

American Economic Association

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Source: *The American Economic Review*, Vol. 96, No. 2 (May, 2006), pp. 31-34

Published by: American Economic Association

Stable URL: <http://www.jstor.org/stable/30034609>

Accessed: 14/01/2010 20:51

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After Kyoto: Alternative Mechanisms to Control Global Warming

By WILLIAM D. NORDHAUS*

After more than a decade of negotiations and planning under the Framework Convention on Climate Change (FCCC), the first binding international agreement to control the emissions of greenhouse gases has come into effect in the Kyoto Protocol. The first budget period of 2008–2012 is at hand. Moreover, the scientific evidence on greenhouse warming strengthens steadily as observational evidence of warming accumulates. The institutional framework of the Protocol has taken hold solidly in the European Union's Emissions Trading Scheme (ETS), which covers almost half of Europe's carbon dioxide emissions.

Notwithstanding this apparent success, the Kyoto Protocol is widely seen as somewhere between troubled and terminal. Early troubles came with the failure to include the major developing countries along with lack of an agreed-upon mechanism to include new countries and extend the agreement to new periods. The major blow came when the United States withdrew from the treaty in 2001. By 2002, the Protocol covered only 30 percent of global emissions, while the hard enforcement mechanism in the ETS accounts for about 8 percent of global emissions. Even if the current Protocol is extended, models indicate that it will have little impact on global temperature change. Unless there is a dramatic breakthrough or a new design, the Protocol threatens to be seen as a monument to institutional overreach.

Nations are now beginning to consider the structure of climate-change policies for the period after 2008 to 2012. Some countries, states, cities, companies, and even universities are adopting their own climate-change policies. Are there, in fact, alternatives to the scheme of trad-

able emissions permits embodied in the Protocol? The fact is that alternative approaches have not had a serious hearing among natural scientists or among policymakers. What are some alternatives?¹

For global public goods, there are three potential approaches: command-and-control regulation, quantity-oriented market approaches, and tax- or price-based regimes. Of these, only the tradable-quantity and the price-like regimes have any hope of being reasonably efficient.

Under a tradable-quantity approach, an agreement proceeds by setting limits on emissions by different countries. The limits are partially or wholly transferable among countries. This is the approach taken under the Kyoto Protocol. This approach has very limited international experience under existing protocols such as the CFC (chlorofluorocarbon) mechanisms and somewhat broader experience under national trading regimes, such as the U.S. sulfur dioxide regime.

A radically different approach is to use harmonized prices, fees, or taxes as a method of coordinating policies among countries. This approach has no international experience in the environmental area, although it has modest experience nationally in such areas as the U.S. tax on ozone-depleting chemicals. On the other hand, the use of harmonized, price-type measures has extensive international experience in fiscal and trade policies, such as with the harmonization of taxes in the European Union and harmonized tariffs in international trade.

These thoughts on the structure of international agreements to control global warming should not be regarded as negotiating strategies

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¹ There is a vast literature on the economics of climate change, as well as on alternative institutional mechanisms. Some of the important work is referred to in other papers in this session. For a background paper with a more complete discussion and references, see the author's Web site at http://www.econ.yale.edu/~nordhaus/homepage/recent_stuff.html.

for diplomats gathering at the next Conference of the Parties. Rather, they are a *conceptual framework*—particularly for economists who are advising governments and international organizations. They provide an optimal benchmark for policy against which alternatives can be measured. Against this benchmark, the Kyoto Protocol fares poorly. If we are to make significant progress in slowing global warming, we will have to do more and do it more efficiently.

Price-Type Approaches to Climate Change

Price-type approaches (or hybrids that combine price and quantity controls) have been discussed in a handful of papers in the economics literature, but much more careful analysis remains to be done. I will highlight a few of the details.

For concreteness, I will discuss harmonized carbon taxes (HCT). Under HCT, there are no international emissions limits; rather, countries would agree to penalize carbon emissions domestically at an agreed upon and harmonized “carbon tax.” This is essentially a dynamic Pigovian pollution tax for a global public good. The carbon tax is negotiated, but conceptually it is determined by weighing environmental and economic objectives. This might involve aiming to limit changes in concentrations of greenhouse gases or global mean temperature below some level, or it might use some kind of cost-benefit approach. Unlike the quantitative approach under the Kyoto Protocol, there are no country emissions quotas, no emissions trading, and no base-period emissions levels. The efficient tax would be equalized across space and grow over time at approximately the “real carbon interest rate.”

It would be critical to have the cost of emissions reductions shared among nations. It would be reasonable to allow participation to depend upon the level of economic development. For example, countries might be expected to participate fully when their incomes reach a given threshold (perhaps \$10,000 per capita). Additionally, poor countries might receive transfers to encourage early participation. The issues of sanctions, taxation location, international-trade treatment, and transfers to developing countries under an HCT system are important details that

are subject to discussion and refinement. If carbon prices are equalized across participating countries, there will be no need for tariffs or border tax adjustments among participants. While much work on the details would be required, this is familiar terrain because countries have been dealing with problems of tariffs, subsidies, and differential tax treatment for many years. The issues are elementary compared to those of a quantity-based regime.

The literature on regulatory mechanisms entertains a much richer set of approaches than the polar quantity and price types that are examined here. Important combinations or hybrids include quantity controls with price caps and floors, or harmonized taxes with quantity caps. This discussion focuses on the price-type mechanism because it is superior in so many respects.

Comparison of Price and Quantity Approaches

Policymakers, environmentalists, and negotiators are so accustomed to quantity constraints in environmental policy that the fundamental advantages of price-type approaches have been largely overlooked. The price-type approach is particularly advantageous for “stock global public goods” such as global warming. Some points are familiar to environmental economists, but others have particular force in an international regime.

- The fundamental defect of the Kyoto Protocol lies in its objective of reducing emissions relative to a baseline of 1990 emissions for high-income countries. This policy lacks any connection to ultimate economic or environmental policy objectives. The approach of freezing emissions at a given historical level for a group of countries is not related to any identifiable goal for concentrations, temperature, costs, damages, or “dangerous interferences.” It is not inevitable that quantity-type arrangements are inefficient. The target might be set to ensure that the global temperature increase does not exceed two or three degrees Celsius or for some other well-defined and well-designed economic and environmental objectives. That would be a welcome alternative to the current structure.
- A related issue concerns the baseline policy against which countries set their policies.

Quantity limits are particularly troublesome in a world of growing economies, differential economic growth, and uncertain technological change. These problems have become evident under the Kyoto Protocol, which set its targets 13 years before the control period and used baseline emissions from 20 years before the control period. Base-year emissions have become increasingly obsolete as the economic and political fortunes of different countries changed. The 1990 base year penalizes efficient countries (like Sweden) or rapidly growing countries (like Korea and the United States). It also gives a premium to countries with slow growth or with historically high carbon-energy use (such as Britain, Russia, and Ukraine).

The baselines for future budget periods and for new participants pose deep problems for the Kyoto Protocol. The natural baseline, were it feasible to calculate, is the zero-restraint level of emissions. That level is, in practice, impossible to calculate or predict with accuracy. Problems would arise in the future as to how to adjust baselines for changing conditions and to take into account the extent of past emissions reductions.

Under a price approach, the natural baseline is a zero-carbon-tax level of emissions, which is a straightforward calculation for old and new countries. Countries' efforts are then judged relative to that baseline. It is not necessary to construct a historical base year of emissions. Countries are not advantaged or disadvantaged by their past policies or the choice of arbitrary dates for the baseline. Moreover, there is no asymmetry between early joiners and late joiners.

- One key difference between price and quantity instruments concerns the structure of the uncertainties—and uncertainty is clearly a central feature of climate-change policy. As is well known, if the curvature of the benefit function is small relative to the curvature of the cost function, then price-type regulation is more efficient, and the converse holds true.

While this issue has received little attention in the design of climate-change policies, the structure of the costs and damages in climate change gives a strong presumption to price-type approaches. This is the dynamic extension of the famous Weitzman price-

quantity theorem. The reason is that the benefits are related to the stock of greenhouse gases, while the costs are related to the flow of emissions. This implies that the marginal costs of emissions reductions are highly sensitive to the level of reductions, while the marginal benefits of emissions reductions are essentially invariant to the current level of emissions reductions. More generally, where the damages are caused by stock externalities (as is the case for climate change, because damages are a complicated function of the stock of greenhouse gases), then the damage function is likely to be close to linear with respect to current emissions. Abatement costs, by contrast, are likely to be highly nonlinear as a function of emissions. This combination of relative nonlinearities means that emissions fees or taxes are likely to be much more efficient than quantitative standards or auctionable quotas when there is considerable uncertainty, as is clearly the case for climate change.

- Closely related to the point about uncertainty is that quantity-type regulations are likely to show extremely volatile prices for the trading prices of carbon emissions. Carbon prices are likely to be extremely volatile because of the complete inelasticity of supply of permits in the quantity case, along with the presumption of quite inelastic demand for permits in the short run.

We have preliminary indications that European trading prices for carbon dioxide are highly volatile, fluctuating in a band ± 50 percent over the last year. More extensive evidence comes from the history of the U.S. sulfur-emissions trading program. Sulfur dioxide trading prices have varied from a low of \$70 per ton in 1996 to \$1,550 per ton in late 2005. This is analogous to a carbon-trading program because the supply is virtually fixed and the demand is inelastic because of the low substitutability of other inputs for sulfur in the short run. Both programs build in some banking features, which can, in principle, moderate price volatility.

Such rapid fluctuations would be extremely undesirable, particularly for an input (carbon) for which aggregate costs might be as great as petroleum in the coming decades. An analogous situation occurred in the United

States during the “monetarist” period of 1979–1982, when the Federal Reserve targeted quantities (monetary aggregates) rather than prices (interest rates). During that period, interest rates were extremely volatile. In part due to the increased volatility, the Fed changed back to a price-type approach after a short period of experimentation. This experience suggests that a regime of strict quantity limits might become extremely unpopular with market participants and economic policymakers, as price variability caused significant changes in price levels and import and export values.

- An important advantage of tax mechanisms is the strong fiscal-policy preference for using revenue-raising measures rather than quantitative or regulatory measures. When prices are raised and real incomes are reduced by regulations, this increases the inefficiency losses from the overall tax system. This effect is the “double burden” of taxation (misnamed as the “double dividend” from green taxes). If the carbon constraints are imposed through taxes that are then rebated in taxes that have approximately the same marginal deadweight loss as the carbon taxes, then the overall efficiency loss from taxation will be unchanged. If the constraints under a quantity-based system are imposed by allocations that do not raise revenues, then the conventionally calculated abatement costs will underestimate the economic costs, and the efficiency losses from the price-raising elements should be added to the abatement costs. Rough estimates indicate that the losses here are likely to be large.

While it is possible that emissions permits will be auctioned (thereby retaining the revenues and removing the double burden of taxation), history and current proposals suggest that most or all of the permits are likely to be allocated at zero cost to “deserving” parties, or will be distributed to reduce political frictions. In the cases of sulfur dioxide allowances and CFC production allowances, *all* the permits were allocated to producers. The point here is that using tax approaches rather than quantity approaches will help promote a more efficient collection and recycling of the revenues from the carbon constraints.

- A final question applies particularly to international environmental agreements and concerns the administration of programs in a world where governments vary in terms of honesty, transparency, and effective administration. One of the subtle problems with quantity-type systems is that they are much more susceptible to corruption than are price-type regimes. An emissions-trading system creates valuable tradable assets in the form of tradable emissions permits and allocates these to different countries. Limiting emissions creates a scarcity where none previously existed and, in essence, prints money for those in control of the permits. Such wealth creation is potentially dangerous because the value of the permits can be used by the country’s leaders for nonenvironmental purposes rather than to reduce emissions. If oil ministers in corrupt countries pocket oil export revenues, why would they not pocket emissions permits as well (perhaps after suitable “privatizations”)?

A price approach gives less room for corruption because it does not create artificial scarcities and monopolies. There are no internationally tradable permits handed over to countries or leaders of countries, so they cannot be sold abroad for wine or guns. Any revenues would need to be raised by taxation on domestic consumption of fuels. In fact, a carbon tax would add absolutely nothing to the instruments that countries have today. The only difference would be the international approval of carbon taxes, which probably adds little to their acceptability in corrupt countries. The dangers of quantity as compared to price approaches have been shown frequently when quotas are compared to tariffs in international trade interventions.

The coming years will undoubtedly witness intensive negotiations on global warming as concerns mount and the quantitative approach under the Kyoto Protocol makes little difference. As policymakers search for more effective and efficient ways to slow the trends, they should consider the fact that harmonized environmental taxes on carbon are powerful tools for coordinating policies and slowing climate change.