Designing a Tradable Permit System
to Control SO₂ Emissions in China:
Principles and Practice

A. Denny Ellerman*

This paper discusses the problems of implementing a cap-and-trade system for controlling SO₂ emissions in China. It describes the evolution of current air emissions policy for SO₂ emissions and focuses on two critical aspects for establishing a tradable permits system in China: the transition from (non-tradable) facility-specific permits to tradable (emission) permits and the integration of tradable permits with the pre-existing pollution levy system. A major theme throughout the paper is that the requirements for establishing an effective tradable permits system do not differ greatly from those for an equally effective tax or command-and-control regime. Although each instrument has distinctive features, the differences among them are mainly ones of form. All require that the same fundamental problems be solved: How to allocate the cost burden of reducing emissions, what specific requirements to place on emitting sources, and how to ensure compliance.

INTRODUCTION

As China’s economy has grown, atmospheric pollution has become a matter of increasing concern to policymakers at all levels of government. One of the principal pollutants has been sulfur dioxide (SO₂), which is emitted in varying intensity when coal, China’s most abundant fossil energy resource, is burned. Excessive SO₂ emissions can cause serious health problems locally from high ambient concentrations, as well as non-health-related damages that can occur from acidification at some distance from the source of emissions.

The Energy Journal, Vol. 23, No. 2. Copyright © 2002 by the IAEE. All rights reserved.

Comments from Stephanie Benkovic, Noreen Clancy, Paulette Middleton, and Hongjun Kan are gratefully acknowledged. I am especially indebted to Lu Shen, candidate for master’s degrees from the Sloan School and the John F. Kennedy School of Government at Harvard University, for assistance in the research underlying this paper and to the Rand Corporation and MIT’s Center for Energy and Environmental Policy Research for funding this research.

* Executive Director, Center for Energy and Environmental Policy Research, Massachusetts Institute of Technology, One Amherst Street (E40-279), Cambridge, MA 02139-4307, USA. E-mail: ellerman@mit.edu
In recent years, Chinese environmental authorities have expressed interest in the use of tradable permits as a regulatory instrument to control SO₂ emissions.¹ This interest arises from the increasing attention given throughout the world to the use of market-based instruments as a means of achieving environmental objectives and the successful use of tradable permits to reduce and to limit SO₂ emissions in the United States. Moreover, the least-cost property of market-based instruments is particularly appealing in China, where the competition to meet social needs is great and the income level is relatively low.

This paper focuses on the two main issues that will have to be considered in designing a tradable permits program for the control of SO₂ emissions in China: the transition from non-tradable facility permits to tradable emission permits and the integration of a tradable permits program with the pre-existing pollution levy system. These two issues are discussed in the third and fourth sections of the paper. The second section briefly summarizes the starting point for the implementation of a tradable permits system, namely, the existing structure of Chinese policy for controlling SO₂ emissions. Reference is made throughout the paper to the experience with SO₂ emissions trading under the U.S. Acid Rain Program (Ellerman et al., 2000), which offers an instructive example as the first large-scale application of tradable permits for controlling emissions of any kind.

This paper does not discuss in any detail the considerable standard setting, monitoring, and enforcement capabilities that will be required to reduce SO₂ emissions in China, regardless of instrument choice. Instead, a bold simplifying assumption is made: that China will successfully control SO₂ emissions at an appropriate level. This optimistic assumption allows the discussion to focus on the unique requirements of a tradable permits system and how they differ from those of other instruments for controlling emissions. A major theme throughout the paper is that the requirements for establishing an effective tradable permits system do not greatly differ from those for an equally effective tax or command-and-control regime. Although each instrument has distinctive features, the differences are mainly ones of form. All require that the same fundamental problems be solved: how to allocate the cost burden of reducing emissions, what specific requirements to place on emitting sources, and how to ensure compliance.

The transitional nature of the Chinese economy is recognized but not discussed in detail. China's transition is twofold, from a pre-industrial and socialist economy to one that is industrial and market-oriented. Market-based

¹ Studying the feasibility of adopting a cap-and-trade system for the control of SO₂ emissions in China constitutes a major component of the activities under the existing Cooperative Agreement between the U.S. Environmental Protection Agency and China's State Environmental Protection Administration at the request of the latter. This paper is an adaptation of a report written as part of these cooperative activities and translated into Chinese by Hongjun Kan.
instruments presume markets; and, where the set of laws, institutions, and practices that are associated with market economies are not fully developed, these instruments, whether they be taxes or tradable permits, will experience a transitional phase. The conditions characterizing this transition do not require that the goal of efficient and effective environmental control be abandoned, but successful implementation of market-based instruments will depend on the pace of the more general economic transformation.

2. THE EXISTING FRAMEWORK FOR SO₂ CONTROL IN CHINA²

2.1 General Context

Responsibility for the development and implementation of environmental policy in China is split between national and local levels. In general, the central government provides policy direction and the legal and institutional framework while local levels of government are responsible for implementation and enforcement, often including the choice of appropriate measures to achieve national goals. At the national level, the two principal bodies are the State Council, which provides broad policy guidance, and the State Environmental Protection Agency (SEPA), which is the administrative agency charged with the development and elaboration of this policy. At the local level, the Environmental Protection Bureau (EPB) is responsible. This division of responsibility is similar in some ways to that in the United States, where primary and secondary standards for criteria pollutants are established at the national level and states are expected to comply with these standards through State Implementation Plans.

Despite this similarity in structure, three salient differences should be noted in any comparison with the United States. First, the devolution of authority to the local level is greater in China than in the United States, at least at this stage of policy development. Second, more experimentation occurs at the local level, typically with pilot programs, than has been the case in the United States. Moreover, the central authorities in China encourage this experimentation to determine effective measures that can be adopted and propagated nationally. Third, the significant devolution of responsibility to the local level and the emphasis on experimentation result in a more incremental approach to policy development in China than in the United States. Chinese policy emerges, through a process that is both pragmatic and ad hoc, by successive steps, each of which provides more guidance from the center and a stronger legal basis for specific actions at the local level.

In the late 1970s and 1980s, environmental policy in China could be characterized as taking a direct but selective project- or process-specific approach. Certain projects, known as National Environmental Pollution

² This section draws heavily from Benkovic (1999) and Luo et al. (2000).
Treatment Projects, new facilities, and some highly polluting processes, were designated for controls and for special allocations of resources in the national five-year plans. Unless singled out by process or project, most existing facilities were unaffected. The adoption of the Air Pollution Prevention and Control Law (APPCL) in 1987 signaled the end of this selective approach and the beginning of the current approach, which is more comprehensive in scope and more indirect in the choice of instrument.

This evolution in environmental policy can be seen in the adoption of policies and measures for controlling SO$_2$ emissions. The first general measure to address SO$_2$ emissions dates back to 1982 when the pollution levy, which was introduced in the late 1970s, was applied to industrial SO$_2$ emissions. More serious attention began to be given to SO$_2$ emissions in 1990 with the State Council’s “Suggestions on the Development of Acid Rain Control.” This document enunciated the concept of Two Control Areas to designate areas receiving priority in controlling emissions. The first of a series of extensions in coverage and increases in the rate of the SO$_2$ pollution levy took place in 1992. The Ninth Five-year Plan in 1996 introduced the concept of Total Emissions Control, which shifted the focus of regulatory attention from emission rates to total emissions. Finally, in April 2000, the People’s Congress adopted sweeping changes to the 1987 APPCL that incorporate the policies and measures developed during the 1990s and provide a stronger legal basis for their implementation. These changes focus regulatory efforts on the most polluted areas, shift the emphasis of control from emission rates to total emission discharges, change the base of the pollution levy from excess emissions to total emissions, and establish emission permits as the vehicle by which national policy will be implemented at the local level.

This last provision is an important step away from a centrally directed, project-specific approach toward a more decentralized and comprehensive structure for controlling SO$_2$ emissions. The transition from facility permits to tradable permits is the subject of the next section after a more extended discussion of the three principal components of existing SO$_2$ emissions control policy in China: the Pollution Levy System (PLS), Two Control Areas (TCA), and Total Emissions Control (TEC).

### 2.2 The Pollution Levy System

The Pollution Levy System is the most long-standing component of China’s regulatory structure for controlling emissions and discharges of all types. In principle, it imposes a penalty on emissions or discharges in excess of some standard applying to a particular process or plant. The use of the term “levy” conveys an important legal distinction, denoting that the payment is not a tax falling within the jurisdiction of the national authorities, but a fee imposed and collected at the local level to fund both administrative expenses of the local Environmental Protection Bureau (EPB) and investment in abatement projects.
Designing a Tradable Permit System / 5

As such, the PLS illustrates the nature of relations between the national and local government levels in the development and implementation of environmental policy: The basic guidance and legal authority to impose the pollution levy derive from the national level, while assessment, collection, and use of funds reside at the local level.

Perhaps the most important effect of the PLS has been to fund the local Environmental Protection Bureaus, of which more than 1,600 have been established throughout China, employing more than 20,000 persons to implement environmental policy in accordance with the guidelines set by national authorities. The Chinese pollution levy has empowered local regulatory authorities and created a unique, decentralized administrative structure that is developing the capacity to implement and enforce national policy at the local level. As noted by other authors (Wang, 2000; Wang and Wheeler, undated), this decentralization lends itself well to endogenous enforcement, in which community pressures reflecting differences in economic development and environmental quality explain differences in effectiveness.

The incremental nature of policy development in China is illustrated in the application of the PLS to SO₂ emissions. The PLS was first applied to SO₂ emissions in 1982 as a fee of 0.04 RMB/kg (≈ US$0.50/short ton @ 8 RMB/US$) on excess emissions from industrial processes only (excluding electric utilities). With the increased emphasis on SO₂ emission control in the 1990s, a trial program was begun in nine cities in which the PLS rate was increased fivefold to 0.20 RMB/kg (≈ US$23/short ton) and it was applied to total SO₂ emissions from utility as well as industrial sources. Starting in 1996, this trial program was expanded to include all jurisdictions within the Two Control Areas. Higher levy rates have been tried in two instances: new sources face a double levy rate of 0.40 RMB/kg (Meng et al., 1999), and a pilot program with a higher tax rate of 0.63 RMB/kg (≈ US$70/short ton) was initiated in 1998 in three cities. Finally, and most significantly, the 2000 revisions to the APPCL formally changed the base for the pollution levy from excess emissions to total emissions.

Despite its success in funding the requisite administrative structure, the PLS has exhibited a number of problems. First, it applies only to medium-sized and large sources; with rare exception, smaller enterprises, particularly town and village enterprises, are not included. Even so, collections are far below what emissions data indicate they should be. ³ Second, the levy is set too low to encourage significant SO₂ abatement. A level frequently cited as being more likely to provide an effective tax, 1.26 RMB/kg (≈ $140/short ton), is roughly six times the current level in most jurisdictions. Third, the utilization of the

3. For instance, collections from electric utility sources, which are relatively large and more easily monitored than smaller sources, have been estimated to be about 25% of what could be expected, based on actual utility emissions (Benkovic, 1999).
reinvestment portion of the PLS leaves much to be desired. The target level for recycling revenues to local enterprises for abatement projects is 80%; however, the actual percentage recycled is usually estimated to be 50–60%. Moreover, the recycled portion is often given back to the business paying the levy to defray its own abatement expenditures, and this practice has led naturally enough to withholding the amount to be returned. At best, this recycling of PLS revenue as a proportion of the assessment does not direct funds to the most economically attractive abatement projects; at worst, the effective pollution levy rate is reduced from an already low level. Finally, deficiencies in emission measurement often lead to negotiated payments only roughly—if at all—related to actual emissions. Negotiated payments are an effective and perhaps initially unavoidable way to raise revenue; however, for the pollution levy to significantly affect abatement behavior, the incidence of the levy must fall on actual emissions.

2.3 Two Control Areas (TCA)

The State Council’s 1990 “Suggestions” introduced the concept of two control areas, one for acid rain and the other for ambient concentrations of SO₂. This concept was embedded in the planning that culminated in the Ninth Five-year Plan, adopted in 1996. The TCA component of SO₂ control policy is not an instrument like the pollution levy for affecting abatement behavior, but rather a means for prioritizing SO₂ control efforts. It designates the standard, and thereby the cities and regions that should receive extra attention and resources. The SO₂ Control Zone comprises cities in North China where the ambient SO₂ concentration exceeds 60 μg/m². The Acid Rain Control Zone includes areas in South China where the pH value of precipitation is lower than 4.5 and sulfur deposition exceeds the critical load. Within the two control areas, certain municipalities are designated as “key,” and they are slated to receive more aggressive emissions control targets.

As a device for prioritizing abatement efforts, this component of Chinese environmental policy offers no guidance regarding instrument choice. It is intended to work in conjunction with the pollution levy, Total Emissions Control, emissions trading, and any other measure that might prove useful and effective. As can be seen with the evolution of the PLS for SO₂ emissions, changes in either coverage or levy rate are tried first in key municipalities; then, if proven successful, the changes are applied more broadly within the Two Control Areas and eventually in the non-TCA areas of China, as environmental priorities and political limitations dictate. The changes in the APPCL of April 2000 and their implementation in the Tenth Five-year Plan have maintained and intensified the focus on the Two Control Areas by setting specific targets for
Designing a Tradable Permit System / 7

total SO₂ loadings and expanding the number of key cities slated for priority efforts to one hundred from forty-seven during the Ninth Five-year Plan.⁴

2.4 Total Emissions Control

Total Emissions Control is the newest and, since 2000, the most important element of Chinese environmental policy. Specifically, it places a ceiling on total emissions for twelve major pollutants, including SO₂. The concept arose in 1996 from a series of State Council documents and SEPA action plans, and became incorporated by amendment into the Ninth Five-year Plan to work in concert with the existing guidance concerning the Two Control Areas. The 2000 revision of the APPCL embedded TEC in the fundamental law and thereby shifted the focus from controlling concentrations to controlling total loadings. At present and in the absence of clearly specified and credible sanctions for exceeding the ceilings, the TEC provides a target more than a cap, but it still provides a measure for judging the effectiveness of control measures.

The national limit for SO₂ emissions in the Ninth Five-year Plan was 24.5 million metric tons (approximately the 1995 level of emissions),⁵ and this national limit was allocated among the thirty-one regions. These regional targets were intended to limit emissions for all areas within the TCA zones to the 1995 level, except for a group of municipalities in Eastern China that received target allocations at a level 10% below the 1995 baseline because of their greater population density, higher level of economic development, and more abundant resources for implementing policy.

As of 1999, SO₂ emissions in China totaled 18.6 million tons, 25% below the national target, and all but three regions met the regional targets in the Ninth Plan. Although local efforts to control emissions from major sources contributed to this decline in SO₂ emissions, two other aspects of the restructured Chinese economy played a large role. First, economic changes and explicit policy succeeded in closing down small enterprises, particularly small coal mines producing relatively high-sulfur coal, and small, inefficient, thermal electricity-generating units. Second, China’s ongoing economic transformation has diminished production from large and medium-sized state-operated enterprises (SOEs) whose output is typically emissions-intensive.

The Tenth Five-year Plan has set a national TEC ceiling for 2005 of 18 million tons for all of China (approximately the 2000 level), and a more

⁴ Ambient air concentrations of SO₂ emissions in Chinese cities have been falling slowly but steadily over the years, but much remains to be done (Wu, Wang, and Meng, 2000). Monitoring results in 1999 indicate that approximately one-third of 338 cities in China did not meet National Class 2 standards for normal residential areas (0.06 mg/m³) and 15% did not meet the less stringent Class 3 standards applicable to special industrial zones (0.10 mg/m³).

⁵ Actual SO₂ emissions for the 1995 base year were 23.7 million tons. The 2000 target reflects additions to the base year that are said to reflect unexpectedly low SO₂ emissions during 1995.
restrictive total of 10 million tons for the Two Control Areas. Allocation of this target to subordinate jurisdictions is currently taking place in conformance with the Two Control Area criteria, with special focus on the one hundred key municipalities characterized by high existing SO₂ pollution, high SO₂ emissions, or failure to achieve prior emissions targets.⁶

In contrast to the Ninth Five-year Plan, in which the 24-million-ton national cap was allocated only to the regional level, the regional caps in the Tenth Five-year Plan are being distributed to lower levels of government.

3. FROM FACILITY PERMITS TO TRADABLE PERMITS

The provision in the 2000 amendments to the APPCL requiring facilities to have emission permits established an important precondition for controlling SO₂ emissions. These permits are not tradable permits; they might more properly be called facility permits since they impose conditions that limit emissions in some manner at a particular facility. Tradable (emissions) permits, often called allowances, entitle the holder to emit a specified amount without further conditions; and they can be distributed to a facility in an amount that may be less than emissions at the facility. The development of a tradable permits system for SO₂ emissions in China can be usefully seen as a movement from these non-tradable facility permits to tradable emission permits.

Both types of permit effectively reduce emissions, although one does so by imposing emission-reducing conditions on the operation of individual facilities while the other requires that emissions from all affected facilities be "covered" by allowances equal to emissions. Emissions trading can occur with both forms of permit. In one case, a tradable credit is granted after appropriate administrative review for emission reductions beyond what is required by the facility permit, while in the other, trading is a matter of right. Both permits create rights to emit and allow emissions trading. In one case, the rights to emit attach to the facility meeting the specified conditions and some portion can be traded but only after administrative review and approval. In the other case, the rights to emit are explicitly embodied in the allowances, which are tradable without further review and therefore readily separable from any particular facility.

The process of moving from non-tradable facility permits to tradable emission permits in China will differ from the process that has occurred in the U.S. and other OECD countries where tradable emission permit systems have been implemented or are being proposed. In these latter countries, facility permits with all associated monitoring and enforcement capabilities are already in place, and the cap-and-trade system is simply added. In contrast, China has

⁶ Wu et al. (2000) provide a proposal for allocating the 18-million-ton national and 10-million-ton TCA targets to the 31 regions.
Designing a Tradable Permit System / 9

had little experience with issuing, monitoring, and enforcing facility permits and the two types of permit will be developed concurrently.

Avoiding facility permits altogether and moving directly to allowances is an alluring prospect, but the practical reality is that facility permits will be indispensable in the early stages of implementing emission control measures, particularly in a country where the markets that are assumed by market-based instruments exist in rudimentary form. Moreover, wherever environmental goals are multiple, such as to improve ambient air quality in cities and reduce acidic deposition, more than one instrument is desirable. For instance, in the United States, facility permits coexist with tradable permits, effectively allowing multiple goals to be achieved.7

Even so, there is an advantage in moving quickly to primary reliance on a cap-and-trade system. Gaining that advantage will happen more quickly if the local EPBs design the facility permits to be consistent with the eventual use of tradable emission permits. Once the national and regional TEC caps have been allocated down to the local level, the most important issue facing the EPBs will be what instructions to include in facility permits to ensure that the local cap is not breached. The form these instructions take will determine not only how costly it will be for each EPB to achieve its cap, but also whether a tradable permits system will emerge in China. Accordingly, this section discusses how the distinctive requirements of a tradable emission permit system can be incorporated in the design and implementation of facility permits to encourage the development of allowance trading.

3.1 Establishing Tradability and Allocating the Cap

The EPBs enjoy considerable discretion in the specific requirement they impose on emitting facilities within their jurisdictions. For example, firms might be instructed to pay a tax per unit of emissions that is sufficiently high to motivate them to reduce emissions enough to stay below the local cap. Alternatively, sources might be required to install equipment or undertake practices that will reduce aggregate emissions to the required level. Finally, as a logical extension of the process by which the national TEC cap is assigned to subordinate levels of government, each facility might be allocated its share of the local cap and told simply to make sure that emissions do not exceed this amount.

An instruction with an embedded quantity limit differs from an allocation of tradable permits in like quantity in two respects. First, the facility would receive a cap of, say, one hundred tons instead of receiving one hundred allowances to emit one ton. Second, the facility is instructed to stay within the

7 In the United States, ambient air quality standards are met through the use of conventional command-and-control regulations, and these regulations can and in some cases do restrict the extent to which facilities can trade SO2 emissions under the Acid Rain Program.
one hundred tons limit instead of being instructed to return an allowance for
every ton emitted. In the absence of a market for allowances, the two sets of
instructions would be equivalent in effect. Facilities would reduce emissions to
stay within the quantity limit or the number of allowances and they would incur
differing marginal costs of abatement. All that would distinguish the two
requirements would be the formalities of compliance. In the one case,
determining that emissions are less than the quantity limit would suffice; in the
other case, a further step of surrendering allowances equal to emissions would
be required.

Still, there is a point in issuing the quantity limit in the form of
allowances when markets are not well developed. It is virtually certain that the
distribution of the EPB cap to firms, whether in the form of a quantity limit or
of an equal number of allowances denominated in tons, will not be such as to
equalize marginal costs among all emitting units. Initially firms may treat their
allowance allocations as quantity ceilings and incur differing marginal costs of
compliance; however, if the ability to sell and to buy is clearly understood to be
acceptable, firms will seek to reduce their costs by finding trading partners to
eliminate differences in marginal costs. Thus, issuing the quantity restriction in
a form that makes trading emission reductions at the margins practicable
provides the incentive for firms and intermediaries to create a market in
allowances with the consequent gains in economic efficiency.

Issuing the instruction in the form of allowances creates another
problem that is sometimes seen as unique to tradable permit systems: allocation,
or deciding how many allowances to grant to each firm. Although the form is
different, the fundamental task—distributing the cost burden of the required
emission reduction among firms and sectors—is no different from what an EPB
would have to do if it chose to meet the cap through use of the more familiar
command-and-control measures. The task of allocating allowances seems so
difficult mostly because the distribution of the cost burden is explicit and
transparent. Imposing a uniform emission rate limit or a technology mandate on
all sources sufficient to achieve the cap seems to provide a more objective basis
for the reductions required of all firms, but the burden of emission reduction
will have been distributed just the same.

Even so, the allocation of permits to emitting sources will be easier if
some basic principle can be used as a starting point, and that principle could be
the standard that might have been applied in the absence of a tradable permits
system. This was the case in the U.S. Acid Rain Program. An emission rate of
1.2 pounds of SO₂ per million Btu of heat input (≈ 137 grams per kilocalorie)
had become embedded in the air emission regulatory structure in the United
States as an appropriately stringent level of control that would apply eventually
to all sources. Accordingly, the initial principle for allocating allowances to

10 / The Energy Journal
firms was based on the product of this emission rate and historical heat input.\textsuperscript{8} However, many adjustments were made through some thirty distinct provisions in the enabling legislation.\textsuperscript{9} These adjustments in the allocation of allowances redistributed the cost burden among facilities in the same way that one might imagine that a regulator who recognized the implications of cost heterogeneity would do in implementing a uniform standard.

Whether a regulator would have the will and the knowledge to impose differential standards reflecting cost heterogeneity in a manner that would achieve both equity and efficiency can be questioned, but allocating the quantity limit in the form of tradable permits removes the issue. The regulator can allocate allowances, using all the knowledge available at the time, in what seems to be the most equitable or efficient way and leave it to participants, acting in their own self interest, to eliminate any differences in marginal cost that emerge. Unlike the zero-sum game that makes the initial allocation of allowances so difficult, this second, market-driven reallocation of permits (and of abatement effort) enables both sellers and buyers to benefit, and total societal costs to be reduced, as well. Furthermore, each deviation in one direction is automatically offset by a deviation in the other direction, unlike what usually occurs in tax or command-and-control systems. When these control systems are adjusted to meet equitable concerns, some departure from either effectiveness or efficiency, if not both, is typically incurred.

3.2 The Scope of Trading

 Tradable permits imply some domain in space and time over which emissions can be traded. When trading occurs through the creation and transfer of credits within the confines of facility permits, this issue is decided on a case-by-case basis. Unfortunately, the review process required to make this determination imposes high transaction costs, which generally lead to the poor results associated with this form of emissions trading (Hahn and Hester, 1989). A tradable permit system avoids these costs by making emissions trading a matter of right; however, the scope of trading must be defined at the outset.

\textsuperscript{8} Sources having an emission rate in 1985 less than 1.2 lb SO\textsubscript{2}/mmBtu were issued permits equal to the lower rate multiplied by baseline energy use. The resulting cap required a reduction of emissions that was deemed sufficient to achieve the environmental objective of eliminating damage from acid rain.

\textsuperscript{9} See Joskow and Schmalensee (1998) or chapter 3 of Ellerman et al. (2000) for a discussion of these exceptions. The level of the aggregate cap was not increased greatly because the generosity to some was recouped through a "ratchet" provision that reduced the allocations slightly to everyone else.
3.2.1 The Spatial Dimension

The geographic scope of trading can be defined as narrowly as several sources within an industrial facility or as broadly as all sources within an EPB’s jurisdiction, or even more broadly to include sources in adjacent EPBs. The basic consideration is the environmental effect of the marginal unit of emissions, but this effect must be interpreted realistically. The environmental effect of emissions from several exhaust stacks at a single facility can be assumed to be the same, and this logic can be extended easily to emissions from adjacent facilities. Since it would make no sense to trade with sources that have no impact on the environmental objective embodied in the cap, the question becomes, “how far can the trading zone be extended?”

An EPB with several geographically distinct areas of environmental concern within its jurisdiction has several alternatives. One would be to allow trading within each area but not among them. Rarely, however, do emissions affect only the area where a source is located. Typically, some pollution within any given area originates from emissions transported by wind from other areas. One way to address this concern is to assign different redemption values to permits obtained from sources in different areas. Thus, permits issued in area A could be deemed to cover a ton of emissions for all sources in area A, but permits issued in the adjacent area B would be deemed to cover only half a ton if presented for compliance by a source in area A. Given sufficient information about the atmospheric transport and transformation of emissions, schemes of differential pricing can be devised; however, such information is not always available, and even when it is, the added complication and cost may overwhelm the environmental benefit. When wind direction is variable and atmospheric transformation depends upon meteorological conditions that also vary, it is often found that different areas are polluting each other. This reciprocal nature of pollution suggests yet another alternative, which is to broaden the scope of trading to include both areas so that permits issued in areas A and B are equally valid when presented for compliance in either area. This last alternative is especially attractive when there is considerable uncertainty about what happens to emissions from particular sources, or when the policy goal is to effect a general reduction in emissions in order to meet multiple environmental goals.

Even with the uncertainties and reciprocal nature of pollution, a potential problem remains: “hot spots” or the possibility that the pattern of abatement arising from a wide, unrestricted market in allowances may lead to concentrations of emissions in certain areas that will violate local air quality goals. The solution to this problem is not to restrict trading, but to use another instrument to ensure achievement of the purely local goal. This has been the case with the U.S. Acid Rain Program, which was enacted on top of an elaborate command-and-control program, designed to avoid adverse local health effects, which had been in existence for over two decades before the SO$_2$ cap-and-trade program was enacted. Since nearly all sources were in compliance
Designing a Tradable Permit System

with the pre-existing ambient air quality standards for SO₂ when the Acid Rain Program was enacted and a further 50% reduction in aggregate SO₂ emissions was required, most sources are effectively unrestricted in trading. Nevertheless, they must operate within the limits imposed by local environmental regulations. Thus, hot spots, defined as violations of local ambient air quality standards, did not appear as a result of emissions trading in the United States, mostly because of the sequence in which the regulatory structure for controlling SO₂ emissions was developed.

There is no particular reason why the sequence followed in the United States—getting the local conditions right first, then trading to deal with regional problems—should be observed in China. The practical reality in China is that, for the most part, neither local nor regional conditions for avoiding environmental damages are being met. The all-important imperative is to reduce emissions; where and how are, for the moment, secondary considerations. If allowance trading leads more surely to emission reductions, then it should be adopted because it will reduce emissions sooner. The argument is not to ignore local details, but to recognize that there is as much logic, and perhaps more, in implementing broad emission reductions first and then tending to the local details, as there is in making sure that the local details are right before engaging in emission reductions. This sequence of focusing initially on broad emission reduction goals and then tending to local details was recognized in a recent study by the Chinese Academy for Environmental Sciences, which noted that Class 2 ambient air quality standards for SO₂ are not likely to be met unless total SO₂ loadings within the Two Control Areas are reduced to below 12 million metric tons (Wu et al., 2000). This sequence is as applicable when the EPB is deciding the scope of trading within its jurisdiction as it is at the national level.

The concern about hot spots also arises with conventional command-and-control instruments, but the presumption is that the regulation imposed upon particular firms can be changed later to ensure that local air quality goals are being met. The same presumption can and should be made with tradable permits systems. If the cap is successfully enforced and is adequate in the aggregate, then it is not possible for all or even most areas to be hot spots. They will appear in a market-based system only when emissions causing the worst pollution are more costly to abate than other emissions. If hot spots appear, they can be treated with supplementary instruments—either a higher pollution levy, as discussed in the next section, or other command-and-control restrictions that can be incorporated in a facility permit. These supplementary instruments will create differences in the marginal cost of abatement, but such differences are the
logical consequence of uniform ambient air quality standards that may be more costly to attain in some areas than in others.10

3.2.2 The Temporal Dimension

Emissions trading between different periods of time can occur through banking (i.e., being able to use permits issued in one period for compliance in a later period) and through borrowing (i.e., being able to use allowances issued for use in later periods for compliance in the current period). In most allowance-based systems, banking is allowed but borrowing is not. In existing programs, banking has provided an incentive for earlier emission reduction and it has moderated otherwise volatile permit prices. This latter role is particularly significant when the spatial dimension of the trading market is limited, either for environmental reasons or as a result of slow market development, as might be the case for an economy in transition.

The incentive provided by banking to move emission reductions forward in time can be illustrated by a simple example. Imagine a firm that faces three abatement options: 1) reducing emissions by 10% at low cost, 2) reducing them by 25% at somewhat higher cost, and 3) reducing emissions by 50% at higher cost. Suppose further that the firm faces an initial requirement to reduce emissions by 10% and a later requirement to reduce them by 50%. Without banking, the firm would adopt the 10% reduction technology initially and the costly 50% reduction technology only when required; there would be no incentive to reduce emissions by 25% in the early years. Banking provides that incentive, although adoption of the 25% technology will depend upon the details of cost differences and discount rates. If adopted, emissions will be reduced more in the early years at the expense of delaying (not avoiding) the adoption of the 50% technology. Over the entire period of accumulating and drawing down the banked allowances, cumulative emissions are the same, but the timing of the required emission reduction is accelerated. For a country like China that seeks to reduce highly polluted areas quickly, such an incentive is highly desirable.

This incentive is particularly important when doubt exists about how quickly allowance markets might develop. In this example, a single firm might adopt the 25% reduction technology, even without banking, if it could find buyers for its unused allowances in a market that facilitates spatial trading. But, if the spatial market is small or non-existent, banking would provide the only incentive for firms to adopt the 25% control technology. Banking allows firms

10. Taking these supplementary measures in hot spots will increase emissions in surrounding areas; however, these areas will have reduced more than the average and are therefore less likely to have violated local requirements. If new hot spots appear, additional action can be taken until the complete set of environmental goals is achieved.
to form their own internal, temporal markets in which they can reduce costs at the same time as they move abatement forward in time.

The experience with banking in the U.S. Acid Rain Program shows that, when emission reduction requirements are phased in, banking will shift the required emission reductions forward in time. During the five-year transitional phase in this program, a total of 11.5 million allowances were banked (about 30% of the total number of allowances issued for those years) for later use when the national cap would be lowered and the marginal cost of abatement would be higher. In China, the targets under the TEC policy are also phased-in: from nearly 25 million tons in 1995 to 20 million tons in 2000, to 18 million tons in 2005 for all of China, and to 10 million tons by 2010 for the Two Control Areas. Although the 2000 target for all of China was easily met and the 2005 target is only moderately constraining (= 2000 emissions), the target of 10 million tons in 2010 will require existing firms within the Two Control Areas to make significantly greater emission reductions.

When abatement requirements are not being phased in, banking has an important role to play in dampening price fluctuations by allowing firms to maintain an allowance inventory, just as would be done for fuel or any other essential input. Without banking, the supply of allowances for each period would be fixed and any unexpected change in demand would cause prices to fluctuate more than they would with some carry-over. With banking, an unused allowance retains value in the next period, placing a floor under prices in the current period. Similarly, inventory carried over from earlier periods will cushion the effect of unanticipated increases in demand on prices in the current period. Although not usually allowed, borrowing could provide a similar price-dampening effect.\footnote{Recent experience in California with the RECLAIM NO\textsubscript{x} credit market in Los Angeles illustrates the potential usefulness of temporal flexibility. Because the spatial dimensions of this market are relatively narrow and virtually no banking or borrowing is allowed, an unusual confluence of events increasing the demand for electricity generation in Los Angeles caused NO\textsubscript{x} credit prices to increase from less than $2,000 a ton in 1999 to over $70,000 a ton in 2000. Had firms been able to borrow from future periods (at discount), the price spike would not have been as high.}

3.3 Informational Requirements: Measurement and Registries

A third distinctive feature of tradable permit systems is the informational requirements arising from the nature of compliance in these systems. Compliance requires a matching of emissions and permits and for the system to have integrity emissions must be measured and an accurate accounting of allowances must be maintained at all times.

The measurement of emissions is a unique requirement of market-based systems, whether taxes or tradable permits. In contrast, emissions need not be
measured to determine compliance with command-and-control regulations that mandate technology or emission rate limits. All that is necessary is to ensure, usually by periodic inspection, that the required equipment is installed and operating or that the fuel burned is of the specified quality. The obvious problem is to ensure that the equipment is operating between visits; however, where measurement is difficult and expensive, there is no alternative to these less efficient but usually effective measures.

The cost of measurement is one reason why command-and-control measures might be adopted instead of tradable permits or taxes, but in China the choice has been made, even if implementation may take some time. The Pollution Levy will require emissions to be measured if it is to be effective in abating emissions; and compliance with the cap that is allocated to the EPB from higher levels of government will also require that emissions be measured, whatever the nature of the instruction given by the EPB to emitting facilities in its jurisdiction. For instance, if the EPB were to issue a mandate to burn coal of a sulfur quality below some specified level, the amount of coal burned by the facility will have to be reported in addition to verifying that the sulfur content of the coal complies with the mandate. Similar considerations apply for abatement equipment. In all cases, the EPB will require the same information to determine total emissions as what is required to determine compliance in a tradable permits system.

Monitoring is usually thought of as requiring real-time and continuous measurement of emissions, but this is not necessarily the case. Approximate methods suffice, and material balance calculations based on fuel sampling and engineering specifications can provide measurements of the requisite quality and integrity. For instance, in the U.S. Acid Rain Program, alternative methods are used for small sources for which the installation of continuous monitoring equipment would be unduly expensive. In other instances, it may be more feasible and accurate to measure “upstream” from the actual point of emissions. For instance, household emissions would be very difficult to measure, but the sulfur content of coal or petroleum products sold for consumption in the household sector could be measured much more easily. In these cases, the point of regulation, where emissions and allowances are matched, would be moved upstream.

The other distinctive informational requirement of a tradable permits system concerns the accounting for allowances. Since the allowances submitted for compliance may not be the same as those issued initially to a particular source, some means must exist to track permits from the time they are issued until the time they are withdrawn from the system for compliance, and to ensure that permits are not used twice. This requirement calls for the EPB to develop a registry or, as it is called in the U.S. Acid Rain Program, an Allowance Tracking System, to maintain a record of all allowances issued, transferred, and submitted for compliance. Registries are bookkeeping systems that maintain for each emitting source an account into which permits are initially placed and
subsequently deducted in an amount equal to emissions at the end of each compliance period. Since no actual certificates are issued, the permits are bookkeeping entries that can be readily transferred from one account to another upon appropriate instruction from account holders, in the same manner as funds are transferred upon appropriate instruction among checking accounts at a bank.

4. INTEGRATION OF TRADABLE PERMITS WITH A POLLUTION LEVY SYSTEM

The theoretical and applied literature in environmental economics often presents tradable permits and taxes as alternative, mutually exclusive instruments for achieving environmental goals. This treatment could be interpreted as implying that a tradable permits system should replace China’s pollution levy on SO₂ emissions, but doing so would pose many practical problems. Not only is the PLS the most well established instrument for meeting environmental goals in China, but, more importantly, it provides funding for the EPBs, which are the critical level of government for implementing effective control of SO₂ emissions regardless of instrument choice. Fortunately, the choice is not so stark.

Replacing the pollution levy on SO₂ emissions is neither necessary nor desirable, but a choice must be made concerning which instrument is the primary one for achieving environmental goals. If tradable permits are to be primary, the pollution levy can continue to exist as a subordinate instrument to achieve other goals. The cap embodied in the tradable permits system would determine the aggregate emissions on which the levy would be paid, and the price of permits would be reduced by the amount of the levy; otherwise the two instruments could coexist without adverse effect. The converse is, however, not true. If the PLS is to be the primary instrument, tradable permits would be redundant and there would be no point in maintaining a registry, allocating permits, or determining the scope of trading.

4.1 Taxes and Tradable Permits?

Some basic features of taxes and tradable permits will help to explain how the pollution levy and a tradable permits system could work together. Figure 1 presents the relationship between emission levels and the cost of emission control.

The horizontal axis represents total emissions and the vertical axis indicates the cost per unit of abatement. The downward sloping line plots the marginal cost of reducing emissions against the corresponding level of total emissions. In Figure 1, the numbers are purely illustrative; the marginal abatement cost schedule could be that for a single firm, for all firms within the jurisdiction of an EPB, or for China as a whole. The emission level $E_0$ indicates uncontrolled emissions, for which the marginal cost of abatement is zero, by
definition. Any lower level of emissions requires some cost to be incurred for abatement, and the cost of the last unit of abatement is reasonably presumed to increase steadily as more emission reduction is undertaken. At some relatively high marginal cost, such as that required to switch all sources to natural gas, SO₂ emissions would be zero.

Figure 1 can be used to illustrate the fundamental equivalence between tax and quantity instruments, or between using the PLS or tradable permits as the primary instrument. Suppose the regulatory authority wishes to limit total emissions to \( E^* \). One means would be to issue tradable permits in the amount \( E^* \) and to impose a very large penalty for emitting without a permit. With a functioning permit market, the clearing price would be \( p \), equal to the marginal cost of achieving the last unit of abatement required to meet the cap, \( E^* \). Alternatively, the regulatory authority could impose a tax, \( t^* \), equal to \( p \), which would cause firms to undertake abatement costing less on the margin than \( t^* \), which would be the same amount as would occur with the issuance of permits equal to \( E^* \). As presented so far, there would appear to be no difference between imposing a tax in the amount \( t^* \) and distributing permits in the amount \( E^* \); however, the two instruments differ significantly in their informational and distributional characteristics.

The informational aspect concerns the regulator’s knowledge of the backward-sloping line in Figure 1. As presented there, the regulator is assumed to know the price and quantity relationship for marginal abatement cost with certainty, in which case the choice between \( t^* \) and \( E^* \) makes little difference. In practice, the regulator will not have this information, or at best only a vague idea of the relationship. As a result, the regulator faces a choice: either to fix the quantity of emissions by issuing permits in the amount \( E^* \) while remaining uncertain about the marginal cost of abatement, or to fix marginal cost (price) by imposing a tax \( t^* \) on emissions, remaining uncertain whether the desired level of emissions \( E^* \) will be achieved.

The distributional aspect of the choice between permits and taxes can be described by reference to the areas A and B in Figure 1. Area A is the total cost of abatement incurred by firms in reducing emissions from \( E_0 \) to \( E^* \). Firms incur this cost regardless of whether the tax \( t^* \) is imposed or tradable permits are issued in the amount \( E^* \). The area B represents the scarcity rent associated with constraining total emissions to \( E^* \) and the distribution of this rent constitutes a distinguishing difference between tax and permit systems, at least from the standpoint of the SO₂-emitting firm.

12. In reality, the marginal abatement cost schedule may not rise smoothly and monotonically as depicted here, but be characterized instead by horizontal segments, or steps, of varying length that rise from the least costly segment to the most costly one.

13. The now classic answer to this problem depends on the relative slopes of the marginal benefit and marginal cost curves (Weitzman, 1974); however, reasons of political economy seem often to result in choice of quantity instruments even when price instruments would be preferable.
When a tax \( t^* \) is imposed, area \( B \) is the amount of tax revenue paid to the government for the right to emit emissions \( E^* \) and the full cost to the firm is then \( A + B \). In effect, the government receives the scarcity rent by charging \( t^* \) for the right to emit. The emitting firm will naturally avoid all emissions for which the marginal cost of abatement is less than \( t^* \) and that marginal cost will be passed on to customers in the price of output.

When a tradable permits system is used, the distributional consequences depend on the allocation of the permits. If the government were to auction the permits, the consequences to the firm would be largely the same as with a tax. The regulatory authority would receive the scarcity rent, firms would incur a total cost equal to \( A + B \), and the marginal cost would be passed on in the price of output. The only difference would be that the price is not pre-determined, as in a tax system, but depends instead on the demand conditions at the time of the auction. If the permits were issued to firms without payment, or “grandfathered,” these firms would receive the scarcity rent. Trading of these allowances among firms would ensure that each firm faces marginal costs equal to \( p \) so that the total abatement cost equals \( A \), as before; however, on the assumption that firms recover marginal cost on all output, the total cost of the constraint to firms would be \( A - B \). Although the marginal cost will always equal \( p \), the net total cost of the environmental constraint to firms could be positive \( (B < A) \) or even negative \( (B > A) \), depending on the shape of the marginal abatement cost schedule. The outcome for individual firms will depend upon the permits received by each firm and its own abatement cost schedule. Inevitably, some firms will be better off than others, but all will be better off with grandfathered permits than with a tax or with auctioned permits.

The ultimate distributional consequences of these alternatives depend on how the first recipients of the scarcity rent, firms or governments both of which are legal shells, further recycle the revenue represented by area \( B \). A large literature exists on the possibilities of government beneficially recycling the revenues from environmental taxes or permit auctions to obtain a “double dividend,” but the more immediate and practical problem for environmental regulators is likely to be firms’ attitudes toward the use of these alternatives for controlling emissions. While taxes promise only higher costs, grandfathered permits offer firms the prospect of additional profit, which can operate as an incentive (or bribe) for accepting an enforceable constraint on emissions. Experience with permit trading in Chile suggests that grandfathered permits encourage firms to come forward with information about their emissions and means of measuring emissions in order to obtain a share of the limited permits (Montero et al., 2002). Tax systems offer no comparable inducement for reporting emissions or accepting the emission constraint. This consideration may be set aside if the regulatory authority is strong and knowledgeable; however, if successful implementation of the environmental constraint depends on the consent and cooperation of those regulated, it becomes more important.
Figure 2. How the PLS and Tradable Permits Might Work Together

Marginal Abatement Cost Schedule

Cost per Unit of Abatement

Emissions

E∗ / E

B2

B1

A2

A1

C

Designing a Tradable Permit System / 21
4.2 The Interaction between Tradable Permits and a Pre-existing PLS

The discussion accompanying Figure 1 treated price and quantity instruments as though only one or the other would be chosen; Figure 2 illustrates how the PLS and tradable permits might work together.

The diagram is the same as Figure 1 except that the pollution levy is represented by the relatively low tax r', which leads to a small amount of abatement and a level of emissions E' that is greater than the desired level of emissions, E*. Assuming that the pollution levy is effectively collected from all sources, the total cost of abatement is represented by area A1, and levies paid to the government equal the sum B1 + B2.

The imposition of an effective grandfathered tradable permits system with E* permits on top of the pollution levy has several consequences. The amount of abatement and the marginal cost of abatement are necessarily greater than would be under the levy system alone in order to reduce emissions from E' to E*. The further reduction of emissions reduces PLS revenue by the amount B1, which the firm will use for abatement expenditure, as well as an additional amount, represented by A2. The scarcity rent received by the firm is the area C, which is smaller than the amount B in Figure 1 by the amount of the PLS revenues B2. In effect, the scarcity rent is shared between the firm and the government in an amount determined by the relationship between marginal cost, mc, and r'. Finally, the clearing price of permits in the market, p, is not mc, as it would be if there were no PLS, but rather the difference between mc, the level of marginal cost required to meet the constraint E*, and r', the level of the pollution levy.

The reduction of potential PLS revenue by the amount B1 may be a concern to the EPBs. Several responses can be made. First, the word “potential” should be emphasized. To the extent that the pollution levy is not collected from all sources or is incompletely collected from those that do pay something, the amount B1 may exceed the partial amount currently collected on E' emissions. A second response to concerns about reduced PLS revenues could be an increase in the pollution levy rate by some amount that would replace part or all of the revenue loss B1. Such an increase in the levy rate would change the split of the scarcity rent between the EPB and the polluting firms, but the amount of the increase in the EPB share may not need to be large. Yet a third response would be to change the split between the EPB’s administrative expenses and the amounts reinvested in abatement activities. Instead of allocating 80% of PLS revenue to reinvestment in abatement and retaining 20% for EPB administrative expenses, this ratio could be altered. For instance, using the numbers in Figure 2, if 20% of revenues collected on 90 units of emissions is currently required to fund the EPB, then 36% of the revenues collected on 50 units of emissions must be retained for this purpose. The same amount as currently required will be kept to fund the EPB, and an identical amount will be effectively recycled into abatement projects, since the amount of reduced pollution levy collections,
$B_t$, will be allocated to abatement expenditure by firms as a result of the more stringent cap.

4.3 Using the Pollution Levy to Reinforce a Tradable Permits System

The role of the pollution levy need not be limited to that of a convenient pre-existing feature of SO$_2$ emissions regulation that can continue to fund the EPBs. In the spirit of taking full advantage of what is already available and familiar, the pollution levy can be used to reinforce the tradable permits system, constituting an integrated package of instruments working together to achieve environmental goals. Two such reinforcing uses can be envisaged.

4.3.1 A Second-tier Penalty Rate

Like any other regulatory system, a tradable permits system must penalize noncompliance. The pollution levy is an obvious candidate for performing this role because of its former use as a charge for emissions in excess of some required level of control. This use of the pollution levy is no longer possible because of the recent decision to extend the existing pollution levy to cover all emissions from a facility; however, a second, higher penalty tier could be created. An emitting firm would surrender allowances and pay the low, first-tier pollution levy for all covered emissions and the higher, penalty rate for uncovered emissions.

In theory, the level of the penalty rate should be much higher than the expected market clearing price to ensure that the cap is observed and to encourage trading; however, if a market for allowances is nonexistent or slow to develop, a rate that is too high can lead to exorbitant costs or exemption from the emissions control system. In such circumstances, an initially lower penalty rate that would provide incentive for further abatement and for the development of allowance markets would be preferable. An initially lower penalty rate also recognizes the likelihood that an EPB’s allocation of the national TEC limit will be at first more a “soft” than a “hard” cap and that the latter will be possible only as allowance markets develop. Over time, the penalty rate can be raised to a level that would ensure the TEC target becomes a “hard” cap. For the present, the circumstances facing a Chinese EPB attempting to implement measures to meet its cap are very different. Local allowance markets may be slow to develop and at best trading will be local. In these circumstances, an initially lower penalty rate would be advisable.

4.3.2 Using the First Tier as a Second Instrument for Achieving Local Environmental Goals

The other reinforcing use of the pollution levy is as a second instrument for achieving local air emission goals. As explained in Section 3.2.1, a potential
conflict exists between meeting local ambient air quality goals and trading emissions over broad areas. Although experience with the U.S. SO₂ allowance trading and with other programs suggests that problems with hot spots are not as severe as is often feared, the potential remains and the emergence of a hot spot depends on the right combination of circumstances. Where they obtain, a second instrument will be needed to ensure that local air quality goals are met. That second instrument could be some form of command-and-control regulation operating independently of the permit trading system, or it could be achieved by raising the level of the pollution levy’s first tier within the local area of concern to make the purchase of allowances from outside the local area less attractive.

The first tier of the pollution levy becomes a potential instrument because of its interaction with a tradable permits market. Increasing the levy for any subset of firms creating a hot spot will reduce their willingness to purchase permits and thereby increase their incentive to abate more. As a result, the price of permits in the market will decline somewhat, causing other firms not subject to the higher first-tier levy rate to abate less and for emissions to be redistributed away from the hot spot. A difference in marginal abatement cost will emerge between the two zones, but that difference will reflect no more than the differing value placed on emission reduction in the two areas. More importantly, trading between the two zones could still occur so that the efficiency advantages of tradable permits could be obtained within the limits imposed by different air quality goals. Eventually and ideally, a broad geographic market, perhaps China-wide, can be envisaged in which the allowed TEC emissions are distributed by a combination of allowance trading and local adjustment of the first-tier pollution levy rate to ensure that local ambient air quality requirements are achieved.

5. CONCLUSION

The creation of an effective SO₂ cap-and-trade system in China will not be easy, but the difficulty should not be overstated. Most of what may seem difficult about a tradable permits system will be required for any regulatory system that can effectively control SO₂ emissions. Tradable permits systems impose distinctive requirements for how a regulator goes about setting up the regulatory structure, but the alternative systems differ more in form than in substance. Where the alternative is a command-and-control system, as is usually the case, the gains in economic efficiency and environmental effectiveness that are possible through tradable permits justify the greater effort that may be required to overcome the novelty of tradable permits.

Chinese regulatory authorities do not have the luxury of creating a tradable permits system without regard to the environmental measures already in place. Fortunately, the policies that have already been developed for controlling SO₂ emissions in China are not inconsistent with developing a tradable permits system. In particular, the national policy of Total Emissions
Control implies the use of instruments that fix quantities; however, implementation depends on regulatory entities at the local level, where discretion about instrument choice is great and where decisions are likely to be dominated by very practical considerations. The two most important considerations have been emphasized in this paper: 1) how to issue facility permits that will allow and even encourage the development of a tradable permits system, and 2) how to integrate tradable permits with the pre-existing pollution levy system. Neither issue poses an insuperable problem to the creation of a tradable permits system.

Although much can be learnt from experience using tradable permits in the U.S. and elsewhere, conditions in China are unique. China’s simultaneously top-down and bottom-up structure of environmental regulation places a premium on local experimentation and incremental progress, and this resolutely pragmatic approach precludes the all-at-once, top-down implementation that characterized the U.S. Acid Rain Program. Instead, the process seems likely to be one in which Total Emissions Control targets will be progressively transformed from “soft” caps embedded in facility permits into “hard” caps using tradable permits as markets develop and appropriate regulatory mechanisms are put in place. The pace of this transformation in regulatory approach will depend inevitably on the more general transformation of the Chinese economy. Recognizing this dependence is, however, no reason to delay implementation of instruments that presume market institutions. Indeed, their adoption can anticipate and facilitate this more important transformation without adversely affecting the achievement of environmental goals.

REFERENCES

