research on the widest range of technologies, not just those that present the greatest possibility of short-term profits. Numerous technological advances will be required for a sustainable future and a portfolio approach will greatly reduce the risks should some technologies fail (International Energy Agency, 2006a).

Public energy investment should be seen as complementary to, rather than competitive with, private investment. In particular, public R&D should focus on clean energy technologies that are currently far from market feasibility but that offer the greatest potential for substantial carbon reductions. Private investment, particularly in the presence of higher carbon prices, will tend to focus on technologies that offer near-term market profitability. For example, private R&D might focus on the development of more efficient gas-electric hybrid engines while public R&D would concentrate on the development of hydrogen fuel cells as a replacement power plant for vehicles. This complementary process is already occurring as energy market liberalization has motivated private firms to concentrate more on short-term R&D while government research shifts towards a longer-term focus (International Energy Agency, 2003a).

The IEA notes that a future scenario of rapid technological development does not necessarily imply reduced economic growth. In a scenario of significant technological change responding to environmental concerns:

Growth would be slower at the beginning in developed countries, due to the increased costs of providing energy in a more environmentally compatible way. However, as the system responds and technology advances, the net increase in energy prices may not be that big. Furthermore, technological innovation by creating successful new industries and environment-friendly products would foster new economic growth. (International Energy Agency, 2003b, p. 92)

In this IEA scenario, governments aim to improve technologies through a 'mix of government-industry partnerships in R&D and regulation'. Again, a long-term perspective is required that stresses basic research on a broad range of technological options. Even if a concerted technology push were to begin immediately, successful new technologies might not be introduced into the market until at least 2020. A simulation model by Edenhofer, et al. (2005) produces similar results regarding the relationship between economic growth and climate policy – investment in technological change in the renewable energy and carbon capture sectors significantly reduces the costs of climate protection and allows ambitious climate goals to be met, while still permitting stable economic growth.

In the IEA scenario referred to above, the US is not expected to participate in the Kyoto process in the near term. Yet if the US adopts a long-term climate change policy emphasizing aggressive technological development, it may be able to speed up the introduction of new technologies that will eventually bring down the price of carbon mitigation and lead to a more successful international accord subsequent to the Kyoto Protocol. Countries that have ratified the Kyoto Protocol, meanwhile, may face greater pressure to take short-term measures to meet their Kyoto targets. Thus, the U.S. refusal to participate in the Kyoto Protocol could, ironically, offer it a unique opportunity to take a leadership role in developing long-term technological innovations to address climate change.

Public and Private Energy R&D Funding

In 2006 public energy R&D funding in the IEA countries was $10.9 billion (in 2006 dollars). As seen in Figure 1, R&D funding among industrial countries is dominated by Japan and the United States. In the United States, public R&D energy funding peaked in 1979 at $8.5 billion (in 2006 dollars) but in 2006 stood at only 37 percent of this amount, or $3.2 billion. Since the early 1990s Japan has been the world's leader in public R&D energy funding, with a 2006 total of $3.6 billion. In 2006 Japan and the United States accounted for 62 percent of the total public R&D energy funding among the 26 nations of the IEA. Only a few industrial countries are consistently increasing R&D energy funding. The IEA country with the greatest recent increase in funding is South Korea, which increased its public R&D energy funding by 258 percent between 2002 and 2006.

Public R&D funding appears to be particularly important with respect to renewable energy. For example, of fourteen key innovations in the field of photovoltaic energy where the funding source could be identified, nine were developed totally with public funding, four as a result of public-private partnerships, and only one solely from private funding (Norberg-Bohm, 2000). A strength of public U.S. R&D funding for photovoltaic energy has been the attention paid to a wide range of research activities, including basic research. But progress has been limited partly due to the inconsistency of funding.

R&D Funding Using Environmental Taxes

One option for generating additional R&D funding is carbon taxation, either as a direct carbon tax or as revenue from the auctioning of carbon permits under a cap-and-trade scheme. Numerous studies have provided estimates of the socially optimal level of carbon taxation by calculating the present value of damages from carbon emissions. A literature review by Tol (2005) found large variance in carbon damage estimates. Based on 28 studies, the mean carbon damage estimate was $93 per ton but the median was only $14/ton, and the 90 percent confidence interval was -$10 to $350/ton.2 The primary reason for the large difference in carbon damage estimates was the variation in researchers' choice of a discount rate. Tol concludes that it 'is unlikely that the marginal damage costs of carbon dioxide emissions exceed $50/tC and are likely to be substantially smaller than that' (Tol, 2005, p. 2073). This conclusion has been disputed by other analysts (see e.g. Ackerman and Finlayson, 2006). The Stern Review, for example, estimates the social cost of carbon at over $300/ton. To put these figures in context, a carbon tax of $10/ton would increase the price of oil by about 1%, the price of natural gas by about 3%, and the price of coal by about 23% (Harris and Roach, 2007).

Carbon taxation has met with considerable resistance in the U.S., and instituting a significant broad carbon tax appears unlikely in the immediate future. This analysis considers whether a less ambitious carbon tax could raise the funds necessary to permit adramatic increase in public funding for energy R&D. Total carbon dioxide emissions in the U.S. in 2006 were 5.9 billion tons (US Department of Energy, 2008). Assuming all carbon emissions could be taxed, a doubling of US energy R&D funding could be met with a carbon tax of only about 50 cents per ton (See Table 1). Even in the most ambitious scenario, where the US alone doubles global energy R&D funding, a tax of only $1.87/ton of carbon dioxide would be necessary. Thus even a relatively small tax on carbon emissions in the U.S., well below most estimates of the socially efficient carbon tax, could be used to fund a large increase in public funding for climate change research.

The final policy option considered in Table 1 is a tax solely on gasoline. Unlike carbon taxation, a tax on gasoline would not require monitoring of all carbon emissions. The current federal tax on gasoline is 18.4 cents per gallon, with state taxes ranging from six to 42 cents per gallon (American Petroleum Institute, 2006). Total gasoline consumption in the U.S. in 2006 was 9,233 thousand barrels per day, or 142 billion gallons annually (US Department of Energy, 2007). Thus US funding of energy R&D could be doubled with a new gasoline tax of only about two cents per gallon. Alternatively, the U.S. could effectively double global R&D funding with a gasoline tax of 7.8 cents per gallon. As with carbon taxation, an additional gas tax of two to eight cents per gallon would still leave gas taxes in the U.S. well below socially efficient levels (Parry and Small, 2004).

Policy Option	Funding Increase of $3.2 Billion	Funding Increase of $5.0 Billion	Funding Increase of $11.0 Billion
Tax all CO2 emissions	$0.54/ton CO2	$0.85/ton CO2	$1.87/ton CO2
Tax all commercial and industrial emissions	$1.17/ton CO2	$1.83/ton CO2	$4.02/ton CO2
Tax on only gasoline	2.3 cents/gal.	3.5 cents/gal.	7.8 cents/gal.

Table.1 Cost of Increased Public Energy R&D Funding

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