Energy Security and Global Climate Change Mitigation

OP 55
October 2003

Hillard G. Huntington and Stephen P.A. Brown
Forthcoming in *Energy Policy*

Hillard G. Huntington
Energy Modeling Forum
448 Terman Center
Stanford University
Stanford, CA 94305
hillh@stanford.edu
Telephone 650-723-0645
Telefax 650725-5326

Stephen P. A. Brown
Research Department
Federal Reserve Bank of Dallas
Station K
Dallas, TX 75222
stephen.p.brown@dal.frb.org
Telephone 214-922-5152
Telefax 214-922-5194

Keywords: Climate change policy, energy security.

Abstract

Industrialized countries may reduce their costs of meeting carbon constraints if they penalize fuels not only on the basis of their carbon intensity but also on the basis of their import-export status. Simulations of these policies show that participating industrialized countries can reduce their costs and hence increase their willingness to participate. However, they will impose higher costs on the world, because the most carbon-intensive fuels will not be taxed the most heavily. Such a bias creates a "how" inefficiency in addition to the "where" and "when" inefficiency created by current international agreements to control greenhouse gas emissions. Although countries have always had such incentives, these considerations must be more fully acknowledged in today's energy markets, after September 2001.

Keywords: Global climate change, energy security.

Acknowledgements: The views in this paper are the authors and should not be attributed to either the Energy Modeling Forum or the Federal Reserve Bank of Dallas.

Introduction

The World Trade Center disaster and subsequent geopolitical developments have revived energy security as a critical policy concern. This issue never really evaporated. Asian countries have always placed a premium on domestic sources. European countries have had contentious debates about "cross-border" policies that have protected domestic electricity and natural gas. Even before the recent terrorist threats, President Bush proposed comprehensive US policy that favors domestic sources.

Although energy security focuses upon energy vulnerability rather than energy imports, there may be economic and political incentives to reduce energy imports. As fears about the stability of the world's energy resources grow, policymakers may merge these security concerns into the climate change policies that they are also considering. If policymakers punish energy imports and favor domestic energy sources, they are likely to choose different climate policies than if they were concerned with abating greenhouse gas emissions alone. We offer a few tentative conclusions about how security concerns may influence the future path of climate change abatement strategies.

Evidence already exists that countries were concerned about these issues even before September 11, 2001. As proposed in 1993, the U.S. Btu tax would have penalized oil more than natural gas, and both more than coal on the basis of carbon content, even though climate concerns should have meant the same carbon tax on all three fuels. More recently, the economic interests of domestic coal producers in both Australia and the United States made both countries reluctant participants in the Kyoto negotiations.

The Analysis

Recent climate change policy studies have focused almost exclusively on the cost of compliance with the Kyoto protocol. In these studies, industrialized countries are assumed to restrict emissions to some targeted level (usually linked to but not necessarily equal to 1990 levels), while developing countries are not.[1] This assumption results in a global "where" inefficiency because less costly opportunities to reduce emissions outside the industrialized countries are not exploited. The studies also target large reductions from the baseline relatively early in the horizon (e.g., 2008-2012 instead of a later date). This assumption results in a global "when" inefficiency because it boosts costs and places them sooner than desired by retiring energy-using capital equipment faster than would be dictated by economic efficiency alone.

Although a number of studies about policies to mitigate global climate change consider global "where" and "when" inefficiencies, all assume that participating countries will adopt only globally efficient measures in the choice of fuels whose use will be reduced. In other words, countries always choose the measures that will reduce greenhouse gas emissions at the *lowest cost to the world*. Participating countries are never allowed to choose those policies that will reduce greenhouse gas emissions at the *lowest cost to the country taking the action*, even if such a strategy may involve higher costs to the world. Such an approach seems to ignore that countries do have a choice about *how* they abate emissions. In essence, previous studies examine the consequences of imperfectly efficient policy along the global "where" and "when" dimensions but assume a perfectly efficient policy along the global "how" dimension.

We can incorporate the "how" inefficiency in the analysis by making modest adjustments to the calculated costs of abating greenhouse gas emissions. When reduced fossil fuel usage is the means for reducing carbon emissions, the incremental direct cost can be computed by moving up the fossil fuel demand curve in the traditional manner.[2] In addition to these costs, participating countries may incur wealth losses or gains on volumes that are internationally traded. These wealth changes, or "terms-of-trade" effects, are computed as the change in the fuel price times the level of exports or imports. If a policy reduces the world price of a fuel, it will increase the full incremental cost of reducing its usage when the fuel is exported and will decrease the cost of reducing its usage when the fuel is imported. For example, Australia and the United States would find it more expensive to reduce coal than oil or natural gas because they have large domestic coal resources. Most European countries may want to reduce oil imports more strongly than would other countries because most European countries are more dependent on imports for their oil.

Countries that are concerned about minimizing their own internal costs of compliance with a carbon target, are likely to consider such issues as terms-of-trade effects. At an aggregate level, however, one country's gain in the terms of trade will be offset by losses in other countries. Consequently, countries that pursue strategies to reduce their own costs of compliance will be doing so at the expense of their trading partners.

Conceptually, these terms-of-trade effects apply to all goods and services that use energy as an input, but we will restrict our focus to those within the energy sector for several reasons. The effects in the energy sector are more sizable and therefore are more likely to influence energy and climate change policy more than the effects on other sectors. Energy producers and utilities cannot easily shift the location of their resources and future generating plants to avoid carbon-mitigation strategies. In contrast, other sectors that might experience terms-of-trade effects are much more diverse interest groups that can migrate to nonparticipating regions and that each have lower stakes in trying to influence energy and climate policy. The costs of organizing these separate groups into one coherent policy are likely to prevent their active participation in influencing policy.

Although many other climate change studies have computed terms-of-trade effects, they invariably assume that each country adopts a given policy that taxes fuels on their carbon intensity. Our approach is fundamentally different in that the selection of the policy is *endogenous* rather than exogenous.[3] We simulate the framework numerous times to find the single lowest cost policy to the country for each level of carbon abatement. They will no longer select a strict carbon tax, which may have a higher cost due to its energy trade position. The need for numerous simulations requires that we use a simpler framework than the full-scale integrated assessment tools usually applied to this problem, but our estimates of the costs and carbon leakages associated with a Kyoto-type policy are very similar to those derived from these larger systems.

We have calibrated our framework to be consistent with a recent US Energy Information Administration's *International Energy Outlook*. We consider five major world regions: United States, other OECD countries, transitional countries that were formerly socialists, oil exporting countries, and all remaining developing countries. Markets for oil, natural gas, coal and all remaining energy are represented. The demand for each energy form has own-price and cross-price elasticities selected from the extensive econometric literature. Price elasticities for supply are generally judgmentally determined. In the results reported here, oil-exporting countries are assumed to be imperfect competitors who seek to maintain their market share.[4]

Each policy case assumes that the OECD seeks to reach a different emissions target. The compliance rate is defined as the percent of the assumed reduction relative to what would be required to keep emissions at 1990 levels. Thus, a 100% compliance rate means that the OECD will reach its 1990 level by some year, in this case, 2010. The framework searches for the set of fuel taxes that will achieve this OECD reduction at the least cost. The effects of the policy will depend upon which costs the OECD seeks to minimize. The following three strategies are considered:

- *"World-cost minimizing"* - The OECD adopts policies to reduce its CO_2 emissions in a manner that keeps world costs as low as possible.
- *"OECD cooperative strategy"* - The OECD members adopt policies that minimize the total cost to the OECD countries for achieving each level of CO_2 abatement.
- *"OECD non-cooperative strategy"* - The United States and the other block of OECD countries act independently of each other in an attempt to minimize their own costs while taking the behavior of the other country block as given. Equilibrium values are established through a Nash-Cournot solution.

It should be emphasized that participating countries consider only the costs of reducing carbon emissions in these scenarios. Their decisions do not incorporate the significant public goods benefits from either reducing climate change or mitigating energy disruptions.

Some Results

One important result is that OECD's costs of abating carbon emissions vary across fuels and depend critically on import-export status. At relatively low levels of abatement, the direct costs of abatement will be negligible and costs of abatement will depend primarily on the terms-of-trade effects. At these low levels, the costs of abatement through oil will be negative because the OECD imports the fuel and will obtain sizable gains in the terms of trade by reducing its usage. Because these gains are losses to oil-exporting countries and to the OECD's trading partners, the OECD has an incentive to conserve more oil than would be viewed as desirable from a world perspective.

Another important result is that the OECD cooperative strategy will reduce the region's own costs of achieving any given level of compliance, relative to the world-cost minimizing strategy. The main reason for this discrepancy is that the OECD countries can count a reduction in the world price of oil as a benefit while ignoring the revenues lost by world oil exporters. Again, this difference provides the OECD countries with an incentive to reduce oil consumption more than is optimal from the world perspective. As long as the OECD imports or exports carbon-based fuels with non-OECD countries, it can find a policy that reduces its own costs below that of a pure carbon tax. It does so by taxing the fuels that it imports more heavily than those in which it is self sufficient and both more heavily than fuels it is exporting.

A third result is that costs for the world are higher with the OECD cooperative strategy than they are for the world-cost minimizing strategy. This result seems obvious because any deviations from the world-cost minimizing strategy must entail higher costs for the world. Nevertheless, this finding is worth emphasizing because it demonstrates clearly the "how" inefficiency induced by letting each block focus exclusively upon its own terms-of-trade gains or losses.

A fourth result is that the OECD noncooperative and cooperative strategies appear to yield similar OECD and world costs because the two blocks into which we divide the OECD have similar trade positions. (This result could change if we further disaggregated the OECD into its component countries). When the two blocks do not cooperate and base their choice of policy on their own costs, each block fails to take into account the terms-of-trade gains (primarily from oil) in the other block of OECD countries. As a result, abatement costs to the OECD for any particular compliance level are somewhat higher and those for the world are somewhat lower than for the cooperative OECD strategy.

A fifth finding is that at relatively low abatement rates (below 47% of compliance with 1990 levels in our simulations), the OECD can find a policy mix that produces net benefits (negative costs) for itself. These benefits are fundamentally different than the usual "no-regrets" position based upon market failures in the purchase of energy-efficient technologies.[5] Without government action, there would not be a no-regrets position because each individual consumer earns too small a welfare gain to justify his costs of reducing energy. However, once governments are allowed to organize their residents, it can count welfare gains of reducing the price of imported energy against the direct costs of reducing energy use. That is the no-regrets position being discussed here.

A sixth result is that the disparity between OECD and world interests is greater for programs that call for less mitigation of carbon emissions because at low levels of mitigation, term-of-trade effects dominate the direct costs of energy conservation.[6] For example, at a 50% compliance rate with 1990 emissions levels, we estimate OECD costs to be $35 per ton for the world-cost minimizing strategy and $2 per ton for the cooperative OECD strategy. This gap between the two estimates narrows to $2.65 per ton at 100% compliance. Thus, the effects of the how inefficiency are greatly magnified, if one thinks that country inaction or the difficulties of organizing a common effort will lead to relatively small policies at first rather than large, dramatic programs. The same results would apply if countries did not need to adopt large reductions in their emissions, because they had substantially lower baseline emissions than expected in many climate change studies.

Summary

In addition to the global "where" and "when" inefficiencies in carbon abatement policy, there may also be a global "how" inefficiency associated with a country's energy imports and exports. If participating countries seek to minimize their own costs rather than the world's costs, they may choose substantially different abatement policies than are assumed in most climate change studies. Whether a country agrees to a target for a given amount of carbon abatement (focusing on quantity) or to reach a given marginal benefit associated with carbon abatement (focusing on the carbon price), it has an incentive to choose policies that deviate from those which would minimize world cost.

Rather than simply abating on the basis of carbon intensity, the country will prefer to cut emissions more greatly with those fuels that it imports and less greatly with those that it exports.

References

Brown, S P A and Huntington, H G (2003) "Terms of Trade and OECD Policies to Mitigate Global Climate Change," *Economic and Financial Policy Review*, Federal Reserve Bank of Dallas, <http://www.dallasfedreview.org/> forthcoming.

U.S. Energy Information Administration (various issues) U.S. Department of Energy *International Energy Outlook* Washington, D.C., U.S. Government Printing Office

Weyant, J P and Hill, J. (1999) "Introduction and Overview," in *The Costs of the Kyoto Protocol: A Multi-Model Evaluation*, edited by J P Weyant, *Energy Journal*, special issue, pp. vii-xliv.

Notes

---

1. At the end of 1997 in Kyoto, all Parties to the United Nations Framework Convention to Climate Change agreed that Annex B countries (developed economies and the so-called economies in transition) would reduce emissions 5.2 per cent below 1990 levels over a commitment period 2008-2012. The protocol is not confined to reducing carbon dioxide emissions. It is comprehensive in its coverage of greenhouse gases and includes sources, sinks, and six greenhouse gases: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride. Developing countries are not obligated to impose restrictions under this proposal. The sixth session of the Conference of the Parties failed to resolve some key disputes about implementation of the Kyoto agreement, including such issues as whether to include carbon sinks and how much emissions trading should be allowed. More recently, the Bush administration has announced that the United States would not accept the protocol's provisions.

2. Weyant and Hill (1999) provide a clear exposition of this approach for computing the direct costs.

3. The approach, detailed results, and literature review are described in much greater detail in Brown and Huntington (2003).

4. It did not seem credible to assume that the oil-exporting countries were perfectly competitive. Therefore, the analysis incorporates an additional cost of using oil, the global quantity of which has been artificially restricted by OPEC to achieve profits above competitive levels. The resulting case means that the world minimization case is not simply a carbon tax.

5. The analysis does not include these market failures for ease of presentation rather than for any prior beliefs about their relative importance. If these failures were distributed evenly across all fossil fuels, our

costs curves would be shifted rightward, resulting in our cost curves converging at higher implementation rates. To fully incorporate this issue, we would need to know the size of these effects in each fuel market and how quickly these cost-free opportunities would disappear over time in the absence of any policy changes.

6. Our supporting paper (Brown and Huntington, 2003) develops abatement cost curves that incorporate the terms-of-trade as well as direct effects and that show how the incremental full costs change when the abatement level increases. These curves can be quite helpful in understanding how the compliance rate affects a country's full costs of participating, but they have not been shown here to save space.