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Market-Based Solutions to Environmental Problems: Discussion

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ABSTRACT

There is rapidly growing interest in the use of market-based (MB) instruments in environmental policy. The papers in this session discuss three relatively new areas for such policies: groundwater contamination, nonpoint source surface-water pollution and carbon sequestration. The papers point out the potential for MB policies in these areas, but significant challenges remain. This comment highlights challenges related to five issues: monitoring and enforcement, trading ratios, baselines, transaction costs, and risk and uncertainty. All these issues must be addressed before MB policies can take the full step from economic theory to regulatory reality.

Key Words: *global warming, carbon sequestration, groundwater contamination, nonpoint pollution, effluent trading, tradable emissions permits*
JEL categories: Q2, Q28, Q25

Once viewed as only a pipe dream of academic economists, the trading of environmental flows is being increasingly sought by policy makers to address a wide range of issues. In addition to the well-known SO_2 market that was set up by the 1990 Clean Air Act, markets for other air pollutants are active in numerous states, wetlands mitigation banks are being widely used, and international CO_2 trading was written into the Kyoto Protocol on Climate Change. The idea is catching on, and policy makers and economists alike are beginning to look at virtually every environmental problem and asking, "Can trading be used to solve this problem?"

The papers presented in this session discuss the potential for market-based (MB) environmental policies in three arenas in which there has been little or no experience with MB policies. Randall and Taylor look primarily at the potential for these policies to address problems of surface water pollution from nonpoint sources. Zeuli and Skees consider how a national market for carbon sequestration might affect southern agriculture. Finally, Morgan, Coggins and Eidman discuss how they plan to study the potential application of a MB approach for addressing contamination of underground aquifers.

The challenges faced in each of these new venues are perhaps most easily seen by contrasting them with the issues where MB programs have been so successful—air pollution from point sources. First, there is the issue of dispersion. In the most simplistic economic models of MB programs we typically assume that the pollutant is uniformly mixed so that the damage caused by a pollutant is independent of its source. While even air pollutants are typically not uniformly mixed, the nega-

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tive impacts from air pollution are, relatively, quite evenly dispersed over large areas. Second, there are the issues of monitoring and enforcement. By definition, we can point to the pollution that is generated by a point source. If Firm A says that it has reduced its pollution, this can be verified by monitoring the output from Smokestack A. Because of these characteristics, regulatory agencies have been relatively comfortable with the adoption of markets to address air pollution problems.

These two characteristics that have made MB initiatives in air pollution markets so successful are sorely lacking in each of the problems considered in the papers presented here. For both of the papers addressing water pollution issues, the pollutants are clearly not uniformly mixed. As Randall and Taylor put it, for water pollution policies, "the immutable fact that water tends to flow downhill provides an enduring organizing principle." On the other hand, this is not an issue for Zeuli and Skees since global climate changes is one of the few environmental problems for which the externality is truly uniformly mixed. The three papers have in common the fact that the environmental flow of interest cannot be readily quantified. Even with thorough and costly scientific study it would be impossible to identify exactly how much pollutants leave a farmer's land or how much carbon is sequestered.

The implementation of MB programs in the areas considered in these papers must, therefore, overcome the numerous challenges that arise because of problems of nonuniformity and unobservability. In the next section I consider a number of practical issues that must be addressed in the development of such MB programs, issues that take on enormous importance as we move from the textbook to the world of laws and regulations. I close my comments with some conclusions and predictions, discussing what we have learned from the papers regarding the prospects for MB policies in these three areas.

Economic Theory vs. Regulatory Reality

While economists were the original advocates for market-based pollution control programs, much of the current evolution of this area is taking place in a quite different environment where political priorities and regulatory constraints have more importance than cost minimization and economic efficiency. As we move from the textbook to the real world, it is essential that economists appreciate the differences between our models and the reality of the forces that actually determine the final form that such programs take. I highlight five issues that become critical when we move toward implementation, and discuss how these papers have or have not addressed these issues.

Monitoring and Enforcement Issues—the Legal Foundation of Transferable Rights

One of the essential characteristics of efficient property rights is that they are enforceable. For a right (or responsibility) to be enforceable, not only must it be well defined but it must also hold up if challenged in court. The current papers involve trading by nonpoint sources. Defining the rights and responsibilities for such agents is not an easy matter. As noted by Randall and Taylor, economists have come up with a number of mechanisms that can be used to address the informational problems that arise in the case of nonpoint pollution. Joint liability as proposed by Segerson and other contract mechanisms can, in theory, lead to optimal choices over nonpoint source pollution. However, Randall and Taylor go on to note that many such programs may violate "ordinary notions of fairness," making them unacceptable from a legal perspective. I speculate that the tenuous legal foundation for these mechanisms is the primary reason that they have yet to be applied by resource managers (Shortle, Horan and Abler). As Randall and Taylor propose, such mechanisms may face fewer problems when used to create positive incentives. Finding ways to implement such programs is an area that demands further research.

The alternative to joint liability is to base transferable rights on practices rather than standards. This approach has a number of limitations of its own. The focus of the work by

Morgan, Coggins and Eidman is to improve the predictability of the relationship between practices and contamination. Certainly this is an important concern and one in which substantial progress can be made. But it might be that the black box of a complicated model might actually be inferior to rules of thumb. If the model shows that Farm A must be held to a substantial higher standard than Farm B, will the model hold up in court to legal challenges? Most models involve enough assumptions and guesswork to make them extremely susceptible to scientific criticism. I wonder whether regulatory agencies will risk their time and resources on a program that can so easily be toppled.

Ironically, the issue with the greatest problems of monitoring and enforcement may have the fewest problems in this regard. In the area of carbon sequestration, monitoring the actual amount of carbon sequestered is likely to be a very difficult exercise. Zeuli and Skees report studies that have found carbon sequestration rates that vary by orders of magnitude. In this case, however, it is not clear that the uncertainty is that problematic, for all that matters is that the total amount sequestered is sufficient. If Farmers A and B receive 50 credits each, the total goal of 100 is achieved as long as 100 units are sequestered, regardless of the distribution between A and B. Of course it is important to get the average right for only then will the nation's carbon sequestration goal be achieved. Moreover, improved accuracy in carbon sequestration estimates will make possible more precisely established incentives. However, to the extent that rates of carbon sequestration vary for reasons that are largely out of the control of the farmer and unrelated to practices, little may be gained by improvements in the scientific estimates of carbon sequestration. Since there are no local impacts and actually quantifying actual sequestration is so difficult, a program that seeks to achieve the average without too much concern that each participant is paid for his or her actual sequestration may satisfy legal standards as well.

Stavins has argued that there are five levels in the cycle of environmental impacts at which pollution might be regulated: (1) inputs, (2) emissions, (3) ambient or concentration levels, (4) exposure and (5) risk. It would appear that MB policies dealing with nonpoint pollution problems have little choice but to regulate at the first level, i.e., based on practices rather than actual flows. This is unfortunate. While movement from (2) to (5) on Stavins's list would lead to marginal improvements in the correlation between the point of regulation and the actual regulatory concern, any movement away from (1) can yield substantial benefits of a very different kind. As Randall and Taylor point out, if pollution regulations can be shifted from practices to performance standards the entrepreneurial energies of agents are liberated and the result can be substantial reductions in costs. Sometimes, simply informing the agents that a standard needs to be reached can provide the necessary incentives to reduce pollution. For example, following a preliminary analysis of the members of the Tar-Pamlico Association, 80% of the required reduction was achieved with only operational changes requiring minimal capital outlays (Green).

Randall and Taylor go on to suggest that as producers achieve greater latitude regarding their ways of meeting environmental standards, innovation offsets as proposed by Porter and van der Linde might actually be achieved, meaning that the net cost of being regulated could actually be negative. While there is substantial debate over whether such offsets are a regular feature of our economy (Palmer, Oates and Portney), it is clear that they cannot occur in a standard command and control environment.

As a halfway step, some gains can be achieved if improvements in models make it possible to quantify environmental flows associated with a broader range of practices. With this in mind, therefore, scientists should attempt to develop models that predict flows based on as wide a range of practices as possible. In Morgan, Coggins and Eidman's model they plan to obtain very accurate predictions regarding only two land-use policies. I think more might be learned if we had less precision regarding a wide range of practices. If decision makers have greater flexibility regarding how they respond to market pressure, the benefit of MB policies can be markedly increased.

Trading Ratios

An issue that is closely related to monitoring and enforcement is that of trading ratios. At the most basic level a trading ratio is used to adjust the market so that apples are in fact traded for apples. For example, in an effluent-trading program proposed for the Long Island Sound, a separate damage coefficient was established for each of eight regions depending upon their impacts on the Sound (Kearney Inc.). Based on these damage coefficients, 36 distinct trading ratios resulted so that, in principle, any trade would have a neutral impact on the water quality.

As Randall and Taylor note, however, trading ratios are routinely used in effluent trading markets, justified not only on the need to equate damages from different sources but because of the uncertainty surrounding nonpoint-source reductions (Malik, Letson and Crutchfield). As they point out, if the trading ratio is excessive, it can impede trades and, in their words, violate the *raison d'être* of the program itself. Clearly, trading ratios have the potential to seriously hamper the ability of markets to work. However, there are numerous legitimate reasons for maintaining a trading ratio greater than 1:1.

First, one must recognize that like any policy change the move to a MB program must be "sold" to major stakeholder groups. The cost-minimizing objective promoted by economists is likely to be unattractive to environmentalists. Accordingly, high trading ratios are often promoted as an attractive feature of the program in that each transaction will actually lead to an environmental improvement. Environmentalists are thus more likely to support such programs. Of course, there is an efficiency cost for this political payoff, but such inefficiencies are hardly unique to MB programs. While our role as economists is to point out these costs, we should also be slow to criticize policy makers for whom political pressures are real constraints on policy.

A second point, and one which Randall and Taylor discuss, is the role that uncertainty plays in determining the optimal trading ratio. Given the relative uncertainty surrounding the effectiveness of nonpoint-source abatement, a positive ratio may be optimal. As seen in the paper by Morgan, Coggins and Eidman, technological innovations and scientific research can reduce the uncertainty surrounding nonpoint-source impacts. Along the same lines, Randall and Taylor mention similar attempts to improve the scientific basis for trading being implemented by the Army Corps of Engineers in wetland mitigation banking programs. Nonetheless, it can be quite expensive to obtain the precise information leading to the "ideal" ratio so that each trade is environmentally neutral. Extending the framework of Malik, Letson and Crutchfield, it could easily be shown that there is an efficient level of information, a level at which a trading ratio greater than 1:1 would be retained. In conversations with one regulator, it is clear that this reasoning is one reason why trading ratios are being used in Michigan's state-wide pollution trading program (pers. comm., David Batchelor, Michigan Department of Environmental Quality, Aug. 18, 1999).

Baselines

MB programs involve financial incentives to individuals for variations from a baseline level of emissions or abatement: e.g., farmers would be compensated for increasing their carbon stock or decreasing their pollution or would pay for the right to increase their pollution. In each scenario, therefore, the establishment of the baseline becomes a critical issue in determining the impact of the program. For economists, this is typically thought to be a rather unimportant concern since, following Coase, we do not expect that the distribution of the rights will affect the efficiency of the outcome. Not surprisingly, this simplistic result does not hold as soon as some of the restrictive assumptions are relaxed (Montero, Stavins).

If the rules for the establishment of baselines are inappropriately designed, there is potential for moral hazard type problems as agents might profit from increasing their emissions in the short run in order to be paid to reduce them later. Furthermore, as Zeuli and Skees point out, a program that rewards 'bad performers' and leaves "good performers" with no rewards is unlikely to gain much support among either regulators or stakeholders.

Randall and Taylor argue that MB policies represent a way to overcome what Randall calls "the isolation paradox" in which the key to successful resolution of problem requires finding ways for disparate interests to coincide. The isolation paradox can be overcome by programs that seek "a shared vision" and, therefore, consensus among stakeholders. The level at which baseline rights and responsibilities are set can be critical to achieving such consensus. Stakeholders often have very clear perceptions as to what is and is not a fair allocation of baseline rights and responsibilities. Even if it appears on the surface that an outcome is "win-win," if some parties feel that they are being treated unfairly by a program the prospects for success are limited.

Setting baselines in a manner that does not reward poor actors is critical to having a politically palatable program. On the other hand, the efficiency of these programs requires that there be an incentive for such agents to participate. One way around this dilemma is to set the baselines based not on actual practices but on generally acceptable practices. In the case of carbon sequestration, for example, farmers with degraded soil may be allowed to obtain credits only once they have restored the soil to a "normal" condition while other farmers might have credits immediately available for sale without any further interventions. Of course, setting such thresholds can lead to inefficiencies because farmers with poor soil have, on the margin, no incentive to restore their soil until they have reached the baseline. However, such inefficiencies may be necessary in order to achieve broad-based support for the program.

Of course the primary role of the baselines is to ensure that the environmental policy objective is achieved. In market-based programs the baseline reflects the point from which trading will begin. Such programs are typically designed so that even if trading does not take place the policy objective is reached. As Zeuli and Skees point out, if baselines allocations are set based on a norm for acceptable practices, farmers could be rewarded for measures that they are already carrying out. Such credits certainly could not be counted in the national accounts of carbon reductions and, as such, the overall baseline would have to be adjusted downward accordingly.

Transaction Costs

Substantial attention has been paid in recent years to the importance of transaction costs in MB policies (Stavins, Montero). Zeuli and Skees' comment regarding the carbon market is equally true for any application of market-based instruments: searching for efficient institutional arrangements that reduce transaction costs and share the risk is the key to potential success. One way that such costs can be substantially reduced is by having central clearinghouses through which all or most trades are made. This is the approach used in the Tar-Pamlico case discussed by Randall and Taylor. Zeuli and Skees argue that a similar system would make sense in the market for carbon sequestration, particularly given that most of the potential participants are small private landowners.

When informational costs are high because of the nature of the site-specific nature of the permit, there may be no alternative but for trading to take place via bilateral negotiations. Atkinson and Tietenberg show that when bilateral trading takes place the result can be less-than-optimal trades taking place and leading to substantially less cost savings than are predicted in standard models. Without any reference to actual trading cost, they find that cost savings under bilateral trading are only 50–60 percent of the least-cost benchmark. Given these results, economists should be cautious in portraying markets as if they are frictionless environments in which buyers and sellers can easily find each other. For example, the market mechanism proposed by Morgan, Coggins and Eidman in which an abstract auctioneer responds instantaneously to bids leading to a single price for all agents is substantially cleaner than the markets that are currently operating or under development in the U.S. Their results, therefore, may give an overly optimistic picture of the potential savings that could be achieved through MB policies in this context.

Risk and Uncertainty

Zeuli and Skees make an important point that is often ignored in the literature on market-based instruments: the risk preferences of participants in such a market will play a major role in determining whether they participate or not. Economists should carefully watch the insurance instruments that these authors discuss. The development of similar instruments for other environmental disamenities is an area that needs much work. There are many problems where negative externalities arise because of the risky environment that agents face. For example, Babcock shows that nitrogen applications, on the margin, play a more important role in risk reducing than they do in enhancing yield. Hence, it would be quite interesting if the role of risk could be built into the farmer's responses in the model to be built by Morgan Coggins and Eidman. Could markets be developed that involve state contingent payoffs? If so, it may be possible to further reduce the actual costs of achieving water quality goals.

Of course, risk and uncertainty are issues not only for the participants in the markets, but for the agencies as well. Particularly when MB policies involve transferring abatement credits from point sources to nonpoint sources, each trade moves the pollution under the agency's purview to a realm of much greater uncertainty. As discussed above, regulators sometimes respond to these risks by placing barriers in the way of trades in the form of high trading ratios. Alternatively, they minimize their risk by requiring excessive reporting and restricting trading to only those trades that pose little potential risks. As we seek to expand the frontier of MB policies, we should watch carefully for ways to reduce the risk exposure of the regulatory agency as well.

Conclusions and Predictions

The papers in this session consider the potential for market-based policies in three relatively new arenas: nonpoint pollution to surface water, nonpoint pollution to groundwater and carbon sequestration by agriculture and forestlands. I conclude with my prognosis about the potential for success in each of these areas.

There is no doubt that market-based approaches will play an important role in the control of nonpoint-source pollution. Randall and Taylor list programs in 15 states that are in various stages of development or implementation. Like the Fox River program started nearly 20 years ago, some of these programs will probably fail (Apogee Research). However, with the growing structure of rules governing such trading, and rapidly increasing experience, many programs will persist and market-based approaches will become a standard instrument in the policymaker's toolbox. Certainly, as Randall and Taylor point out, the process of developing these programs can be as important as the final form itself. It is through this process, I believe, that Randall's isolation paradox is overcome.

There is no doubt, as Randall and Taylor argue, that much could be gained by switching to performance-based trading away from trading based on practices. As a practical matter, however, I see progress in the form of greater variability in acceptable practices as more likely than moving towards the monitoring of actual flows. Keeping in mind the limitations of such practice-based approaches, however, regulations should include an explicit mechanism through which the range of acceptable practices can be expanded. This would create an incentive for nonpoint sources to sponsor research that will find innovative ways to reduce their pollution and document the efficacy of these practices. Land-grant universities should see this line of research as a service to both the agricultural sector and the environment.

In the area of groundwater contamination, I think there is also some potential for market-based mechanisms. Given the spatial variability in impacts on groundwater systems, there are obvious opportunities to reduce the costs of cleaning up our nation's groundwater supplies. However, I am not optimistic that it will take the form proposed by Morgan, Coggins and Eidman. As the authors have shown, the modeling complexity required for a single simulated environment is extremely complex, data requirements are enormous and the simplifications that must be made are extremely restrictive. When we venture out of the computer simulation model into the real world I see little hope for actually quantifying each farmer's contamination of a distant well. Given the cost and complexity, I would be surprised if actual trading programs are able to adopt such models as the foundation for trading.

Even if my skepticism proves true, however, this does not mean that the authors' modelling effort will be wasted. Once such a model is developed it can be used to study the potential for alternative market structures that might be more practicable. The authors might gain some valuable insights by comparing the theoretical optimum with simplistic systems in which credits are calculated based on practices and trading ratios based on distance. When their modeling exercise is complete there is no question what they will find—costs are reduced by the fictitious trading program. They need to then take the next step and look at realistic ways that markets might work to resolve groundwater contamination focussing on both the realities of data and modeling limitations and the fact that markets will not work as smoothly in the real world as they do inside a Pentium processor.

Finally, will MB instruments play an important role in the reduction of CO_2 to control the problem of global warming? It is important here to note that trading might take place on at least two levels: trading between nations and trading within nations. Trading between nations is written into the Kyoto Protocol and it is very likely that we will see trading taking place at that level. Zeuli and Skees' paper addresses the potential for MB policies to play a role within the US with specific attention to southern agriculture. As they note, initial steps are already being taken in this area and 2.8 million metric tons of carbon credits have been sold to a Canadian consortium. If the U.S. ever signs the Kyoto Protocol, it is likely that the demand for these credits will expand greatly.

While quantification of sequestration credits is a substantial challenge, because the benefits of sequestration are uniformly dispersed with no local consequences correct quantification is not as critical in this market as it is in the water pollution cases discussed in the other papers. As long as the formula used to calculate sequestration is correct on average, the markets will achieve the sequestration goal regardless of how imprecise the measure might be at any one location. This gives regulators a degree of flexibility that might be capitalized on to reduce transaction costs and increase trading.

As they point out, however, the distinction between stocks and flows is critical. If a coal-burning utility seeks to offset its CO_2 emissions by paying a farmer to increase the stock of carbon in the soil in one year, that stock must be permanently bound. The farmer's ability to participate next year is substantially diminished. Therefore, it is unclear how long agriculture can be an active participant in markets for carbon sequestration since over time the opportunities there will be used up. Eventually, the nation's sources of CO_2 flows will have no choice but to reduce their output.

Zeuli and Skees make a reasonable case that Southern agriculture is likely to benefit from such a market, and that conversion of land to forestry is most likely form that this will take. Given the evidence they cite on the motivations behind forestry on private lands, it seems likely that farmers will be willing to convert land into forest for relatively small levels of compensation. Again, helping such markets to develop could be a great service to the agricultural community.

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