Permit or Fee?

Finding a better way to control industrial SO_2 emissions in China

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1.0 Introduction

Since it began to reform its economy in the late 1970s, China has experienced rapid industrial growth. As a result, China became one of the most polluted countries in the world. The total economic damage due to air pollution (includes urban air pollution, indoor air pollution and acid rain) alone is estimated at US$48 billion a year, which approximately equals seven percent of the gross domestic product (World Bank 1997, p.23). One of the principal pollutants in air pollution is Sulfur Dioxide (SO_2). Excessive SO_2 emissions and related acid rain can cause serious health problems for the local population from high ambient concentrations. Furthermore, these emissions and acid rain can also create non-health-related problems, such as damage to crops, forests and buildings.

The huge losses due to the SO_2 pollution forces the Chinese government to put more effort into designing and implementing pollution regulations to reduce SO_2 emissions. China, like many other countries, has chosen an incentive-based regulation system as the primary instrument and a command-and-control regulation system as the supplemental instrument to reduce its industrial SO_2 emissions (World Bank 2001). The pollution levy system,[1] one form of the incentive-based regulation, has been adopted since 1979 and continued functioning after several revisions and refinements. However, there are some arguments about whether China should keep the current pollution levy system or adopt another form of the incentive-based regulation, which would be a tradable permit system.

Either the emission fee system (named the Pollution Levy System in China) or the tradable permit system has its unique advantages and disadvantages.[2] First, under an

emission fee system, to meet a given pollution-control target in a cost-effective manner, the environmental authority must know certain aspects, such as the industrial structures or the marginal abatement cost of each industry. In contrast, under a tradable permit system, the above information does not have to be determined. Instead, the total amount of emissions and the allocation of these emissions have to be indicated. Besides these advantages, to accomplish the target under the tradable permit system, the environmental authority has to monitor SO_2 emissions, track pollution data and register new firms. Therefore both systems demands a great deal of information.

Second, a tradable permit system provides a more direct way to control SO_2 emissions since it put a cap on the total amount of emissions. Therefore unlike under an emission fees system, the environmental authority does not have to know the marginal abatement cost while adopting a tradable permit system. However, a special approach can be used in an emission fee system when the marginal abatement cost is unknown. Under this approach, the environmental authority can set a charge for SO_2 emissions and use a "trial and error" procedure to achieve the optimal charge standard. Obviously, the frequent changes and costs associated with this procedure could be a barrier for this approach.

Third, under an emission fee system, the environmental authority has to adjust the charge rate regularly in order to offset the impact of the inflation and the growth in the number of firms. But under a tradable permit system, the authority considers the emission level with macro respect. As a result, the impact of the inflation and the total number of firms do not have impact on the total SO_2 emissions.

Fourth, tax revenues collected under an emission fee system can both fund the operation of the environmental authority and return to the firms as investments for pollution reduction.[3] On the other hand, no revenues can be collected under a tradable permit system unless the government distributes these permits by auction. Under other methods, such as per capita distribution and grandfathering, revenues can not be generated. In addition, there are some transaction costs for buying and selling permits under this system (Tietenberg 2000).

This paper provides a comprehensive review of the current SO_2 charge system in China, identifies both advantages and disadvantages of the pollution levy system and the trading permit system, and discovers SO_2 emission problems at the town and village level. The paper finally reveals that the pollution levy system is more suitable to control industrial SO_2 emissions from township and village industrial enterprises (TVIE) and the tradable permit system has its unique advantage in application to county and above county-owned enterprises (CAOE) based on the fact that large amounts of SO_2 are emitted from town and village industrial enterprises (TVIE) and the potentially relaxed environmental enforcement at the town and village levels currently in practice.

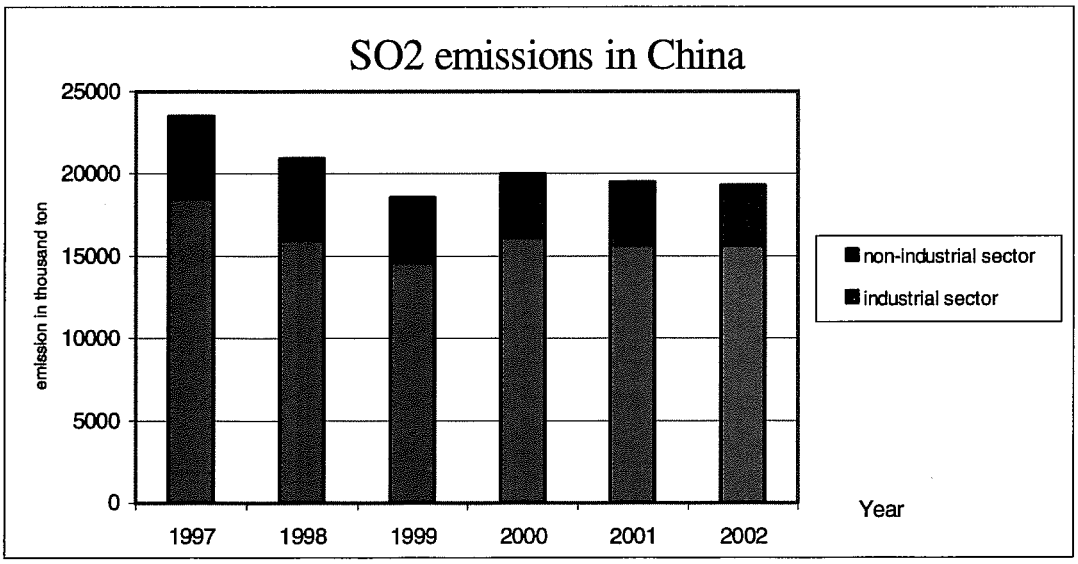
The paper is organized as follows: Section 2 reviews the fact of SO_2 pollution in China and the types of control methods used in China. Section 3 provides a comprehensive review on the literatures. Section 4 reveals two problems at the town and village levels: the new structure of industry and the framework of the environmental agency structure. Based on these two problems, Section 5 addresses the solutions and provides some recommendations on choosing the appropriate types of instruments to control industrial SO_2 emissions in China. Finally Section 6 summarizes the paper.

2.0 SO_2 pollution problems and the current control methods used to control industrial SO_2 emissions in China

2.1 Background

Figure 1 shows the trend of SO_2 emissions in China. Between the years of 1997 and 1999, SO_2 emissions from both industrial and non-industrial sources had been going down gradually. In 2000, SO_2 emissions increased 7.5 percent compared to emissions in 1999. SO_2 emissions stayed approximately the same level since then (NBSC 2000-2002). From Figure 1, we also know that the industrial sector is the major contributor for the total SO_2 emissions. In 2002 Industrial SO_2 emissions reached 15.62 million tons, which is about 81.1% of the total SO_2 emissions.

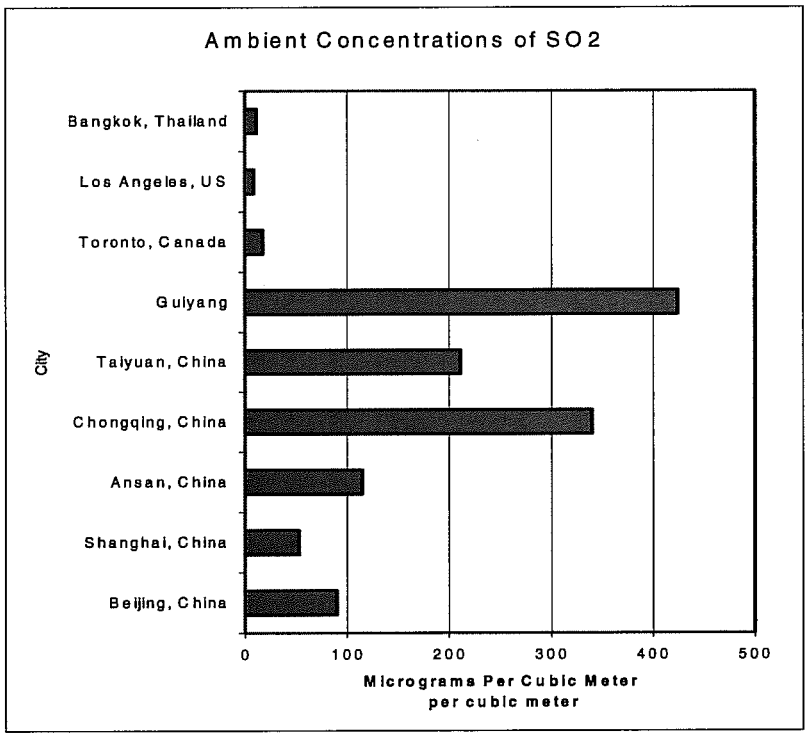
Figure 1



Source: National Bureau of Statistics China 1997-2002

As a result of excessive SO_2 emissions, people in most cities in China suffer from high ambient concentrations of SO_2 pollution. As shown in Figure 2, SO_2 concentrations in many cities have been far over the WHO Standard (60 micrograms per cubic meter annually). For example, the ambient concentrations of SO_2 in Guoyang, China are 424 micrograms per cubic meter, which is 25 times than the SO_2 concentrations in Toronto, which is only 17 micrograms per cubic meter. Excessive SO_2 emissions will not only create health-related problems but will also create non-health-related problems. According to a study done by the World Bank (World Bank 1997, p.27), the estimations of SO_2 damage to farming and forestry in 21 provinces in China was about US$4.36 billion in 1995. [4]

Figure 2



Source: World Bank (1997)

There are two main reasons for the excessive industrial SO_2 emissions in China. One is the broad use of coal in production. The other is the inefficiency of energy consumption per unit of output. Coal, the most abundant fossil energy resource in China, is broadly used for production across all industry sectors. In 2000, China's total coal consumption was 1.24 billion tons (NBSC 2001). The coal used in China generally carries high sulfur content. After coal is burned, sulfur will combine with oxygen to form a pungent gas: Sulfur Dioxide (SO_2). An early study showed that coal burning accounted for 90 percent of the total SO_2 emitted in China during the early 1980s (Edmonds 1994, p.164). Since coal is the cheapest and most accessible resource in China, there is no sign to show that the consumption of coal will diminish in the near future.[5] Therefore, SO_2 emission will continue to be a major air pollution problem in China. In fact, China is already the third largest emitter of SO_2 after the Commonwealth of Independent States and the Unites States.

The inefficiency of energy consumption per unit output is the other reason for the large amount of industrial SO_2 emissions. "The level of technology of most of its industries is about the equivalent of that operated in western countries in the 1950s or 1960s. Accordingly, the per unit energy consumption for some products is high. Comparing to Japan, where the rate of energy efficiency is relatively high, energy consumption per ton of steel produced in China is higher by 90%, for cement it is higher by 70%, for electricity it is higher by 30%. This implies that in China energy intensity per unit product is nearly double in many cases." (Yang et al. 1997, p.69). As a result, more emissions, including SO_2, are discharged.

2.2 Current Regulation Systems

Pollution Levy System

In order to protect the environment, China issued the "Environmental Protection (Trial Implementation) Law" in 1979, the "Temporary Management Rule on the Pollution Levy System" in February 1982 and the "Air Pollution Prevention and Control Law" in 1987. In these laws and rules, an instrument called the pollution levy system has been identified. It set out clear and specific rules on the objective, approach, management and the use of revenue from the pollution levy system. Today this system is the largest pollution levy system in the world (Yang et al. 1997).

The pollution levy system imposes a fee on emissions or discharges in excess of some standards applying to a particular process or plant beginning in 1982. SO_2 emissions are included within the air pollution category under this pollution levy system: a uniform charge rate of 0.04 RMB per kg SO_2 emitted applies (excluding electric utilities). However, this charge rate was just tested in several provinces and not implemented nationwide at the beginning (Cao et al. 1999). More pilot programs of pollution levy system were developed to gain experience. For example, between 1992 and 1994, a trial program had been implemented in 9 cities and the charge rate increased to 0.20 RMB per kg and it was applied to the total SO_2 emissions from the utility as well as the industrial sectors. In another following trial program started in 1996, new sources were applied to a double levy rate of 0.40 RMB per kg. Also, another pilot program with a higher tax rate of 0.63RMB per kg was initiated in 1998 in three cities (Yang et al. 1997, p78). Researchers believe that the result from these programs will accumulate

experiences and provide a solid foundation for the extension of the pollution levy system in the future.

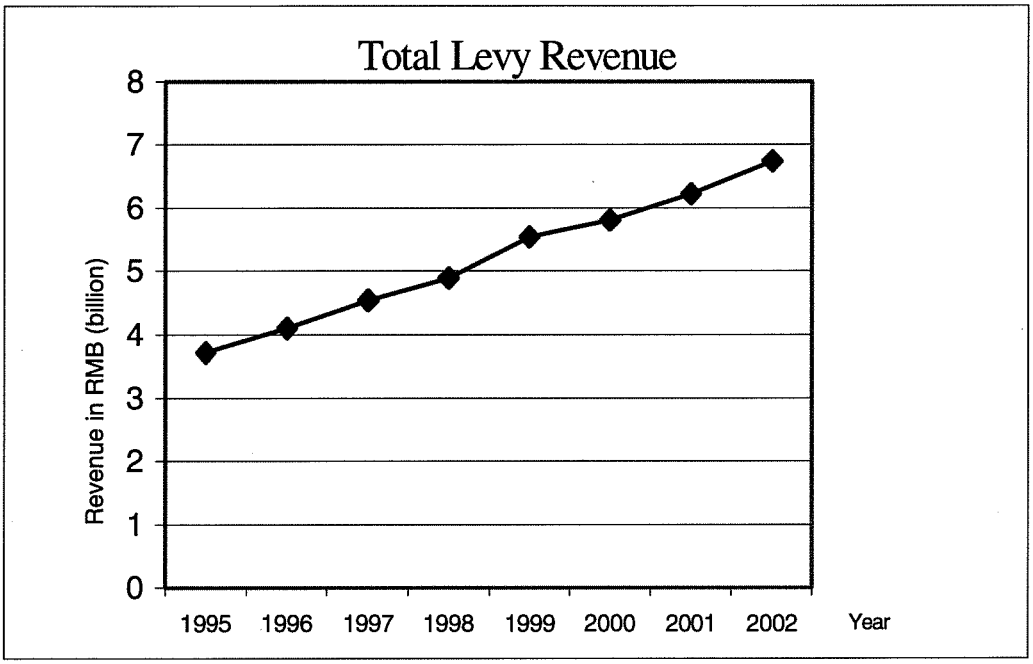
After the successive stages of planning, trial establishment and full implementation over the past 24 years, this system has been revised and refined several times. The year 2000 revision of the "Air Pollution Prevention and Control Law" (APPCL) is another very important revision. It formally changed the base for pollution charge to the total emissions regardless if the emissions exceed standard or not (Ellerman 2002). And the newest China's pollution levy system was promulgated in January 2003 and went into effect in July.[6]

The pollution levy system is, in fact, a form of the emission fee system. The "levy" term emphasizes on its unique collecting channel. Levy is collected by the local environmental bureau (EPB), while Ministry of Finance collects tax (Ellerman 2002). In the pollution levy system, 80 percent of total levy revenues will be distributed back to firms as investments to finance environmental projects such as technology upgrades. The rest 20 percent of collection will be used for the local EPBs' operation. From Figure 3, we can see the total revenue collected has been increased gradually over years.

Despite the achievement the pollution levy system made in China, it reveals several problems in practice. First, although this system covers large numbers of pollution source,[7] most of them are medium-size and large enterprises. Town and village industrial enterprises (TVIE) are not governed by this system. Second, the limited information on the marginal abatement cost creates an obstacle to the application of an appropriate charge rate for SO_2 emissions. At this stage, the environmental authority focuses more on creating funding to control pollution. As a result, the charge rate was set

too low to encourage SO_2 abatement in many enterprises. Furthermore, the lag between the slow increased charge rate and the fast increased inflation rate also offset the effort of the pollution levy system (Yang et al. 1997).

Figure 3



Source: SEPA 1995-2002

Total Emission Control

Total emission control was introduced in China as a concept in 1995 and was first adopted as a policy option in China's "Ninth Five-Year Plan" (1996-2000). The ultimate goal of this new policy was to achieve the total amount of emission reduction target for a particular pollution with Marco-respect (Dudek et al). The national limit of SO_2 emissions was set at 24.5 million tons in this plan.[8] In the year 2000 revision of the "Air Pollution Prevention and Control Law" (APPCL), total emission control was identified as

the foundation to control air pollution, includes SO_2 emissions in the future. This is an important step from a project-specific approach toward a macro respect approach to deal with SO_2 pollution. Furthermore, the "Tenth Five-Year Plan" (2001-2005) set the total national SO_2 emission limit at 10% below year 2000 emissions and these reductions must be met during the "Tenth Five-Year Plan" period (SEPA 2000).

The total emission control is just a basic guideline at the present stage. An appropriate supplemental instrument needs to be adopted to achieve the reduction target under this policy or guideline. A few pilot programs and some academic studies have been done to discover an appropriate instrument for the total emission control policy. The environmental authority conducted a pilot program for a permit system on air pollutant emissions in 16 cities in 1991. This pilot program are model on the "cap and trade" system used in the US to control acid rain. Another pilot project, the first real emission trading project in China also was implemented in 2000 in the cities of Nantong (Jiangsu Province) and Benxi (Liaoning Province). After the completion of those initial pilot projects, it will expand to four provinces, three metropolitan areas and one enterprise. This effort will provide valuable experience to help the environmental authority find better tools to work with the total emission control policy and to achieve SO_2 control targets set out in the "Tenth five-year Plan". Despite the success of these initial pilot programs, a permit system for air pollutant emissions has not yet been implemented in China (Dudek et al.).

Two Control Zones [9]

"Two Control Zones" concept was adopted in 1996. This component of Chinese environmental policy is not an environment instrument and does not offer any guidance regarding choosing the instrument. This concept tends to provide additional care to the serious SO_2 problems in these two areas when applying pollution levy, total emissions control or emissions trading instrument. "The SO_2 Control Zone comprises cities in North China where the ambient SO_2 concentration exceeds 60 micrograms per cubic meter. 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." (Ellerman 2002, p.6). Chinese government usually puts more effort and adopts a stricter policy in the two control zones. For example, in the Two Control Zones, total SO_2 emissions was set out at 20 percent below the year 2000 level under the Tenth-Five Year Plan (2001-2005) while SO_2 emissions for the rest of regions was set at only 10 percent below the year 2000 level in this Plan.

3.0 Literature Review

3.1 Summary of the existing literature

Many literatures have discussed the types of instruments can be used to control SO_2 emissions. The following table (Blackman & Harrington 2000, p7) summarizes these different types of instruments.

	Direct instrument	Indirect instrument
Incentive-Based system	Emissions Fee Tradable Permit	Environmental Tax
Command and Control system	Emissions Standard	Technology Standard

In this table, the incentive-based system refers to the policies that create economic incentive for abatement but do not dictate abatement decisions. In contrast, the command-and-control system refers to the policies that dictate abatement decisions. For both two policies, policies that require environmental authority to monitor emissions are called direct instruments, and policies that do not have the requirements are call indirect instruments. Indirect instruments, include the environmental tax and the technology standard, will not be discussed in the paper since they just act as the supplemental control tools to the direct instruments in the practice.

Almost all researchers agree that the incentives-based system have more advantage than the command-and-control system because it can achieve the same pollution abatement target at the least cost. Its advantage also appears in terms of efficiency and flexibility (Blackman & Harrington 2000). Under the command and control system, the environmental authority must set out lots of rules and standard to firms. Usually the authority will specify what technology each firm must use to be considered in compliance. In contrast, under the incentive-based system environmental authority just simply set out fee or permit, firm can choose any available technology to minimize the cost by their own choice. Therefore, the incentive-based system can accommodate change more easily, whether of environmental quality standards, economic

conditions, or abatement technologies. More discussions on the properties of the incentive-based system and the command-and-control system can be found in Tietenberg (2000).

However there are some obstacles for the greater adoption of the incentive-based system in developing countries. Markandya (1998) identify these obstacles and provides some recommendations on how to overcome these barriers in his empirical study paper. First of all, he suggests that the environmental authority should have extensive knowledge and information on the marginal abatement cost and industry structure. Otherwise the rate of the emission fee being introduced may be set too low or the total emission allowance may be set inappropriate to change firms' behavior. Secondly, strong legal support is fundamental for the implementation of the incentive-based system. If there is a lack of explicit legal and regulatory authority, it is doubtful that the incentive-based regulation can be successfully applied. Thirdly, the incentive-based system is ineffective without reasonably competitive markets. In the case that a competitive market does not exist, if a firm has a monopoly power for example, the firm will pass the fee cost to consumers and the fee will reduce social welfare instead improving it under an emission fee system. Under the tradable permit system, the firm with monopoly power will gather the entire permits and decrease the efficiency of system. Fourthly the environmental authority need to have the financial and administrative capacity to initiate, monitor, and enforce these incentive programs. Scarce workforce can not be fully functional in environmental regulation enforcement. Finally, firms need to have option to choose their own abatement technology. Otherwise flexibility may be compromised and the incentive-based system will be more likely to a command and control system.

Within the incentives-based system, there are some debates on whether the emission fee system (the Pollution Levy System) or the tradable permit system can do a better job to control industrial SO_2 emissions in China. Researchers in favor of the current pollution levy system believe that the SO_2 pollution levy system can play an important role in the environmental management in China after 24 years' practice and refinement. These researchers argue that pollution levy system is a particularly effective economic instrument in China because of its relatively low monitoring cost, revenue generation feature and more available hand-on experience. At the stage of reforming and developing of economic in China, the pollution levy system can still be a appropriate instrument after reforming the charge rates and the charging criteria (Cao et al. 1999, Yang et al. 1997)

On the other hand, some other papers (Dudek et al., Ellerman, 2002) reveal that the tradable permit system can serve the total emission control policy better because the State Environmental Protection Administration (SEPA) already set a target for SO_2 for the 'Tenth Five-Year Plan" (2001 –2005). Dudek et.al and Ellerman (2002) believe that the tradable permit system can achieve the target easily because the tradable permit can both allocate these targets more efficient and create incentive to firms to make abatement.

3.2 Strengths and Weaknesses of the pollution levy system and the tradable permit system

Pollution Levy System

Practical experience

The Pollution Levy System has been applied in China to control pollution for 24 years. Many projects have been done to accumulate experiences in designing and

implementing an SO_2 charge, which includes the charge rate and the utilization of collected revenue. These programs and academic researches provide solid foundations for extending the charge system nationwide (Cao et al. 1999). Comparing it with the Tradable permit system, which only a few pilot is on-going and have not been broadly adopted in China, we can say that these experiment are very important for further regulation systems construction in the future.

Revenues

Another advantage of the pollution levy system is tax (levy) revenues generation. 20 percent of these revenues (along with all fines) will be used for funding the operation of the local environmental Protection Bureaus (EPB). The rest 80 percent of the collected revenues will be distributed back to firms, which can use these revenues to access technologies and equipments to reduce the emissions. Approximately US$3 billion in fee revenue was collected between 1979 and 1995. 29% of this amount was paid by air polluters (Blackman & Harrington 2000). As I mentioned in the introduction section, this re-distribution part of revenues, which is also called "subsidy" may rise the issue of distortion.

Monitoring

Some experimental study shows that the pollution levy system can use relatively simple monitoring equipment and does not demand highly trained workforce. In China the monitoring for the assessment of fees is mostly based on self-reporting, periodic auditing, and crude monitoring technology. Comparing with the continuous emission monitoring systems (CEM), which cost about $124,000 per generating unit (including

capital costs), these monitoring methods have their practical advantages in China which still in her economic reforming and developing stage (Blackman & Harrington 2000).

Blurred Target

The most important weakness in practice for the Pollution Levy System is its uncertainty to achieve the emission target. In theory, the emission fee system will achieve a certain target at the least cost. As I discussed in the other section, in practice it requires extensive research, analysis or trial and error approach to set an appropriate rate to create economic incentive for firms to reduce the projected emissions. If the charge rate incidentally was set too low or firms are not sensitive to the pollution cost, the fee will not be able to create the incentive to reduce emissions. Although all data shows that SO_2 emission target has been achieved in the "Ninth Five-Year Plan", researchers admitted it was mainly because of the closedown of the heavy polluted small-scale enterprises (mainly town and village industrial enterprises) and the slow increase of total town and village industrial enterprises (TVIE). In contrast, under the tradable permit system, the target is clearer because it put a cap on the total emissions. This argument leads us to the properties of the tradable permit instrument.

Tradable Permit System

Direct control

Although many studies have been done, limited data has blocked researchers to further calculate a more accurate marginal cost for adopting a best charge rate under the pollution levy system. Even it have been successfully discovered, it still face the difficulty to apply in the practice since different industrial sectors have different marginal

abatement cost, and even in the same industrial sector the marginal cost will be various depends on the technology, demography and management in pollution levy system. Therefore, if the marginal abatement cost is unclear, a tradable permit system will leads more surely to SO_2 emission reductions. As data and figure shown in Section II, China's SO_2 pollution problem is very serious. For most part of China, neither local nor regional conditions for avoiding environmental damages are being met. Chinese Academy for Environmental Sciences in a recent study recognized China's SO_2 pollution control strategy should initially focus on broad emission reduction goals and then tend to local (Ellerman 2002). Therefore in order to reduce emissions sooner, the adoption of a tradable permit system would be a better choice to reduce emissions sooner and more certain.

Political support

Researchers in favor of the tradable permit system argue that although the tradable permit system for environmental protection is relatively new to China, there are significant political supports from the Senior State Council leaders as well as the former President and Premier. Recently, Xie Zhenhua, the minister of the State Environmental Protection Administration (SEPA), highlighted "emissions trading is widely accepted because it solves more environmental problems with fewer costs" (SEPA 2002). Under the support of higher level authority, some tradable permit pilot programs has been tested to gain the valuable experiences for the further implement nationwide in the future.

Monitoring

An accurate, consistent, complete emissions information is critical for the successful adoption of the tradable permit system. Firms must be confidence that

emissions will be correctly measured and reported, otherwise the permit will be worthless. To maximize the accuracy of the measurement, the best source monitoring should be used is the continuous emission monitoring system (CEM), which cost about $124,000 (including capital costs) per generating unit (Blackman & Harrington 2000). Although with the rapid updated technology, the cost of these monitoring equipments will go down and the equipment will eventually be employed into widespread use, at time being the continuous emission monitoring system (CEM) is stills relative rare, even in industrialized countries. Therefore, other methods of monitoring still need to be used. These methods include emission factors, material balance, and indirect monitoring. The inaccurate, inconsistent and incomplete information received from these indirect monitoring blocks the greater adoption of the tradable permit in China.

Skewed economics development

One of the lessons learned from the U.S. SO_2 trading program is that the distribution of permits should be based on different locations, technological standards, and economic bearing capabilities of different pollution sources within the region (Blackman & Harrington 2000). In China, since the economic development across country has been very skewed during the reforming and developing of economic, the adoption of a tradable permit system has to be specified in the different areas. Based on the economics levels China has been divided into three economic zones: eastern zone, central zone and western zone. Eastern zone is the most economic developed zone while western zone is the least. In practice, since one of the advantages of the tradable permit system is its flexibility, the State Environmental Protection Administration (SEPA) can set out different pollution control targets in three zones. By doing so, it could lower

pollution levels without overburdening the poorer regions. In addition, when nationwide tradable permit programs develop, the wealthier Eastern Zone firms would be able to sell emission permit to the older, less efficient industries in the west zone (Dudek et al.).

Experience from other countries

Since China have little experience in designing and implementing the tradable permit system, it will heavily borrow other countries' experience in order to shift the instrument from one to the other smoothly. But the learning has to be careful because of the different environmental development level. China is still at the designing stage of a regulation system to accomplish the total emission control policy. On the other hand, many OECD countries and the U.S. have already implemented facility permit (another types of permit) to control emissions, which can be easily transferred to the tradable permit system (Ellerman 2002). Many feasible researches on tradable permit system have been done jointly by the Chinese environmental agency and environmental research center from other countries. The U.S. Environmental Protection Agency (EPA) and China's State Environmental Protection Administration (SEPA) has formed a strategic collaboration relationship to conduct studies on SO_2 pollution problems in China. German Development Agency (GTZ), the U.S. NGO Environmental Defense and environmental agencies from other countries also support some programs in China by giving either technical assistance or other forms of assistance. Therefore, the less practical experience should not be a major obstacle for adopting the tradable permit policy in China.

4.0 Problems at the town and village level

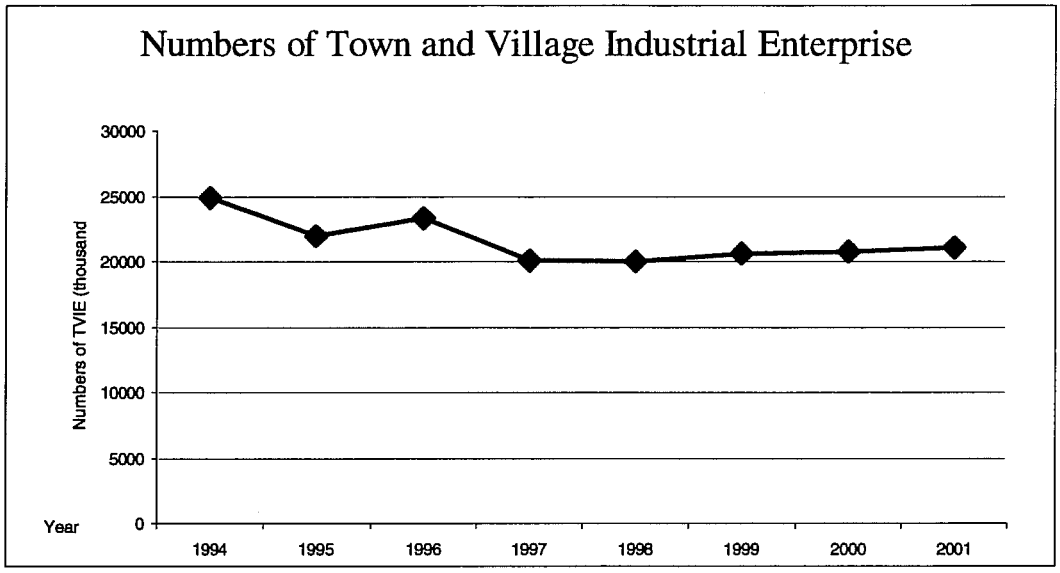
Although the literature provide their unique reviews regarding the best instruments to control industrial SO_2 emissions in China, there are still two major issues that did not discuss in detail. One is the new industry structure during the reforming and developing of economic; the other is the framework of the environmental agency structure. These two issues may be the most important factors for choosing the instrument in China.

4.1 New structure of the industry

Traditionally industrial sectors in China are classified into two basic groups: county and above county owned enterprises (CAOE) and town and village industrial enterprises (TVIE). CAOE includes State-Owned Enterprises (SOE) and collectively owned enterprises at the county level and above. TVIE were originally commune-based industrial enterprises and were administered through the Ministry of Agriculture.

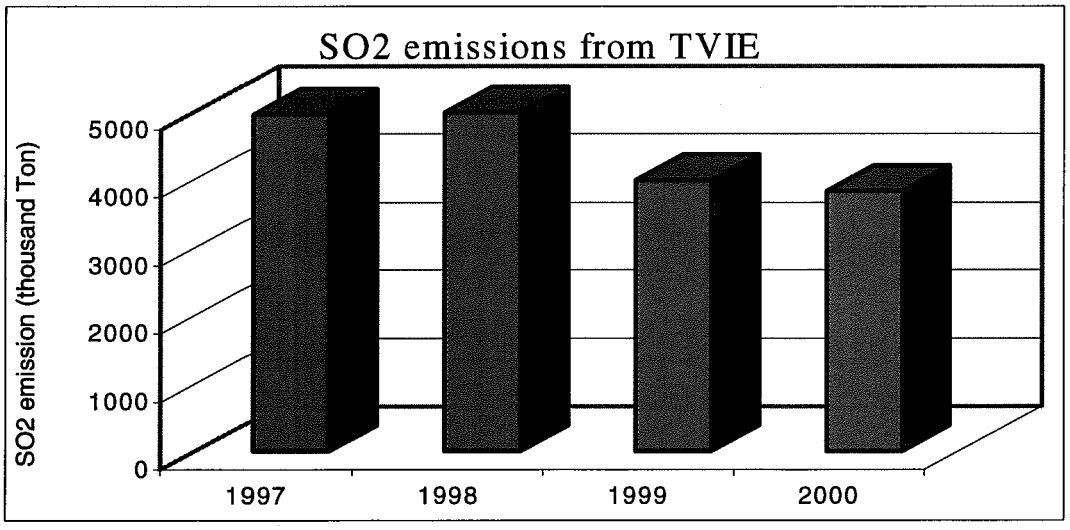
With economic reforming during the past two decades, the structure of industry has undergone great changes. In this process, the expansion of TVIE has been most important in changing the structure of industries. Figure 4 shows the total number of TVIE between 1994 and 2000. The impact of the Asian economic crisis and the closedown of heavy polluted enterprises (mainly TVIE) by the central government result in the declination in the total numbers of TVIE in 1997. The numbers of TVIE has been stabilized and increase slowly since then. In 2001 there are total 21.2 millions town and village industrial enterprise (NBSC 2001).

Figure 4



Source: NBSC (1994-2001)

Figure 5



Source: SEPA (1997-2000)

Although SO_2 emissions from town and village industrial enterprises (TVIE) has shown the decreasing trend in Figure 5, it still accounts for a large portion of industrial SO_2 emissions. In 2000 SO_2 emitted from over 20 million town and village industrial

enterprise is 4,630 thousand tons, which is still account for 28.7% of total industrial SO_2 emissions (SEPA 2000). Since the massive number of TVIE and most of them are small-scale with out-of-date technology and owners and managers of these enterprises have low environmental awareness, it imposes great difficulty for control SO_2 emission from these enterprises. Yang et al. (1997) also points out the low environmental monitoring capacity in town and village level is another reason that SO_2 emissions reduction in this level is inefficient. According to World Bank (2001), the command-and-control system is still used to control SO_2 emissions from town and village industrial enterprise (TVIE). Therefore a separate, more effective instrument should be adopted to control SO_2 emissions from these town and village industrial enterprises (TVIE).

4.2 Framework of the environmental agency structure

Chinese environmental authority comprises by two basic agencies: national environmental agency and local environmental agency. National environmental agency is called the State Environmental Protection Administration (SEPA),[10] which is in charge of designation and development of the environmental regulation and administration services. The local environmental agency includes provincial environmental protection bureau, municipal environmental protection bureau, county environmental protection bureau and town or village environmental protection bureau (Ellerman 2002).

The local environmental agencies are mainly responsible for the monitoring of pollution and the enforcement of the environmental regulation. According to World Bank (2001), the environmental agency had put more effort to control the urban environment in the past. As a result, most of county and above owned enterprises (CAOE) have more

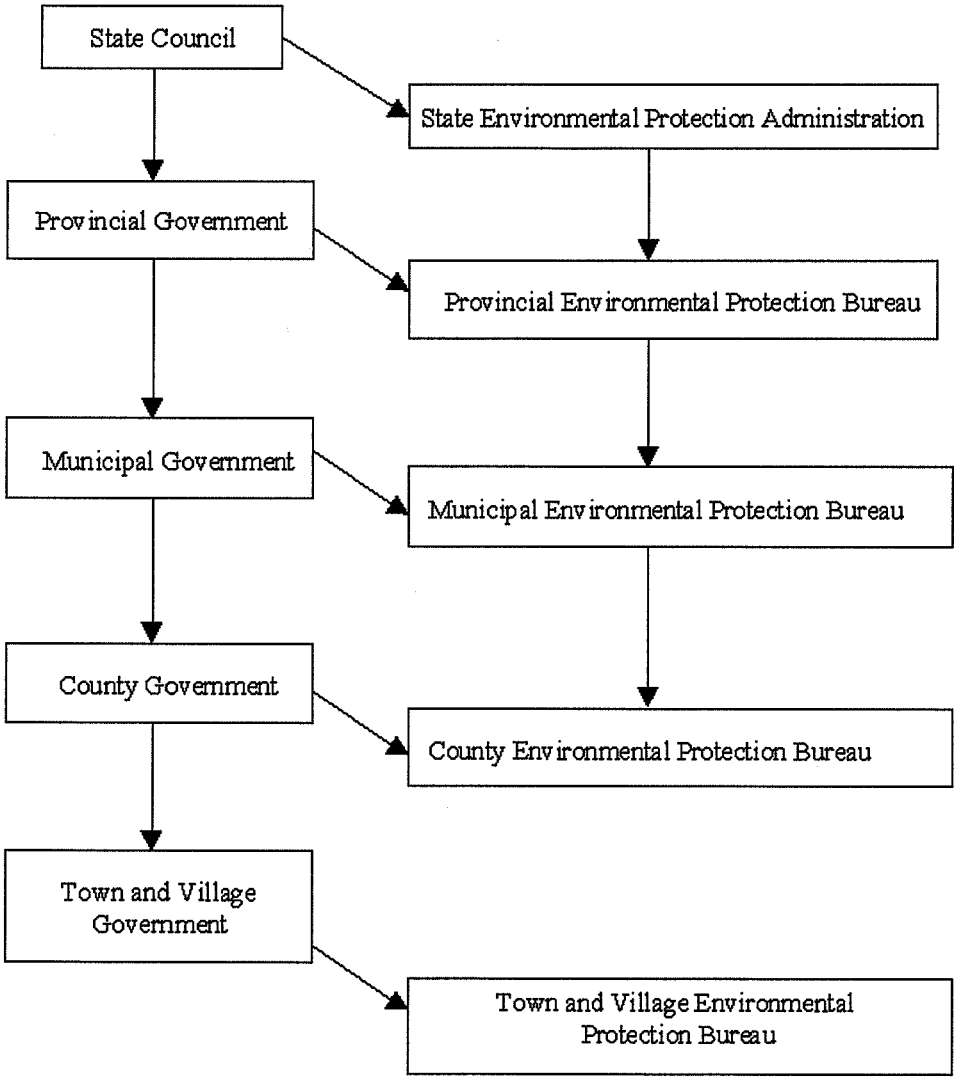
awareness on the enforcement of the environment regulation. These firms usually are very sensitive to any charge in the environmental regulation. In contrast, firms in rural areas, most of whose are town and village enterprises (TVIE) do still not have great awareness on the environmental issues. To raise these firms' sensitivities on this issue, the environmental agency has to work with other ministries, such as the Ministry of Agriculture to educate the TVIEs to be aware of the environmental regulations.

Lieberthal reveals the structure of current framework of the environmental agency. Currently, local Environmental Protection Bureaus (EPB) are under the lead of both local government and higher level Environmental Protection Bureau in China. This relationship is also called "horizontal-vertical" relationship. As show in Figure 6, the lower level EPB not only reports to higher level EPB and ultimately to SEPA, but also receives the lead from the local government. Under such relationship, appointments to head of local EPB need to be both nominated by local government and endorsed by the higher level environmental protection bureau (EPB). Since the major purpose of the local government right now is to maximize income, employment and stability in his territory, this relationship may create some degree of problem. For example, facing the dilemma of maximizing the local socioeconomic and enforcing the environmental regulation, the town or village EPB may enforce regulation loosely.

Also, from the statistics (SEPA 1998-2002), the environmental agency and their employees at town or village level are relatively low. For example, in 2002, the total number of agency at town and village level is only 1,886, which are about 16 percent of total government environmental agency nationwide. The employees employed in this agency are 5,140, which is only 3.33 percent of total employment in environmental

agency. All of these create obstacles to enforce the environmental regulations in the rural areas where town and village industrial enterprise (TVIE) resides.

Figure 6 Framework of the environmental agency



5.0 Suggestions on the regulation systems used to control industrial SO_2 in China

The concept of the total emission control will be the fundamental air pollution policy in China. Since the tradable permit system and the pollution levy system can work together without conflict (Ellerman 2002), the best regulation system to accomplish the emission target should be a mixed structure of two systems: a tradable permit system regulating county and above county owned enterprises (CAOE) and a pollution levy system regulating town and village industrial enterprises (TVIE). Under this proposal, the State Environmental Protection Administration (SEPA) first sets out a national cap for SO_2 emissions and allocates SO_2 emissions target to each region based on demography, technological standards, previous SO_2 emissions record and economic bearing capabilities of different pollution sources in each region. For example, for the province within Two Control Zones, SEPA may distribute fewer targets than other regions in order to control the serious existing SO_2 or acid rain problems. The following steps of allocation of these permits will be done by the local environmental protection bureau (EPB) since they have more experiences in applying the pollution control system. State Environmental Protection Administration (SEPA) will only provide assistance and guideline to the allocation procedures.

Unlike in a pure tradable permit system, SO_2 emissions target will not totally convert to the pollution permit in this mixed system. Instead, only a certain percentage of SO_2 emissions target will be converted and distributed to county and above county owned enterprises (CAOE), which can use these permits to emit certain amount of SO_2, or sell extra to or buy additional permits from other CAOE depends on its marginal abatement cost. The Pollution levy system will be applied in the town and village industrial

enterprises (TVIE) sector and the rest of the emission target can be recognized as a basic guideline for the local Environmental Protection Bureau (EPB) to control SO_2 emissions from these TVIE.

By constructing such system, the environmental authority could control industrial SO_2 emissions more effective in both sectors. In this mixed system, the environmental authority has put most industrial pollution sources under its consideration and controls them as a whole. "In recent years China's township and village enterprises have developed rapidly. Because of their small scale, out-of-date technology, and higher consumption of energy, they have also created more pollution source" (Yang et al. 1997). The large number of TVIE and the inadequate monitoring equipment and backward technology of monitoring used to control SO_2 emissions from these TVIE also hinder the possibility of the tradable permit application over these TVIE. In this proposed mixed system, by applying the pollution levy system that has been practiced for 24 years in China to these TVIE, TVIE will receive the economic incentive to reduce SO_2 emissions. On the other hand, by shifting SO_2 pollution regulation system applied to most of county and above owned enterprise (CAOE) from the current pollution levy system to a tradable permit system, the new regulation system will serve the total emission control policy better. More examples and discussions can be found in Tietenberg (1995).

The following are some properties of this mixed system:

Enforcement:

Since the local EPB is also under the lead of local government as well as the lead from higher level EPB, sometimes their enforcement may be weak due to the priority

economic goal set by local government. This structure will not change in the future. Under the proposed mixed system, the potential of weaken enforcement can be partially offset because part of the target has been allocated already. Since under a tradable permit system most of monitoring and tracking will be done by the continuous emission monitoring systems (CEM), it will be very difficult for local EPB to loose the enforcement since the record is continuously. Also if the CEM is broadly used in the monitoring process, the workload to the local environmental enforcement will be better off since these CEM are highly automatic. The local EPBs can shift their focus from CAOE to TVIE without losing any control over the SO_2 emission from CAOE sector. By doing so, the scarce workforce could work effectively to control both industrial sectors.

Revenues and Funding

At time being the operation of local EPBs heavily relies on the revenues collected from levies and fines. The EPBs can not enforce regulations effectively with budget constraints. In a pure tradable permit system, unless the permits are distributed by auction, there will have no revenues, which is very important for the environmental enforcement. In contrast, the proposed mixed system continues providing some revenues just like the pollution levy system does because the levy system is still in use to control SO_2 emissions from TVIE sector.

Moreover, additional funds are needed because the part of funds from the levy system has been worn off by applying tradable permit system. Some reforms within the pollution levy system can be done to access the funds. For example, the portion of revenues that will be distributed back to industries could be decreased and the charge rate could be increased (Yun 1997).

Monitoring:

The most important aspect of emission monitoring is that the method should keep accurate and consistent across sources as possible. The U.S. experience suggests the best monitoring equipment in the tradable permit program is the CEM. Due to the massive numbers of SO_2 pollution sources in China and the cost of installing such equipment, it will be impossible for China to install the CEMs for all SO_2 emissions sources in the near future. There will likely be a transition phase for the emission measurements where some sources will use mass balance estimation methods while others will use the CEM. However, CEM should be employed as soon as the fund is available. And the current monitoring used in most of CAOE, such as self- reporting mechanism, and a system to verify emissions data on an annual basis should be updated before the tradable permit system is introduced. In the TVIE sector, monitoring technology should be upgraded to the technology, such as combustion or post combustion control and emissions declaration, currently used by CAOE sector. The mixed system can not work effectively if the monitoring of both CAOE and TVIE sector are inadequate.

Education:

A survey based on 50 industrial enterprise shows that 93 percent of TVIE admit that the lack of environmental management training for staff is a serious obstacle to pollution abatement. 66 percent TVIE feels that the lack of information on pollution abatement technology and management is also an obstacle to pollution abatement (Ma & Ortolano 2000). Therefore under the pollution levy system applied to TVIE, besides the current duty they do, local EPBs should also educate TVIE how to reduce SO_2 emission at the least cost and forward the information on the technology TVIE could choose.

Another survey (Wang & Di 2002) discovers the environmental performance of upper level government in China has strongly and positively influenced the environmental effort of the township government. Therefore a broader education through all government unit could lead the local EPB carry out stricter enforcement because of the special "horizontal and vertical" relationship discussed before. By doing so, not only the local environment would be better, but also the amount of available funds for the local EPB will become larger.

Charge Rate:

Over the past decade, SEPA have been improving the compilation and standardization of environmental data and statistics. However, the emission data from township and village industrial enterprise sources has not been fully captured. It will take many years for SEPA to gather completed information from TVIE. Therefore, a trial and error approach based on the current rate charged to CAOE should be used to implement the pollution levy system in TVIE sector even if may be very different. The actual marginal abatement cost may be lower in TVIE than in CAOE since most of them are small scales and use backward technology.

Command-and-control methods

Under this theory, the impact on the human health and environment should be considered first when the environmental damage is overwhelming. Since under the tradable permit system the pollution permit can be trade freely nationwide, it may create some hot spots in some highly industrialized areas or increase SO_2 emissions in the Two Control Zones. To eliminate such problems, the command-and –control method is still an effective instrument. For example, it may regulate that the firms in the Two Control

Zones can not buy permit freely from other regions and such transaction has to be approved by the Local Environmental Protection Bureau (EPB).

Legal Support

The concept of total emission control China's was written in the year 2000 revision of the "Air Pollution Prevention and Control Law" (APPCL). The pollution levy system is also addressed in law and rules. Although there are also significant political support from the Senior State Council leaders as well as the former President and Premier for the tradable permit system, there is a lack of explicit legal provisions regarding tradable permit system in all the regulation. Without explicit legal and regulatory authority, it is doubtful that tradable permit system can be successfully applied.

6.0 Conclusion

This paper first reviews the current fact of SO_2 emission and the charge system used to control SO_2 emissions in China. In this paper it also discovers the two major difficulties to apply either the incentive-based regulation system solely to control SO_2 emission in China. One is the rapid change of industry structure; the other is the weak enforcement of the local environmental protection bureau (EPB). To better solve these problems, the paper addresses its argument: two incentive-based systems should coexist to control the industrial SO_2 emissions in China: a tradable permit system regulating the county and above owned enterprise (CAOE) and a pollution levy system regulating the town and village industrial Enterprise (TVIE).

[1] The special term for emission fee system in China's practice.

[2] The following discussion of advantages and disadvantages is based on Tietenberg (2000, ch.15).

[3] The analysis of this revenue has to be careful because a return as a subsidy could distort the effect of revenues

[4] Total: 31 provinces, municipalities and autonomous regions in China, excludes Hong Kong, Macao and Taiwan

[5] Overall, electricity in China is still in short supply. Coal will heavily used in generating electricity in the near future. Hydroelectric Power, such as Three Gorges Dam, will only be a supplemental source.

[6] Source: website of State Environmental Protection Administration (SEPA). http://www.zhb.gov.cn/

[7] 915,000 enterprises are in pollution levy system in year 2002. (SEPA 2002)

[8] The target is in the same level of SO_2 emission in 1995 and it had been achieved by the end of 2000.

[9] " The total of the newly identified Acid Rain Control Zones and SO_2 Control Zones is 1,090,000 sq. km, or 11.4% of China's total land area. The area of the Acid Rain Control Zones is 800,000 sq. km, or 8.4 % of the total territory area while the area of the SO_2 Control Zones is 290,000 sq. km, or 3% of the total land area (SEPA, 1998)." (Cao et al. 1999).

[10] Former National Environmental Protection Agency (NEPA)

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