V

Designing a Transborder Trading Scheme

The Kyoto Accord: Lessons for Transborder Trading?

Concerns about anthropogenic global warming from greenhouse gases led to the international agreement known as the Kyoto Accord. The accord, which is not fully ratified, sets targets and timetables for 39 industrialized countries to reduce emissions of six greenhouse gases implicated in global warming. The United States, for example, would cut greenhouse emissions 7% below 1990 levels on average during the years from 2008 to 2012 (Fisher, et al. 1999). Similar cuts are required in Western Europe and Japan. Russia and Ukraine must freeze emissions at 1990 levels (Victor 1998).

Greenhouse gases mix on a global scale. Once the gases are emitted, air currents carry them worldwide (although there is some evidence that mixing does not occur between the northern and southern hemispheres). Mixing pollutants, such as greenhouse gases, are ideal candidates for emissions reduction trading since mixing prevents the formation of local hot spots. Indeed, Kyoto relies heavily on emissions trading as a mechanism for achieving national goals.[1] The logic for emissions trading is compelling. Reducing emissions in Western countries, where strict environmental regulations have been in effect for decades, is difficult and costly. But in developing nations, the fruits hang low and are thus easy to pick. Projects to refurbish inefficient power plants in Poland have cut greenhouse gas emissions at one-tenth the cost incurred in the West, for example (Victor 1998). Trading lets investors earn valuable emission permits while the Poles get new technology. It is expected that emissions trading will reduce the cost of implementing the Kyoto Accord by as much as half (Victor 1998).

The development of an emissions trading scheme for greenhouse gases has proved to be a complex and difficult process. A number of issues need resolving (Boemare and Quirion 2002; Rosenzweig, et al. 2002), including those concerning trading mechanisms, permit allocation, monitoring, and enforcement. During a series of international meetings over several years, including important meetings in Marrakech and Berlin, these issues have been decided for the most part. By July 2003, 118 countries had ratified the Kyoto Accord, including 32 industrial countries. Nevertheless, the accord is on the verge of collapse (Global Environment Committee 2003). The United States withdrew from the agreement in 2001 and Russia announced its intention to withdraw in late 2003, both citing fears it would reduce economic growth. Undoubtedly, skepticism about the importance of greenhouse gases in global warming also contributed to the countries' decisions.

The experience of the Kyoto Accord illustrates the many problems faced by policymakers attempting to design an emissions trading program on the U.S.-Mexican border. Many technical issues concerning the mechanism of trading must be solved. Perhaps more important is whether the political will exists to coordinate environmental policy across the U.S.-Mexican border. This chapter addresses the issues involved in designing such a transborder trading regime.

Elements of Trading Schemes

As has been argued throughout this monograph, emission reduction permit trading is superior in many situations to traditional command-and-control because it makes achieving air quality standards possible at a lower cost. The idea is straightforward—firms that can reduce emissions below a specified target generate permits that can be sold to other firms. By generating cash flow, emissions trading provides an incentive for firms facing low abatement costs to reduce emissions. At the same time, firms facing high abatement costs can avoid those costs by purchasing permits as offsets. By contrast, traditional command-and-control forces facilities to meet similar emission standards regardless of abatement costs. While simple in principle, the actual implementation of a trading permit system requires dealing with a number of specific issues related to permit allocation and enforcement. The resolutions of these issues have important implications for the trading system and will determine whether or not policy goals can be achieved at reasonable costs.

Development of an emissions trading program will involve compromise. Economists argue that the guiding principle in the design of an abatement policy should be efficiency. That allows features of an emissions permit trading scheme to be chosen for their ability to minimize the social and transactional costs of achieving a given policy goal. After all, this is the *raison d'etre* for emissions trading. Of course in practice, politics often trump efficiency considerations. A political entity proposing a trading scheme will be subject to diverse pressures from different special interests on virtually every aspect of the proposal (Boemare and Quirion 2002). Ignoring lobbyists' demands altogether is a recipe for political failure. It follows that understanding the efficiency and political implications of a trading program can inform the decision-making process.[2]

Table 1 lists major features that must be dealt with in developing a transborder emissions trading program. In the first column, 10 attributes of emissions trading programs are listed. The second column briefly describes each attribute. The third column lists alternative policy choices. The first feature listed is the trading regime. This refers to the decision between adopting a cap-and-trade program and a baseline-and-trade program.[3] A cap-and-trade program involves the establishment of an overall emission rate sufficiently low enough to achieve the desired ambient air quality standards. A baseline-and-trade regime does not seek to establish an overall emission level, but rather sets a standard for a given facility. The second feature listed is the initial allocation of permits. Interestingly, this is more a political question than an economic one, as any initial allocation can, in principle, achieve desired emission levels. Distributional and equity issues, therefore, determine how permits are to be initially allocated. The third and fourth features listed involve the extent of coverage. Should coverage be broad, involving multiple airsheds and industries, or should it be limited? This decision involves technical issues specific to particular pollutants, which are beyond the scope of this monograph. Nevertheless, economics does provide some insight into these issues. The next feature listed is the degree of intertemporal flexibility. Economists generally argue for greater temporal flexibility, but borrowing against future emission reductions is controversial, as there is concern among environmental activists that the promised emission reductions will not materialize. Monitoring, enforcement, and liability are closely linked. Any enforcement action is predicated on the monitoring of emissions to detect violations. The assignment of liability to either the seller or the buyer of permits has important efficiency implications, depending on the characteristics of the enforcement regime. Perhaps the most politically charged issue in the design of a transborder emissions trading program is the harmonization of air quality standards across jurisdictions. It will be argued here that this is a non-issue when it comes to transborder permit trading. The following is a discussion of each of the features listed in Table 1 in detail.

Regulatory Regime: The Choice Between Cap-and-Trade and Baseline-and-Trade

In a cap-and-trade system, regulators determine the desired ambient air quality for a particular pollutant, then issue permits sufficient to achieve the standard. The allowed maximum level of emissions is the cap. Permits are standardized, usually expressed in units of emissions per year, and transferable, which facilitates trade. Establishing a cap-and-trade program requires well-developed environmental infrastructure. Regulatory coverage should be broad, with most or all sources covered. Unfortunately, Mexico lacks the resources to establish a tough environmental regime. Mexican environmental regulations are not strictly enforced, and Mexico does not have a comprehensive permit program. As yet, there is no up-to-date comprehensive environmental inventory (although one is being developed in conjunction with the Western Governors Conference, see box, page 53). Indeed, a significant portion of the Mexican economy

Table 1. Features of Emission Trading Programs

Attribute	Description	Alternative Solutions
Regulatory Regime	Mechanism for determining total permits available for trade	Cap-and-trade; baseline-and-trade
Permit Allocation	Initial allocation of permits among potential traders	Auction; exogenous; output-based
Determination of Baseline	Determination of the baseline in a baseline-and-trade regime	Exogenous; output-based
Spatial and Sectoral Coverage	Region and industries to be covered	Limited coverage; broad coverage
Trading Organization	Whether to require trading via a centralized exchange	Private exchange; public registry; no exchange or registry
Intertemporal Flexibility	Whether to allow borrowing and banking of permits	Banking current unused permits for future use; borrowing future permits for use today; no banking or borrowing
Monitoring	Monitoring emissions by a third party to ensure environmental standards are met	Monitoring by the seller's jurisdiction; monitoring by the buyer's jurisdiction; private monitoring; public monitoring
Enforcement	Mechanism for enforcement of environmental standards	Enforcement by the seller's jurisdiction; enforcement by the buyer's jurisdiction; enforcement via private court action
Liability	Allocation of liability for failure to meet stated environmental standards	Seller liability; buyer liability
Harmonization	Whether to require uniform environmental standards across jurisdictions	Harmonize; don't harmonize

Source: Adapted from Boemare and Quirion 2002; Rosenzweig, et al. 2002 remains in the informal sector with little or no oversight by regulators. (For example, the Ciudad Juárez brick kiln industry, a major source of pollution in the Paso del Norte, is not currently subject to strict environmental enforcement.) The border region is years away from developing the regulatory institutions necessary for a cap-and-trade program.

Under a baseline-and-trade program, a baseline is established for each covered emitter. If an action is taken that reduces emissions, the difference between the baseline and the new level of emissions is the amount of emissions available for trading. Such a reduction is said to have generated an emission reduction credit (ERC).[4] ERCs can be bought and sold, and purchasers of ERCs would be allowed to emit above their baseline.

While the overall air quality standard is guaranteed under a cap-and-trade regime, no such assurance exists with baseline-and-trade. In fact, it could come to pass that an ERC could be used as an offset that allowed an increase in emissions at a site located in a nonattainment area. Indeed, it is even conceivable that an ERC could be generated at the same time that overall environmental quality in a region declined. To avoid these sorts of perverse outcomes, care should be taken to ensure that abatement projects used to generate ERCs meet three criteria: emission reductions should be quantifiable, permanent, and real if baseline-and-trade is to be effective.[5] An ERC is quantifiable if the emission reduction can be measured with confidence using a replicable methodology. An ERC is permanent if the reduction in emissions will continue for a substantial period of time, usually the life of the facility generating the emission credit. To be real, an ERC must represent a net improvement to the environment.

Quantifiability and permanence are essentially technical monitoring issues within the purview of environmental engineers and monitoring technicians; they will not be discussed in detail here. Reality is an economic issue as well as a technical one. Whether a given abatement project represents a net reduction in emissions depends on the project's effect on equilibrium emissions. Emissions arise as a byproduct from the production of desired products and depend on the technology used in production and on the equilibrium level of output. If abatement is achieved through the adoption of a new technology with lower emissions per unit of output, the reduction in emissions will represent a net gain for the environment. But, if abatement arises from a reduction in output, the outcome may not be a net emission reduction because market forces will cause output to return to the equilibrium level. More specifically, when a firm reduces output to create an ERC, the reduction in output will cause the market price of the goods being produced to rise compared to what it would have been. The higher price provides an incentive for other firms to expand output. Ultimately, expanding production will return prices and production to their initial equilibrium levels. If the firms that expand output use the same technology as the firms that create the ERC, emissions will also return to their initial level. Thus, there will be no net environmental gain and the original abatement project would not produce a real reduction in emissions. Of course, in many cases, the firms expanding output will be using newer production facilities characterized by lower emission rates, so that expanding production will not cause emissions to return to their initial levels. In this case, the abatement project does result in real emission reductions, but the net result is less than implied by the original project.[6]

An example further illustrates the point. Suppose a brick kiln operator agrees to cease production to generate an ERC, which he sells to a manufacturer. The manufacturer then uses the ERC as an offset for a new production facility. Now consider two cases. Given that demand is unchanged, the exit of the brick kiln operator will result in a higher price for bricks locally. This provides an incentive for another operator to expand production to satisfy the demand left unsatisfied due to the ERC. Indeed, if the original brick kiln operator is unscrupulous, he could open a new facility, earning income from the ERC while still producing bricks.[7] In any case, there is no reduction in brick production and no reduction in emissions. Thus, the abatement from the reduction in brick production underlying the ERC is not real. Allowing the manufacturer to use the ERC as an offset would mean deterioration in the local environment.

Suppose now that the demand for bricks has declined, perhaps due to a slump in construction activity. Further assume that the decline in demand was sufficient enough that the brick kiln operator would shut down whether he sells the ERC or not. Again, the emission reduction underlying the ERC is not real because the ERC does not represent a reduction in emissions net of other actions that the brick kiln operator would have undertaken anyway. Using the ERC as an offset would result in a net increase in emissions, so it should not be allowed.

Of course, determining whether an emission reduction is real or not can be difficult in practice because it involves evaluating a counterfactual. That is, it requires evaluating what would have happened had the ERC not been issued.

Cap-and-trade and baseline-and-trade each have their advantages and disadvantages. With a cap-and-trade program, the overall permit level can be set to incorporate health and other environmental externalities in an optimal fashion (Dewees 2001). On the other hand, a cap-and-trade program is more complex to administer and must be implemented on a region-by-region basis. Baseline-and-trade programs can be implemented on a project-by-project basis—a significant advantage on the border. Moreover, a baseline-and-trade program can be established in the absence of a full environmental inventory and with incomplete regulation. For the present, a baseline-and-trade program implemented on a project-by-project basis is the only practical alternative on the U.S.-Mexican border. Baseline-and-trade was adopted by both the El Paso Electric Brick Kiln Project and CleanAir Canada (see boxes, pages 107 and 109).

Initial Allocation of Permits

There are three economically distinct methodologies for determining the initial allocation of permits: auction to the highest bidder, allocation exogenous to the firm, and an output-based allocation (Boemare and Quirion 2002; Rosenzweig 2002). Economists generally recommend the use of auctions for allocating permits for three reasons (Boemare and Quirion 2002; Goulder 1995; Jensen and Rasmussen 2000). First, auctions allocate permit efficiency. Firms with higher abatement costs will purchase more permits while firms with lower abatement costs will choose to forego the purchase of permits in favor of reducing emissions.[8] Second, revenue generated from auctions can be used to reduce distortionary taxes, such as

Structuring Border Trades: El Paso Electric and Brick Kilns[1]

As discussed in Chapter I, El Paso Electric Company (EPE) is using transborder emission trading to meet nitrogen oxides (NO_x) emission targets at its Newman Station plant. Newman Station includes three grandfathered electric generating facilities that are natural gas-fired boilers. EPE must reduce NO_x emissions below stricter new levels or obtain additional allowances. Rather than install on-site abatement technology, EPE determined it would be more cost-effective to obtain additional allowances by using credits generated in Ciudad Juárez.[2] These credits are generated by replacing existing primitive brick kilns with new, low-emission Marquez kilns, thereby reducing PM_{10}. Texas law allows inter-pollutant trading under some circumstances. The brick kiln project involves the exchange of reductions in PM_{10} emissions for NO_x. In designing the emission trade, EPE and the Texas Commission on Environmental Quality (TCEQ) had to deal with a number of the issues inherent in the design of emissions trading programs.

Baseline

Determining the emission reduction from conversion to Marquez kilns involved two steps. First, field tests were conducted by New Mexico State University. These determined that PM_{10} emissions and emissions of some volatile organic compounds (VOCs) were significantly reduced when using Marquez kilns compared to standard kilns. In the second step, EPE constructed a test kiln in Sunland Park, N.M., near the Texas border. Emissions from these kilns were measured using the methodology established by the U.S. Environmental Protection Agency (EPA) for sampling and analysis of emissions from unmodified and modified kilns. Testing determined that the reduction in emissions available for credit creation was 3.3 tons of PM_{10} per kiln per year. By using well-established, replicable methodology, EPE established quantifiability for the brick project. The emission reductions are also permanent in that they can be expected to last for the life of EPE's Newman Station facility.

The emission reductions are also real; the credit is generated by substituting a low-emission technology rather than by reducing brick production.

Coverage

EPE indicated that it would give preference to kilns located near the U.S.-Mexican border. However, any kiln in the *municipo* of Ciudad Juárez is eligible.

Monitoring and Enforcement

Issues associated with monitoring and enforcement are greatly reduced because the proposed kiln modification involves a one-time process change. Each affected kiln owner enters into an agreement with EPE under which EPE funds construction of a Marquez kiln. In exchange, the kiln owner agrees to the destruction of his existing kiln and operates the new kiln in a manner that will create credits for EPE. Texas requires EPE to provide an annual report documenting the ongoing use of the new kiln.

Liability

Any enforcement action will involve EPE only. No enforcement action is expected by Mexican officials.

Harmonization

Enforcement resides with TCEQ and is governed by the Texas State Implementation Plan. EPE must comply with Texas law.

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[1] This section is based on El Paso Electric 2003.

[2] EPE advocated aggressively for statutory and regulatory changes, which culminated in the passage of 30 TAC § 101.337. This lobbying strategy was an integral part of EPE's strategy for emission targets.

Transborder Trades: The Experience of CleanAir Canada[1]

Smog and acid rain are important environmental issues in eastern Canada. CleanAir Canada sponsors an emissions trading program designed to reduce smog and acid rain in eastern Canada by limiting emissions of nitrogen oxides (NO_x) and sulfur dioxide (SO_2). From its inception, CleanAir Canada recognized that prevailing weather patterns made the midwestern United States a major source of acid rain precursors in Canada and that an effective program would require transborder trades. With this in mind, procedures were developed that facilitated international emissions trading between Canada and the United States.

Before a project is certified, applicants must provide a protocol that includes a general description of the emission project and details the qualification methodology. The protocol involves assessing five core criteria: real, additional, verifiable, quantifiable, and unique. Certification of an emission reduction credit (ERC) requires a creation report describing the quantity of emission reduction. Each creation report must be accompanied by a verification report prepared by an independent third party. For projects originating in the United States, the U.S. Environmental Protection Agency is an acceptable third party for verification purposes.

Prior to certification, each project is subject to a review process designed to ensure that only qualified projects are certified. This process includes review by outside experts and requires confirmation by a multi-stakeholder panel. Once approved, a project is re-certified each year during the life of the ERC.

In developing projects for registry with CleanAir Canada, great care is taken to seek out and develop public support. Projects without such public support are usually rejected. For example, local opposition to a project originating in the United States would usually result in rejection of that project.

[1] This section is based on CleanAir Canada 2002; 2004.

sales taxes, thereby improving overall economic efficiency. The third argument for auctions has more to do with equity than efficiency. It is often asserted that giving permits free of charge to industry would be a give-away of public assets and that this cannot be justified for reasons of justice. Of course, this argument can be stood on its head: Industry has already been allocated emission permits and to force it to now pay for those permits represents an unfair tax on the industry, precisely when industry is being asked to incur new abatement costs. There is no economic criteria by which this equity issue can be settled; the solution becomes a political question.[9]

The most common exogenous criterion for allocating permits is grandfathering, under which historical emissions are used to allocate permits.[10] Grandfathering is generally not recommended as it may introduce a bias against new firms that must purchase permits while existing firms receive them for free.[11] Moreover, grandfathering rewards bad behavior by giving the most permits to precisely the facilities generating the most emissions. In the extreme, the prospect of earning a more generous allocation might even induce bad behavior in the run-up to establishment of an emissions trading program. A final criticism against grandfathering is that it reduces the incentive to develop innovative abatement technology because innovation reduces the value of permits.

With an output-based allocation, firms receive an allocation of permits based on production—more production results in more permits. Such an allocation is dynamic in that it changes with current industry conditions. Output-based allocations have generally been superior to grandfathering. First, new entrants into an industry are automatically given an allocation of permits so incumbent firms cannot use permit allocations as a barrier to entry (Malik 2002). Output-based allocations are not based on an individual firm's past emissions, so they do not reward past bad behavior. Thus, output-based emissions, unlike grandfathering, do not provide an incentive to pollute in anticipation of a higher allocation. Finally, output-based allocations reduce the incentive to relocate production to a pollution haven because output at a new location would count against a firm's allocation (assuming that the new location is covered by an emissions trading program). A problem with output-based permit allocation is that it subsidizes production. Assuming that emissions associated with new production meet preset standards, a firm does not have to purchase new permits to increase output. But this means a firm can increase emissions, which imposes costs on society, without themselves incurring costs. Thus, individually and collectively, firms have an incentive to both produce and emit more than is socially optimal.

The existence of market power influences the optimal allocation of permits. When emission markets are competitive, the initial allocation of permits is irrelevant to efficiency because trading will continue until permits are optimally allocated (Montgomery 1972). However, when one firm gains a significant share of the market so that it can influence prices, markets will no longer allocate permits correctly because the monopolist will withhold some permits from the market to drive up the price. This adverse outcome can be mitigated by allocating permits equal to the optimal permit distribution that would arise under competition (Hahn 1984). Of course, if regulators know the optimal allocation, permit markets are hardly necessary. Still, to the extent that regulators can approximate the optimal allocation, then matching the initial allocation to this will improve market performance.

Closely related to the initial allocation of permits for a cap-and-trade regime is determining the baseline for a baseline-and-trade regime (Brown and Walker 2003). Baselines can be based on exogenous factors or on output. Because baseline-and-trade schemes are not universal in their coverage, auctions are not relevant. After all, an emitter could avoid incurring the cost of purchasing permits in an auction simply by refusing to participate. The pros and cons of grandfathering and output-based allocations outlined in the context of cap-and-trade are relevant to the determination of baseline. Despite its drawbacks, the most commonly used methodology for determining a baseline is grandfathering. Alternatively, one could establish a single baseline for an entire industry. This has the advantage that, once established, the baseline could be applied to all firms in the industry. The problem is that it may result in a standard that is too strict, making it difficult for firms not using cutting-edge abatement technology to make improvements that actually generate emission credits. This, therefore, makes an emissions trading program non-operational. A third approach would be to establish a baseline, not by industry, but by technology. This would allow firms not using cutting-edge technology to still generate emission credits. This is the approach used by the El Paso Electric Brick Kiln Project (see box, page 107).

Sectoral and Spatial Coverage

A major concern with emissions trading is that it could result in pollution hotspots. Restricting coverage may be necessary to avoid hotspots, but doing so has the unfortunate effect of limiting the number of emitters included in a trading program. There are several reasons why this is so. First, decreasing coverage lowers the probability that the pool of traders will include firms with both high and low abatement costs, thus limiting the benefit-from-trade (Boemare and Quirion 2002). There are three general categories of gains-from-trade specific to emissions trading. First is the revenue that accrues to the seller, second is the reduced abatement cost accruing to the user, and third is improved environmental quality that accrues to society generally. For these gains-from-trade to be realized, differences in abatement costs among participants must exist. This argues against limiting coverage and for inclusion of the maximum number of participants from diverse sectors using different technologies and production processes.

The second reason for maximizing coverage to the extent possible is to increase market efficiency. Specifically, a major advantage of using markets to allocate permits is that prices can be used as a signal to market participants of the relative value of permits. Firms can use this information to determine their optimal level of abatement activity and permit use. If the price of a permit is high, firms will choose to increase abatement activity; if prices are low, firms will acquire permits via purchases. Generally speaking, market prices more accurately reflect true opportunity costs when transaction volume is greater (Andersson 1997; Liski 2001). In thin markets with few transactions, prices will reflect conditions as of the last trade, which may or may not reflect current conditions. In such a situation, prices are said to be stale. These stale prices may provide firms with incorrect signals, distorting the incentives they face in deciding what abatement activity to undertake. Since including more emitters will increase trade volume, increasing coverage should also increase market efficiency. Unfortunately, expanding coverage sufficiently to make a significant impact on market efficiency is unlikely in the context of the border, where participation is likely to be limited, at least at first. This means posted prices will be an unreliable guide for future transactions and transaction costs will be high. Steps to mitigate these problems, such as streamlining regulation, should be considered.

Increasing the number of emitters covered reduces the market power of any one trader, which is the third benefit of expanded coverage. Market power adversely affects emissions markets by reducing the volume of transactions. A seller with market power will restrict sales to raise prices, while a buyer with market power will restrict purchases to hold prices down (Boemare and Quirion 2002). In either case, lower trading volume prevents full realization of the gains-from-trade from permit trading. Market power in emissions markets can have implications for other markets as well. A firm that gains a monopoly position in the permit market could restrict access by product market competitors, thereby gaining a monopoly position in its product market (Misiolek and Elder 1989). By increasing coverage, the probability that any one firm can gain market power is lowered.

Markets perform better with greater numbers of participants, which argues for maximizing sectoral and spatial coverage to include the most emitters possible. This conclusion, however, is conditional on the assumption that location does not affect the damage from emissions. The concept of mixing uniformity is useful in this context (Hanley, et al. 1997). Mixing uniformity refers to the degree to which a pollutant emitted at one location contributes to the pollution potential at another location. Mixing uniformity varies by pollutant type. At one extreme are greenhouse gases, which are mixing uniformly across the globe. The impact of particulate matter, specifically PM_{10}, on the other hand, is much more localized and measured in tens of miles. The mixing uniformity of a pollutant can depend in a complicated way on climate and geography. The bowl formed by the Juárez and Franklin Mountains in the Paso del Norte, for example, forms a region that tends to trap ozone and in which relatively uniform mixing of ozone occurs. At the same time, the prevailing westerly winds cause the ozone plume from Paso del Norte to extend in an easterly direction (see Figure 1 in Chapter I).

Limiting spatial coverage of an emissions trading program may be necessary when pollutants do not mix uniformly. Otherwise, permit trading might cause unacceptable high concentrations near emitters that have obtained offsets in lieu of further controls, thus creating hotspots. In this context, both Texas (TNRCC 2002) and California (RECLAIM 2004) restrict trading to only those emitters within the same bubble. A bubble is a limited area, usually corresponding to a single urban area, in which a pollutant is assumed to be mixing uniformly. An alternative to using bubbles is to define "exchange rates" between regions with the rate of interregional pollutant transportation determining the coefficient of exchange (Hanley, et al. 1997). Thus, if 20% of a pollutant emitted at A diffuses to B, then a user at B can apply only 20% of an ERC generated at A as an offset. Such a system can be socially optimal; however, administrative costs may be prohibitive, and as of 2002 no program using exchange rates had been established (Boemare and Quirion 2002).

Trading Organization

Minimizing transaction costs is important in the design of an emissions trading program. Financial markets can provide insights in this regard. It is frequently suggested, for example, that an exchange[12] on which standardized emission credits trade, just as shares of IBM stock trade on the New York Stock Exchange, would minimize transaction costs. Exchanges, however, do not always lower transaction costs. They are characterized by high fixed costs and only if the volume of transactions is sufficient are they cost-effective. The fact is that most financial transactions are not made via exchanges but rather involve the direct negotiation between borrower and lender[13] or the use of an intermediary, such as an investment bank. A similar outcome is likely to be true for emissions trading on the border.

In deciding between an exchange and direct negotiation or intermediation, the trade-off is between the higher fixed cost of creating a tradable security and the lower transaction cost per trade. The nature of the market will determine which approach is most cost-effective. If it is expected that there will be an active secondary market with the same security being bought and sold numerous times, then creating a security makes sense. If trades are few or if the characteristics of the emission credit make the cost of developing a security high, then directly negotiating a transaction or using an intermediary is preferred. Markets that include a large number of participants are likely to have a higher volume, hence the organization of an exchange is more cost-effective. Similarly, when the pollutants traded are standardized, volume is likely to be higher and an exchange is more likely to be cost-effective. The greenhouse gas market provides an example that illustrates these points. Coverage is global and greenhouse gases have been standardized in terms of carbon equivalents, making securitization less expensive. Consequently, a nascent global exchange is developing and the volume of emission permits traded is growing. The trading of sulfur dioxide (SO_2) in conjunction with the U.S. Acid Rain Program provides another example. Here again coverage is extensive and the pollutant, SO_2, has been standardized. SO_2 futures are traded on the Chicago Board of Trade.

The conditions that make exchanges cost-effective are not present on the border. Coverage is likely to be limited to one urban area and standardization of emissions has yet to be completed. Creation of an emissions trading exchange specific to the U.S.-Mexican border is likely years in the future, if it should ever become practical. This does not mean emissions trading cannot be a valuable tool in achieving air quality standards, but it is likely that emissions trading will take place via direct negotiation between buyer and seller or via an intermediary acting on behalf of buyers and sellers. For example, the North American Development Bank (NADBank) may be able to play an important role as an agency that intermediates between buyers and sellers of ERCs on the border.

Intertemporal Flexibility

Intertemporal flexibility refers to the ability of firms to bank unused ERCs for later use or borrow future ERCs to use in the present. The basic conclusion coming from economic theory is that greater flexibility improves efficiency, provided there are no temporal hotspots (Rubin 1996; King and Rubin 1997; Yates and Cronshaw 2001; Innes 2003). Emission banking and borrowing allows firms to time abatement activity to maximize the benefit to the firm. Moreover, emission banking provides firms with an incentive to make investments earlier because emissions savings can be used in the future. Indeed, the heavy use of banking has been credited with the early reduction and substantially lower overall cost of compliance in the U.S. Acid Rain Program, which achieved its goals earlier than regulations required (Boemare and Quirion 2002). A further benefit of banking is that it provides flexibility in the face of uncertainty. Should emissions spike, say, due to a sudden rise in demand for the firm's product, the firm avoids compliance costs by either using banked emissions or by borrowing against future emissions (Schenmach 2000; Van Egteren and Webber 1996).

The major concern with intertemporal trading of emissions is the possibility of temporal hotspots, in which permits saved from a previous period or borrowed from a later period allow a firm to emit large quantities of a pollutant in a short period of time. The potential seriousness of such a concern depends on the characteristics of the pollutant. Ozone and PM_{10} are pollutants for which peak levels are important, for example. An obvious fix for this problem is for regulators to impose absolute limits on the level of emissions allowed in any one time period. Such a temporal constraint, when bidding, increases the cost of pollution abatement, but is necessary when temporal hot spots are a concern (Rubin 1997). A major concern specific to emission borrowing involves more politics than economics. If an industry borrows heavily against future emissions, in future time periods when the borrowed emissions come due, the industry will face heavy abatement costs to make up the accumulated deficit. The question is, Will regulators have the political will to enforce air quality standards when faced with intense industry lobbying? If not, then an industry that recognizes this will "game the system" by borrowing heavily today on the assumption that emissions will never need to be repaid, thereby creating a self-fulfilling prophesy (Boemare and Quirion 2002).[14] Two complementary solutions to this situation present themselves. First, borrowing should be limited to sustainable levels by imposing a quota on the cumulative amount that can be borrowed. Second, legislation should be put into place that limits the ability of regulators to waive emissions standards. The second fix is of interest on the border, where the ability of the Mexican Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT) to enforce existing regulations is suspect.

An interesting issue that arises with intertemporal trading is the interaction of banking and borrowing with market power. Hagem and Westskog (1998) show that creating multi-period ERCs can reduce the negative effect of market power in emission markets. When ERCs last only one period, a seller with market power has an incentive to restrict sales to raise prices. But the price increase is less in a market with multi-period ERCs. This is because a firm with market power has an incentive to reduce prices in later periods to induce buying by holdouts. Realizing this, buyers will delay purchases (in effect becoming holdouts) to take advantage of lower prices in later periods, which puts downward pressure on price in earlier periods. That is, expectations of lower prices in future periods reduce prices in the current period. The problem with multi-period ERCs is that they interfere with banking and borrowing. Thus, regulators face a trade-off between mitigating market power and less efficient intertemporal allocation. Indeed, multi-period ERCs improve social welfare, but the gain may be negligible when market power is weak (Hagem and Westskog 1998).

Monitoring, Enforcement, and Liability

Unregulated emitters adjust production to minimize private costs. The implementation of environmental regulation forces firms to alter their production techniques, thus raising private costs (although, social costs are reduced because undesirable pollution is eliminated). The desire to avoid these additional private costs provides regulated firms with an incentive to cheat. Thus, efficiency of an emissions trading system depends on both the technical ability to detect violations and the legal ability to deal with cheating to create an incentive for deterrence (Boemare and Quirion 2002). This raises interesting issues for a transborder emissions trading regime. The United States enjoys unparalleled technical and legal expertise with regard to the environment. Strict monitoring and enforcement is the norm. Mexico, typical of a developing country, has less-strict monitoring and weak enforcement. Consequently, emission monitoring and enforcement of emission reductions in Mexico may not be to the standard required by U.S. officials. One solution would be to allow U.S. officials to monitor emission reductions used as offsets in the United States, but this is likely to be politically unpalatable for both governments. While Mexicans will view such an outcome as compromising national sovereignty, U.S. citizens will be reluctant to foot the bill for enforcement of Mexican environmental laws, even when the benefits to U.S. taxpayers are substantial. A common practice in existing programs is to hire a private third party to monitor and verify emission reductions used in trades (Rosenzweig, et al. 2002). Third-party verification makes sense on the border; this avoids problems of national sovereignty because government officials are not directly involved. Moreover, when parties to the transaction pay for monitoring, verification costs are internalized within the transaction, thus improving the efficiency of markets in correctly pricing trades. Adequate penalties are critical for successful enforcement. Indeed, penalties must increase as the level of noncompliance increases for efficient regulation. Otherwise, emitters may actually choose to pollute more as monitoring becomes more strict (Heyes 2001). This perverse effect arises because some polluters find that stricter monitoring makes compliance too costly, so they choose to increase emissions. This result is prevented if penalties are sufficiently severe.

Closely related to the issue of monitoring are the liability rules that apply when a violation is detected. With seller-liability, the seller is subject to a penalty for excess emissions. Since the ERC remains valid, the buyer remains compliant. With buyer-liability, violations invalidate the ERC so that the buyer using the ERC as an offset becomes non-compliant. Liability can also be divided between both buyer and seller, with penalties accruing to both. Generally speaking, seller liability is easier to administer since monitoring and enforcement can be conducted by a single agency; however, when monitoring or enforcement is weak, pure seller liability should be avoided because sellers will be tempted to over-sell ERCs in the face of little chance of sanction. Allocating some of the liability to the buyer provides an incentive for buyers to monitor compliance. Weak monitoring and enforcement by Mexico argues for allocating liability to U.S. buyers. Under this scheme, violation by Mexican sellers would instigate enforcement action by the U.S. Environmental Protection Agency (EPA) and/or state officials. Thus, U.S. buyers would face a similar incentive for compliance as with a strictly domestic transaction.

Harmonization

Harmonization refers to the establishment of identical standards in two jurisdictions. Many observers point to differences in environmental standards between Mexico and the United States as a reason why transborder emissions trading will not work. Will Mexican officials, for example, allow enforcement of standards in excess of those required under Mexican laws?

The question is, Which ambient air standard should be enforced, U.S. or Mexican? As indicated in Chapter III, Mexican and U.S. ambient air quality standards are similar. Both U.S. and Mexican law authorize the establishment of atmospheric concentration standards. These have been developed for the six criteria pollutants, ozone precursors (volatile organic compounds [VOC] and nitrogen oxides [NO_x]), and various hazardous air pollutants (HAPs). The guiding principle in setting standards in both countries is the protection of human health. When the standards do differ, it is not necessarily true that U.S. standards are stricter than Mexican standards. The United States imposes a one-hour standard on carbon monoxide (CO); Mexico does not, but Mexico does impose a stricter eight-hour standard. For NO_x, the Mexican standard is stricter, but Mexico has no standard for the annual arithmetic average, while the United States does impose an annual standard. The United States and Mexico have the same standard for PM_{10}. Mexico has a stricter one-hour ozone standard but has no eight-hour standard. Mexico has a stricter 24-hour standard for SO_2 but has the same annual standard as the United States. Mexico has no standard for $PM_{2.5}$, while the United States has no standard for total suspended particulates.

A solution to conflicts in standards is to treat the emissions trading program as if it were a domestic transaction in the purchaser's home country, in essence where the credit is being applied, with the exception of using a third-party monitor to certify compliance in the other country. That is, if an ERC generated in Mexico is purchased by a U.S. firm, the purchaser would be allowed to use the ERC as an offset only if the transaction met the requirements for a strictly domestic U.S. trade. Mexican officials would have no active involvement in the transaction. This requires the least amount of international negotiation, yet allows use of emissions trading to achieve environmental goals at a low cost. An important point in this regard is that the selling country always benefits from emissions trading while the purchasing country only benefits if the emission reduction actually occurs. To see this, consider the situation after a trade. Emissions are lower and the selling firm has generated revenues that otherwise would not have been generated. The selling country enjoys both a stronger environment and financial gain. The buying country benefits from the improved environment, but partially offsetting this is the financial loss arising from the payment to the seller. Thus, the seller should favor any trade that the buyer is willing to authorize.

A complicating issue of harmonization is the effect of trading on employment. A wide variety of issues are considered in setting ambient air quality and point-source emission standards, as well as in determining the level of enforcement. Not the least of these issues is the impact of environmental standards on employment. Tighter standards may have a negative impact on employment and jobs. Such job loss has a different impact in a developing country like Mexico than it does in a developed country like the United States. Mexico, like other developing countries, has a limited social safety net so job loss has more serious consequences for a Mexican citizen than for a U.S. citizen. Under these circumstances, it is understandable that Mexico would place a greater value on preserving jobs when evaluating environmental regulation than the United States would. Job loss is not necessarily a byproduct of emission reduction, but certainly job loss can happen. When job loss occurs as an outcome of a U.S. firm's purchase of an ERC from a Mexican emitter, Mexican officials may not want such transactions to be consummated, even though U.S. officials favor the transaction. (While job loss may be an issue in some cases, it was not an issue with the El Paso Electric Brick Kiln Project; see box, page 107).

Emissions Trading on the U.S.-Mexican Border

Emissions trading is particularly well-suited for policy coordination on the border. The border is highly urbanized and most of the population and industry are concentrated in 14 twin cities (Peach and Williams 2000). Many of the twin cities form a single airshed where sources on one side of the border affect air quality on the other side. In three cases, twin cities are labeled nonattainment for the same pollutants on both sides of the border: El Paso and Ciudad Juárez are nonattainment for ozone, carbon monoxide, and suspended particulates; and Ambos Nogales and Mexicali-Calexico are nonattainment for suspended particulates. For all of these twin cities, studies have found that at least some pollution sources on the Mexican side of the border contribute to nonattainment on the U.S. side. These areas at least are candidates for emissions trading programs.

As part of an outreach effort, the authors conducted a series of workshops along the U.S.-Mexican border in Mexicali, Nuevo Laredo, Reynosa, Matamoros, and Ciudad Juárez. Participants from both sides of the border were invited and representatives from state and federal governments, non-governmental organizations (NGOs), academia, and the business community were included. The purpose of these workshops was to bring together interested stakeholders in an open discussion forum for examining the feasibility of emissions trading along the border. More than 200 people participated. Workshops consisted of presentations, small group discussions, and numerous other types of interactions. An important goal was to discern conditions under which emissions trading would receive public support. In this regard, six principles for designing emissions trading programs were identified:

- Emissions trading must respect the sovereignty of both the United States and Mexico

- Only mutually beneficial trades should be allowed; that is, emissions trading programs must result in improved environmental quality for both trading partners
- Emissions trading programs must not adversely affect employment opportunities in either country
- Direct negotiation between U.S. and Mexican government officials should be kept to a minimum
- Where direct coordination between governments is necessary, the negotiations should be handled by local officials when possible
- Emissions trading programs should be phased in over time; as an intermediate step, pilot programs like the El Paso Electric Brick Kiln Project should be implemented

With these basic principles in mind, the authors developed the following recommendations on the design of a transborder emissions trading program.

1. A transborder emissions trading program should be a baseline-and-trade program. Mexico does not currently have the comprehensive emissions inventory required for cap-and-trade, and environmental enforcement is weak. Both of these facts make a cap-and-trade trading scheme impractical. Further, baseline-and-trade allows for project-based trades, which are easier for U.S. officials to monitor if the seller is in Mexico and for Mexican officials to monitor if the seller is in the United States.
2. Baseline should be determined by the officials of the purchaser's jurisdiction. The asymmetry in benefits from emissions trading provide perverse incentives to regulators of the seller's jurisdiction because citizens of the seller's country benefit from both an improved environment and from the cash flow arising from the sale of the ERC. Citizens of the buyer's jurisdiction only benefit to the extent that the value of the environmental improvement exceeds the cost of purchasing the ERC. Thus, officials of the seller's country have an incentive to approve a baseline that generates only marginal, or even no, environmental benefit in the hopes of generating cash flow. The only

incentive to officials in the buyer's jurisdiction is to approve baselines that generate ERCs providing net environmental benefits in excess of abatement costs. Thus, incentives for these officials are more closely aligned with society's and should be given responsibility for determining baselines.

3. Coverage should be as extensive as possible within the twin city airsheds to achieve the maximum gain from emissions trading.
4. An Internet registry should be established for each twin city listing ERCs. A formal exchange is unlikely to be practical in the short run, but Internet registration is a low-cost way to improve market efficiency.
5. Borrowing and banking should be allowed, provided care is taken to avoid intertemporal hotspots. As argued previously, intertemporal flexibility improves efficiency.
6. Projects certified for transborder trading should adopt low-emission technology. This proposal provides two advantages. First, ERCs generated from adoption of low-emission technologies are more likely to be real than ERCs generated from reductions in production. Second, adoption of low-emission technologies is less likely to affect employment adversely.
7. Projects should be chosen for their minimum negative impact on employment. This recommendation is to comply with the concern expressed by workshop participants that emissions trading will adversely affect employment opportunities, which is a special concern among Mexican nationals. It is best not to require that projects generating ERCs have no adverse effect on employment because there may be cases in which emissions trading, while adversely affecting employment, has a lesser adverse effect than other abatement projects.
8. Care must be taken that emissions trading not create temporal or spatial hotspots. While this is more a general consideration than a concern specific to a transborder trading program, concerns about potential hotspots were frequently expressed at workshops and so should be explicitly addressed to maximize public acceptance.
9. Offsets should be more than one-reduction-for-one-pollutant with the ERC to ensure that the trade has an overall benefit to the environment and the health of the residents.

10. Monitoring should be handled by private third parties and paid for by the parties to the trade. The use of third-party monitoring is common among existing emissions trading programs (Rosenzweig, et al. 2002). They are cost-effective, and because they require parties to the trade to pay, they also internalize the cost of monitoring, which helps ensure that only socially beneficial trades take place. An important additional factor for transborder emissions trading is that the use of a private third party reduces infringements on sovereignty.
11. Primary responsibility for certifying ERC trades should rest with the officials of the buyer's home country. The asymmetry benefits that accrue from emissions trading to the seller are again at play. The seller's jurisdiction benefits from reduced emissions, improved air quality, and from the financial gains of selling ERCs; therefore, the seller's jurisdiction always has an incentive to certify a trade, even when environmental gains do not justify doing so. On the other hand, for a trade to benefit the citizens of the purchaser's jurisdiction, transportation of the pollutant must be sufficient such that emissions are reduced in the neighborhood of the purchaser. When this condition is not met, officials of the buyer's jurisdiction should not approve the use of the ERC as an offset. Thus, the officials of the seller's and buyer's jurisdictions face different incentives—the seller's to always approve and the buyer's to approve only if the ERC generates environmental benefits near the buyer. Because only mutually beneficial trades should be approved, only the buyer's jurisdiction has the correct incentive.
12. Enforcement should be the primary responsibility of the purchaser's jurisdiction. Even if no true emission reduction occurs, the seller's jurisdiction benefits from the revenue generated from the sale of the ERC. Thus, the incentive to enforce emission reduction is attenuated for officials of the seller's jurisdiction. The buyer's jurisdiction only benefits if emission reduction actually occurs. This provides an incentive to officials of the buyer's jurisdiction to enforce emission reductions strictly.

13. Liability should be allocated to the ERC's purchaser. Again, officials of the purchaser's jurisdiction have the incentive to enforce emission reductions while the officials of the seller's jurisdiction have a lesser incentive. Allocating liability to the purchaser ensures that the officials with the correct incentive are responsible for enforcement.
14. Air quality standards of the purchaser's jurisdiction should be enforced. This is the only arrangement consistent with national sovereignty. The buyer's jurisdiction must approve the trade, since its emissions are located at a site within its country being allowed exceedence; doing so requires the approval of local officials. The seller, in contrast, is emitting at a rate lower than required by its jurisdiction, so special permission from local officials is not needed by the seller because the seller's action is not in conflict with the laws of the seller's home country.

Endnotes

[1] The Kyoto Accord includes two "flexible" mechanisms for achieving greenhouse gas targets—joint implementation (JI) and clean development mechanism (CDM). JI allows for Annex-I countries to work together to achieve emission goals jointly. CDMs are similar but involve cooperation between the industrialized Annex-I countries and developing non-Annex-I countries. Exactly how JIs and CDMs would work was not specified by Kyoto, but as things have evolved through various rounds of negotiation by the Conference of Parties (COP), particularly the Marrakech COP, it has become clear that the main policy tool for implementing JIs and CDMs will be ERC trading, if Kyoto goes into effect (REC 2003).

[2] Systematic analyses of ERC trading programs are scarce. Schwarze and Zapfel (2000) compare two U.S. programs—RECLAIM and the U.S. Acid Rain Program. Harrison and Radov (2002) explore 10 programs, but only with regard to initial allocations of permits. Sonneborn (1999) evaluates the status of programs as of the late 1990s. Two articles that do systematically discuss elements of trad-

ing programs are Rosenzweig, et al. (2002), and Boemare and Quirion (2002). Much of the discussion in this chapter is informed by these latter two articles.

[3] Boemare and Quirion (2002) criticize the use of this terminology as ambiguous.

[4] The distinction here is between a permit, which is permission to emit a particular quantity of emissions, and an ERC, which is a reduction below a particular baseline level of emissions.

[5] A concept closely related to permanence and additivity is surplus. An emission reduction is surplus if it is over and above the emission reduction required by environmental regulations. That is problematic in the context of the U.S.-Mexican border because environmental laws, especially in the informal sector, are weakly enforced.

[6] The substitution of new technology does not have to be direct. For example, Ontario Electric purchased older, high-emission cars that were then destroyed by crushing. Studies showed that the older cars were replaced by newer vintage, lower-emission cars. The net result was a reduction in overall emissions by the total urban auto fleet.

[7] Of course, a vigilant regulator could prevent this type of unscrupulous behavior by refusing to issue the necessary permits.

[8] While beyond the scope of this monograph, the design of the auction is critical if an efficient allocation is to be achieved (Fisher, et al. 1999). A bidding system with desirable efficiency characteristics is a uniform price open auction (McGuigan 2001). With uniform price open auctions, public bids are submitted. Participants, who are able to review the bids submitted by others, are allowed to revise bids until the close of the auction. The auctioneer determines the price that clears the market and all bidders submitting a price higher than the market clearing price receive an allocation, but pay only the market-clearing price. Those who have participated in multi-unit auctions on eBay will be familiar with this type of auction.

[9] Indeed, the famous Coase Theorem states that the initial allocation of property rights is irrelevant from an efficiency aspect (Hanley, et al. 1997).

[10] Grandfathering is exogenous in the sense that past action, which cannot be altered by current behavior, is what determines the current allocation.

[11] This concern applies only if financial markets are imperfect or incumbent firms enjoy market power.

[12] The financial literature distinguishes between formal exchanges, such as the New York Stock Exchange, and over-the-counter markets, such as the NASDAQ. Almost certainly any emission credit exchange that might be established would be over-the-counter.

[13] Direct negotiations are often facilitated by a broker.

[14] This is an example of a well-known phenomenon in game theory know as time inconsistency.