

A Thesis for Master of Science Degree in Environmental Science



**The Application of Economic Instruments
for Preventing and Controlling the Industrial Pollution
in China**

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Summary

While it is rapidly developing the economy, China is confronted with the rigorous challenges of environmental issues, among which the industrial pollution is the most severe one. It is urgent for China to harness the industrial pollution so that it can achieve sustainable development and take care the environment at the same time. While its economy is transited from a planned one toward a market-oriented one, China has paid great attention to prevent and control the industrial pollution through various environmental policies and measures, in particular, the increasing interests have been shown in the application of economic instruments as the complementary policy tools. This report was formulated under this background.

In the introductory remarks, it points out that the development is the precondition of sustainable development in China, and China is now focusing on economic development and establishing the market economic system, yet the environmental states are still worth worrying about even given the fact that China has made substantial achievements in environmental protection. Meanwhile, it states that the industrial sector is the main source of environmental pollution in China while it is the dominant part in the national economy. In addition, this section defines the three frequently-used environmental policy instruments, i.e., regulatory, suasive and economic instruments, and presents that economic instruments can have a vital role to play in the developing countries.

In section 2, the current situation of China's industry is briefed. The overall development level of industry in China is relatively backward although China has built up an independent and integrated industrial system. The surprising economic, social and environmental losses have been observed. Therefore, effectively preventing and controlling the industrial pollution is an urgent task for China, and these serves as the driving forces behind the application of economic instruments in dealing with the industrial pollution.

In section 3, it reviews the progress in preventing and controlling the industrial pollution in China, and analyzes the environmental policies in China. It presents that China has mainly used the regulatory instruments for environmental management.

In section 4, it systematically describes the role of economic instruments in preventing and controlling the industrial pollution. First, it introduces the evolution of economic instruments as the environmental policy measures in the international dimension, especially in the OECD member countries, through investigating the backgrounds, analyzing the factors involved in the evolution of economic instruments, presents the criteria for choosing economic instruments and the guidelines for implementing economic instruments. While closer looking at practice of economic instruments in the developed world, this section also analyzes the potential advantages and disadvantages of economic instruments, finding that economic instruments could be important environmental policy tools but they should be put in place and need to be carefully designed, implemented and examined so as to ensure that they can be applied to achieve the environmental goals at cost-effective manners

by means of the market mechanisms. Second, this section investigates the application of economic instruments for the industrial pollution prevention and control in China. It introduces the currently-used economic instruments and assesses the effectiveness of economic instruments based on the particular cases of the air pollution charges and the water pollution charges. The basic functions of economic instruments in China are to raise the revenues and modify the behaviors of industries. Although they have contributed much to preventing and controlling the industrial pollution, there exists more rooms for the effective and extensive application of economic instruments. In the end of this section, it analyzes the barriers in the application of economic instruments with respect to conceptual, legal, institutional, information, valuation and manpower problems.

In section 5, it presents the strategies and perspectives in improving the application of economic instruments for preventing and controlling the industrial pollution. First, environmental policy is the guide to the use of economic instruments, and should take into considerations the pricing policies for natural resources, environmental charges and taxes, investment and credit policies, ecological environment compensation policies and pollution trading policies. Particularly regarding the environmental charges and taxes, the rates should be set at appropriate levels so as to stimulate the behavioral changes, and some environmental taxes, such as Coal Tax, CFCs Product Tax and Chlorinated Solvent Product Tax, could be used in China. Second, the environmental legislation is the guarantee for applying economic instruments. The provisions concerning economic instruments for pollution abatement should be reflected in the environmental protection laws as well as other laws such as Tax Law, Civil Procedural Law, Administrative Procedural Law and Criminal Procedural Law. Third, evaluation work is very important to the application of economic instruments. Effective and efficient evaluation can contribute to effective and efficient environmental policy. Forth, information campaigns are a basic element to the application of economic instruments. They can promote to deeply investigate the environmental issues, help to better understand the role of economic instruments in reducing the industrial pollution, and provide the feedback from the stakeholders. Fifth, the international cooperation and assistance is necessary for China to apply economic instruments in addressing the industrial pollution problems. China can take the international experiences as useful references. Finally, this section recommends other economic instruments that could be used in China, i.e., environmental performance bonds, environmental liability insurance, environmental performance disclosures and accredited licensee scheme.

In section 6, the roles of the different stakeholders are described. While the governments have the important role in applying economic instruments, the industries, the communities, the investors, the consumers, the educational and research institutions all have their own roles in promoting the application of economic instruments for pollution abatement.

In conclusion, it figures out that more attentions should be paid to handling the severe industrial pollution. In this respect, economic instruments could have an increasingly important role to play. But economic instruments are not a panacea for the industrial pollution, and need to be tailored to the specific situations. In practice, the best that can be hoped for is a mutually-reinforcing mix of economic instruments,

regulatory instruments, suasive instruments and other measures designed to stimulate the changes across a wide range of fundamentally different activities in relation to economic growth, resource utilization and environmental protection.

All in all, looking forward, if it sticks its efforts to tackling the industrial pollution, reforming the environmental policies, strengthening the environmental legislation, seeking for necessary international cooperation and assistance, accelerating the development of human resources, and overcoming the obstacles which limit the application of economic instruments, China has win-win opportunities in preventing and controlling the industrial pollution through the effective and efficient application of economic instruments, substantially improving its environmental quality, and achieving the sustainable development based on the coordination of economy, society and the environment.

Abbreviations

BOD	Biological Oxygen Demand
CFCs	Chlorofluorocarbons
COD	Chemical Oxygen Demand
CO ₂	Carbon Dioxide
ECE	Eastern and Central Europe
EIA	Energy Information Administration (US)
GDP	Gross Domestic Product
GNP	Gross National Product
IC	Industry Commission (Commonwealth of Australia)
ISO	International Standards Organization
NEPA	National Environmental Protection Agency (China)
NO _x	Nitrogen Oxides
OECD	Organisation for Economic Cooperation and Development
SDPC	State Development and Planning Commission (China)
SO ₂	Sulfur Dioxide
TSP	Total Suspended Particulates (air pollutants)
TSS	Total Suspended Solids (water pollutants)
UK	United Kingdom
UNCED	United Nations Conference on Environment and Development
US	United States
WCED	World Commission on Environment and Development

1. Introduction

Today sustainable development has become one of the most important and popular topics relating to our society. It not only means “meets the needs of the present without compromising the ability of future generation to meet their own needs”, but also implies “limits — not absolute limits but limitations imposed by the present state of technology and social organization on the environmental sources and by the ability of the biosphere to absorb the effects of human activities. But the technology and the social organization can be both managed and improved to make way for a new era of economic growth”, and calls for “a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, the institutional change are made consistent with future as well as present needs” (WCED, 1987). In order to achieve sustainable development of economy and society, it is essential to ensure that population, economy, society, natural resources and the environment are coordinated as a whole. Keeping this in mind, most countries have mapped out their corresponding strategies for sustainable development, and are making great efforts to put these agendas into practice.

China is the biggest developing country with the largest population in the world. The priority of sustainable development for such a country should be on the development. Thus China is now focusing on the economic development, deepening the policy for reforms and openness, and expediting the establishment of the market economic system. However, “Economic development and sound environmental management are complementary aspects of the same agenda. Without adequate environmental protection, development will be undermined; without development, environmental protection will fail” (The World Bank, 1992). As one of the eight global environmental heavyweights (Christopher, 1997), China is confronted with the dual task of developing its economy and protecting its environment. Although China’s sustainable development emphasizes the socioeconomic aspects, it must still be based upon the sustainability of the natural resources and preserving a healthy environment. At the threshold of 21st century, it is of great importance that the China’s economic development should be pursued in parallel with its environmental protection in order that the country can achieve sustainable development.

Since the early 1980s, China has made environmental protection one of its basic state policies and made unremitting efforts towards this end. In the 1990s, China has attached even more importance to environmental protection. It should be said that China has made distinct progress in environmental protection. For example, its pollution intensities (pollution per unit of output) have fallen substantially since 1988 (The World Bank, 1997). However, the overall environmental situation is still far behind the applause. While its economy is undergoing rapid development and its population is keeping growth, China is facing with serious environmental issues in the 1990s and beyond. There exist widespread environmental pollution and ecological damage, seriously impeding the further development of economy and society. The situation is even worsening in some areas. Undoubtedly, preventing and controlling the environmental pollution and reducing ecological damage are quite critical for China to tackle its environmental problems as it is embarking on a gradual path to the industrialization and the sustainable development.

Although China is still an agricultural country, industry takes the dominant part in its national economy. Unfortunately, industry consumes plenty of resources, and becomes the main source of the environmental pollution in the meantime. To a great degree, properly addressing the industrial pollution is a key issue for China to ultimately solve its pollution issues. This needs effective environmental policies integrated by the legislation and management measures.

Environmental policy instruments are the environmental policy-maker's tools in attempting to alter societal processes in such a way that they become and remain compatible with the policy-maker's environmental objectives (OECD, 1994a). In seeking to ensure the sustainable use of environmental resources and the maintenance of stricter levels of environmental quality, environmental policy can make use of or mix of three generally-classified instruments, i.e., direct regulations or command-and-control approaches, suasive instruments, and economic instruments.

Regulatory instruments can be described as institutional measures aimed at directly influencing the environmental performance of the polluters by regulating processes or products used, by abandoning or limiting the discharge of certain pollutants, and/or by restricting activities to certain times, areas, etc., through licensing, setting of standards, zoning, etc. (OECD, 1989). Their main feature is that a specific level of pollution (abatement) is prescribed, and the polluter is left with no choice but comply with the regulation, or face penalties in judicial and administrative procedures (OECD, 1989; OECD, 1994a). As a result, the regulation is often considered inflexible and may not provide the incentives for continuing innovation to reduce the environmental degradation. Besides, the regulation often leads to high costs of administration and compliance (IC, 1997).

Instruments could be labeled "economic" insofar as they affect the estimates of costs and benefits of the alternative actions open to the economic agents, with the effect of influencing the decision-making and behavior in such a way that alternatives are chosen that lead to an environmentally more desirable situation than in the absence of the instrument (OECD, 1989). Based on the market mechanisms, the options can be made more or less (financially or economically) attractive by applying charges or levies, granting subsidies, implementing tax differentiation, and so on. In this way the environmental concerns can in a certain sense be internalized by altering the agent's context rather than the agent's value structure or preferences (OECD, 1994a).

Suasive instruments may be defined as the approaches internalizing the environmental awareness and responsibility into individual decision-making by applying pressure and/or persuasion either indirectly or directly (OECD, 1989). These measures to address the environmental problems can take the form of education, provision of information and training as well as forms of "moral suasion" such as social pressure and negotiation (OECD, 1994a). They are expected to have one characteristic in common with economic instruments: they may be very flexible ones (OECD, 1989). In practice, the suasive instruments are often used in association with the regulatory or economic ones to support their successful implementation.

Economic instruments can achieve the desired environmental effects at the least possible costs which is vital to the developing countries with limited resources and a dire need to maintain their competitiveness in the world market (Theodore, 1993). Given the current situation of industry and the environment in China, economic instruments as complementary policy tools should have unique and realistic functions in dealing with the industrial pollution.

For the above reasons, this paper will be concentrated on investigating and discussing the application of economic instruments for preventing and controlling the industrial pollution in China, mainly through systemically reviewing the relevant literature and thinking about the actual conditions of China's industry and the environment.

2. The Current Situation of China's Industry: A Brief

2.1 The Current Status of China's Industry

Through the efforts of several decades, China has now established an independent and integrated industrial system, and the value of the industrial output has increased year by year. Industry is regarded as the engine of growth for Chinese economy. For example, industry accounted for 48% of GDP in 1995 (The World Bank, 1997). However, the overall level of industrial development in China is very low. The industrial structure is not completely rational, the resource allocation and utilization is quite poor, and the product quality still has much room for improvement. Moreover, the industrial facilities are obsolete, the technological and management levels are backward, and the infrastructure, especially in terms of the energy, transportation and communication sectors, is increasingly constrained by these bottlenecks and the shortage of funds (China's Agenda 21, 1994). There is no doubt that the serious environmental problems have accompanied the growth of this kind of industry in China.

2.2 The Environmental, Social and Economic Costs from the Industrial Pollution in China

Industry in China is highly polluting. Due to the low levels of economic, technological, scientific and educational development and the lack of environmental considerations, the majority of China's industrial enterprises stay at the levels of the 1950s or 1960s, and most industrial projects constructed before the 1980s do not have the installations for pollution prevention and control (SDPC, 1991). In addition, China's industry and overall economy are extremely energy intensive. This traditional development model of high resource and energy consumption connected with the extensive management has brought about the numerous resource waste and severe environmental pollution. To a great extent, the main pollution issues, such as water pollution, air pollution, solid wastes, noise pollution, and so on, are directly or indirectly attributed to the industrial sector. It is reported that over 70% of the

environmental pollution in China is caused by industry, and the impacts of the industrial pollution upon the urban environment are aggravated because 80% of the industrial enterprises are located at or close to the densely-populated cities (NEPA, 1995). Meanwhile, vast economic costs and life losses have resulted from the industrial pollution. For instance, in 1996, 1446 accidents of the industrial pollution were recorded, 172760 persons were exposed to the industrial pollution and 3 deaths were officially reported (NEPA, 1997). A typical case of the industrial pollution is the nearly dead Xiaoqing River. Just 5% of the large industrial polluters in the basin account for more than 95% of the chemical oxygen demand from the industrial wastewater (The World Bank, 1997). Although it is difficult to calculate the precise values, it is conservatively estimated that the environmental pollution respectively cost China approximately 10% of its GDP in 1990 (Smil, 1996), 4% of its GNP in 1992 (Xia, 1996) and 8% of its GDP in 1995 (The World Bank, 1997), and the average annual economic loss in the period 1986-1996 was US\$12 billion (China Economic Review, 1997). As mentioned earlier, industry has the largest pollution share in China, thereby the economic costs of the industrial pollution are proportionally surprising.

Clearly, the industrial pollution ranks amongst the most serious environmental problems facing China. It is urgent for China to incorporate the environmental costs and considerations into the decision-makings when it is developing its industry, and practically prevent and control the industrial pollution so that it can finally cope with its environmental issues and achieve sustainable development of economy, society and environment.

3. The Prevention and Control of the Industrial Pollution in China: A Review

The limited resources and the serious environmental degradation could eventually constrain the economic growth and the improvements in welfare. China has recognized that it must shift from an extensive and resource-intensive development pattern to an efficient and sustainable one. Over the past twenty years China has regarded the prevention and control of the industrial pollution as the focal point of its environmental protection. More than a dozen laws and policies affecting the environment have been enacted, and these now provide a comprehensive legal and policy framework for China's environmental management. The system for pollution prevention and control encompasses a wide range of environmental policies, regulations and standards and a nationwide enforcement network of national environmental protection agency, local environmental protection bureaus working with the sector agencies.

In general, China's environmental policies for pollution prevention and control are based on three main principles. The three principles emphasize prevention first while combining it with control; polluter pays (in other words, "Treat whoever polluted"); and strengthening environmental administration (i.e., "Environmental management relies on the government") (NEPA, 1995). Together with other regulatory programs such as the full utilization of resources, comprehensive

improvement of the urban environment, and preventing and controlling the industrial pollution in combination with technical transformation, the three major policies has formed a coherent system for the prevention and control of the industrial pollution.

In China, pollution prevention focuses on new pollution sources, which are regulated through environmental impact assessments and the Three Synchronizations System, i.e., a project and its facilities for pollution control should be designed, built and operated simultaneously. Pollution from the existing sources is regulated through such measures as pollution levies, pollution discharge permits and mandatory pollution controls (The World Bank, 1997). These programs have played a major role in containing pollution emissions from the regulated industrial enterprises.

At present, cleaner production is also actively promoted in China. With respect to the basic strategy, it has shifted from the end-of-pipe pollution control to the one that spans the whole process of production. Concerning the control of pollutant discharges, concentration control is replaced by combining it with total quantity control. Regarding the control methods, the country has moved from controlling the scattered point sources to combining the centralized and scattered controls. In addition, China has set up the deadlines for the firms that do not satisfy the pollutant discharge standards to solve the problems. Those that fail to meet the standards on the deadline are forced to close down, stop production, or dissolve, merge or shift to other industries. It is reported that to date some 65,244 enterprises have been shut down (China Internet Information Center, 1998).

However, China's efforts for pollution prevention and control have targeted primarily state-owned industrial enterprises. In recent years, the township and village industrial enterprises have rapidly grown and have emerged as an increasingly important source of pollution (NEPA, 1997). In addition, the privately-owned and most foreign companies have substantial pollution emissions. Generally the pollution from these three types of enterprises is unregulated and seldom charged.

Despite the magnitude of the industrial pollution, China has an unprecedented opportunity to improve its environmental quality through preventing and controlling the industrial pollution. Rapid economic growth and high investment rates can be used to develop clear, more environmentally friendly industries. Policies that channel investment into clear production, encourage material and energy efficiency, and encourage conservation of scarce resources could reduce emissions in 2020 below today's levels, improve air and water quality, and lower pollution-related health costs by 75%, even as China quadruples its output (The World Bank, 1997).

In its Ninth Five-Year Plan and the Long-Term Target for the Year 2010 for National Environmental Protection, China set up the ambitious goals: by 2000, the treatment rate of the industrial wastewater and the industrial waste gas will reach 74% and 80% respectively, and the reuse rate of the industrial solid waste will reach 45% (NEPA *et al*, 1996a).

Nevertheless, these outcomes will not happen automatically even though China has attached great importance to the prevention and control of the industrial pollution. Indeed, they will require considerable efforts. Although the structural

changes and the new technology can help reduce the pollution intensities, without new policies the pressures from a growing economy will swamp these improvements, and even undermine the recent gains. The old mode of growth, projected into the future, would generate rising health costs and dramatically raise the costs of cleanup to the future generations. Therefore, the realization of the environmental protection goals must be warranted through the comparatively perfect measures with regard to environmental policy, legislation and management.

As in elsewhere in the world, the conventional environmental management policies in China are heavily based on the direct regulations formulated by the government and guided by the relevant legislation. These command-and-control measures have contributed much to the prevention and control of the industrial pollution in China. However, when China is transiting from the planned economy to the market economy, the regulations tend to be inflexible and can even provide the limited incentives for resource saving and technological innovation in addressing the environmental problems. Moreover, the total amount of the industrial pollution emission is numerous, yet there is not sufficient input for preventing and controlling the industrial pollution. Thus China must revamp and strengthen its environmental policy to harness the market forces and make them work for preventing and controlling the industrial pollution so as to safeguard the environment.

Of recent years, the fundamental role of the market mechanisms has been more and more apparent, and the increasing interests have been shifted toward economic instruments to complement other approaches in halting the environmental issues because economic instruments have the potentials to achieve the environmental outcomes in more cost-effective ways as have been experimented in the market-oriented countries, especially in the OECD member countries. It is undoubted that this will provide China with the helpful experiences.

4. Preventing and Controlling the Industrial Pollution: the Role of Economic Instruments

4.1 The Practice of Economic Instruments for Preventing and Controlling the Industrial Pollution in the International Dimension

Environmental assets and natural resources are valuable in their own right, and major sectors of the economy depend on the use of these resources (IC, 1997). In the past the environment has been abused or poorly used because its true value has not been understood. Environmental pressures such as pollution/waste flows are usually generated by the economic activities (OECD, 1994a). The sustainable management of the environmental resources is not possible until their worth is appreciated and an appropriate price is paid for the benefits received (Soussan, 1992), and yet there are profound problems with valuing the environmental resources which do not have a current commercial price. Moreover, these problems are compounded by the uncertainties of assessing the seriousness of the environmental degradation. Despite the difficulties in accurately monetizing the environment and the pollution,

economists and policy-makers are trying to reflect the value of the environment, internalize the external costs (i.e., the costs that the polluters impose on other members of the society, e.g., health damage, morbidity or mortality increases, less pleasurable recreation experiences, etc.) of the pollution to a certain extent by means of econometric and political as well as legal approaches.

4.1.1 The Evolution of Economic Instruments as the Environmental Policy Measures: An Overview

It is well established that economic activities may lead to effects that are external to those who decide over these activities in the first place and may thus generate social costs (including the environmental degradation) that are not fully translated into private costs (OECD, 1994a). Under this situation, people's interests in viewing and addressing the environmental issues through internalizing the externalities and getting the prices right in the viewpoint of economics have increased along the time.

Pigou (1920) first formalized the impacts of pollution on the working of the economy, which stated that ideally the prices of goods and services should reflect the full social costs including the environmental costs as related to pollution, resource exploitation and other forms of environmental degradation, and called for the internalization of these and other external costs through a centrally imposed system of bounties and taxes. From 1960 onward, especially since 1975, the theoretical merits and demerits of the approaches for dealing with the environmental externalities have been analyzed (Bohm & Russell, 1985). At the same time, the growing severity and pervasiveness of pollution in the industrialized world have driven these attentions. Moreover, there has been increasingly awareness of the institutional failures which result in the environmental degradation. There are two types of most frequently cited institutional failures: *a) market failures*, such as failures of markets to emerge, and failures of the existing markets; and *b) government failures*, such as intervention failures or inappropriate actions of government, whether deliberate or not, and failures due to lack of intervention by government or failures to correct for market failures (OECD, 1994a). All these factors could be regarded as the catalyzers for the generation of economic instruments.

In 1972, OECD elaborated and adopted the "Polluter-Pays Principle", which is used for allocating the costs of pollution prevention and control measures to encourage the rational use of scarce environmental resources and to avoid the distortions in international trade and investment. The principle means that the polluters should bear the expenses of carrying out the above mentioned measures decided by the public authorities to ensure that the environment is in an acceptable state. In other words, the cost of these measures should be reflected in the cost of goods and services which cause the pollution in production and/or consumption (OECD, 1975). Since then the developed countries have widely caught on and developed these ideas in the field of environmental policy and applied them in the arena against the environmental pollution. This has served as an important mark for economic instruments introduced in the environmental policies.

In the 1984 OECD Conference on “Environment and Economics”, the desirability of strengthening the role of economic instruments was emphasized, since they were expected to: (a) be efficient policy instruments; (b) provide the incentives for innovation; and (c) be perceived as a more appropriate set when the environmental policy is shifting towards a more preventive phase (OECD, 1985).

In 1987 the General Assembly of the United Nations adopted a report from the World Commission on Environment and Development (WCED), which emphasized the need for environmental economic policies to be mutually reinforced, in particular, it explicitly advocated the application and use of economic instruments as the strategies for the sustainable industrial development (WCED, 1987).

Afterwards, quite a number of the international declarations and policy statements concerning the environment have underlined the potential usefulness of economic instruments (UNCED, PrepCom. A/CONF.151/PC/50, 1992a), including the Lankawi Declaration on Environment of the Commonwealth Heads of Government (Kuala Lumpur, October 1989), the Bergen Ministerial Declaration on Sustainable Development in the ECE Region (May 1990), the Declaration of the Economic Summit (Houston, June 1990), the Conference on Environment and Development in Asia and the Pacific (Bangkok, October 1990), the Ministerial Declaration of the Second World Climate Conference (Geneva, November 1990), the Second World Industry Conference on Environmental Management (Rotterdam, April 1991), etc..

In 1991 the Council of OECD adopted a recommendation which proposed, *inter alia*, that member countries:

- i) make a greater and more consistent use of economic instruments as a complement or a substitute to other policy instruments such as regulations, taking into account national socioeconomic conditions;
- ii) work towards improving the allocation and efficient use of natural and environmental resources by means of economic instruments so as to better reflect the social cost of using these resources;
- iii) make effort to reach further agreement at international level on the use of environmental policy instruments with respect to solving regional or global environmental problems as well as ensuring sustainable development (OECD, 1991a).

A global milestone in relation to the use of economic instruments for managing the environment was the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. At UNCED itself, a number of economically significant positions, including the use of economic instruments, were accepted. At various places in the main outputs of the conference, there is recognition of the Polluter- (and User-) Pays-Principles, the need to internalize the environmental costs, the precautionary approach to environmental change, and the use of economic instruments. Referring specifically to Principle 16 of Declaration of Rio: “National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment” (UNCED, 1992b); and

Charter 8 of Agenda 21: “What is needed is an appropriate effort to explore and make more effective and widespread use of economic and market-oriented approaches within a broad framework of development policies, law and regulation suited to country-specific conditions as part of a general transition to economic and environmental policies that are supportive and mutually reinforcing” (8.30), “To include, wherever appropriate, the use of market principles in the framing of economic instruments and policies to pursue sustainable development” (8.31, c), “In the near term, Governments should consider gradually building on experience with economic instruments and market mechanisms by undertaking to reorient their policies, keeping in mind the national plans, priorities and objectives” (8.32) (UNCED, 1992c). Therefore, it could be said that it is sustainable development that acts as “a ground for wider policy relevance and support for economic instruments” (OECD, 1994a).

Ever since the environmental quality and sustainable resource use became areas of political concern (especially since the late 1960s), the policy makers have searched for tools with which to achieve their objectives (OECD, 1994a). In various regional settings, the notion of economic instruments appears to have gained support as well. An OECD survey within its member countries in 1987 yielded a total of 150 loosely-defined economic instruments being used, basically distinguished as the following categories: 1) charges, 2) subsidies, 3) deposit-refund systems, 4) market creation, and 5) financial enforcement incentives (OECD, 1989).

In OECD member states, the use of economic instruments has evolved in three stages (Barde, 1997). In the 1970s, user charges were favored; in the 1980s, earmarked charges dominated together with incentive taxes; and most recently, attention is focused on so-called green taxes through the introduction of ecotaxes, sometimes as a part of the overall restructuring of the national tax system. Taxes on energy and pollution components, such as carbon and sulfur, are a notable development in some OECD countries like Nordic countries, France and the Netherlands. There are at least six factors involved in the evolution of economic instruments. They are:

- 1) the often limited performance of direct regulations, being costly and difficult to enforce;
- 2) the move towards “deregulation” or regulatory reforms in various areas of public sector management implying, in particular, the search for economically more efficient policy instruments and increased reliance on the market forces;
- 3) increasing concerns for the environment and the need for more stringent and ambitious policies in environmental protection;
- 4) the search for revenue either for the general government budget or for financing specific environmental programs;
- 5) the need for an effective “integration” between economic and environmental policies;
- 6) the need for more efficient tax policies and tax reforms, implying the removal of distortional subsidies and taxes and their replacement at least in part by the environmental taxes (Barde, 1997).

Furthermore, once taken into effect, the following common elements can be observed in economic instruments:

- a) the availability of alternative behavioral options;
- b) the involvement of government (related) authorities;
- c) the intention of (directly or indirectly) maintaining or improving the environmental quality by applying the instruments;
- d) an impact on levels of costs or benefits of alternative behavioral options (OECD, 1994a).

4.1.2 The Criteria for the Choice of Economic Instruments

According to the Guidelines and Considerations for the Use of Economic Instruments in Environmental Policy set out by the Council of OECD, the choice of economic instruments can be made against the following five sets of criteria:

- i) *Environmental Effectiveness*: The environmental effectiveness of economic instruments is mainly determined by the ability of polluters to react. The primary objective of economic instruments is to provide a permanent incentive to pollution abatement, technical innovation, and product substitution.
- ii) *Economic Efficiency*: In a broad sense, economic efficiency is achieved by an optimal allocation of resources; in a limited but more operational sense, it implies that the economic cost of complying with environmental requirements is minimized.
- iii) *Equity*: Distributive consequences vary according to the types of policy instruments applied. For example, pollution charges or taxes entail additional payment on the discharge of “residual” pollution; additionally their distributive impact would depend upon how the revenue is used. Similarly, with tradable permits, the distributional effects will differ according to their initial allocation.
- iv) *Administrative Feasibility and Cost*: All types of policy instruments involve implementation and enforcement structures. This relates in particular to the ease and cost of monitoring discharges and the number of target groups involved and also depends upon the nature of existing legal and institutional settings.
- v) *Acceptability*: It is of crucial importance that target groups should be informed and consulted on economic instruments imposed on them. In general, the success of any (economic) instrument requires certainty and stability over time with respect to their basic elements (OECD, 1991a).

Besides, there are other considerations in selecting an economic instrument:

- vi) *Flexibility*: It is desirable that the chosen instruments allow for flexibility. There are two main aspects of the flexibility that need to be considered: the ability of an instrument to keep doing its job in the face of changing circumstances, such as changing prices, conditions and public policies; and the degree to which individual firms may choose their own responses within the context of the overall environmental goal.
- vii) *Informational Requirements*: It is preferable that any information which is required for the effective implementation and administration of, and

compliance with, an instrument is readily available, or else not too costly to obtain or develop.

viii) *Consistency*: It should be borne in mind that, with respect to any revenue raising or tax instruments, such instruments should be consistent with the broad tax policy objectives.

ix) *Effects on the International Competitiveness of the Industries*: It is worth noting that the national key industries may often face the intensive competitions from the corresponding international partners. Thus the direct or indirect effects of economic instruments on the international competitiveness of the industries should be considered, but this should not be used as an excuse to introduce the appropriate environmental policies in regard to the long-term benefits and costs of reducing the environmental degradation (IC, 1997).

4.1.3 The Guidelines for Implementing Economic Instruments

Environmental policy is amongst the most sensitive policies. When considering the adoption of economic instruments in environmental policy, it should keep in mind to timely assess the costs and benefits of all policy alternatives. The implementation and enforcement are as important as the development and selection of economic instruments.

In brief, implementing and enforcing economic instruments should take into consideration the following issues: clear framework and objectives; well-defined field of operation; simple mode of operation; acceptability; integration with sectoral policies; manpower and cost of implementation; assessment of economic and distributive consequences; conformity with general principles of national and international trade, fiscal and environmental policy (OECD, 1991a).

In detail, the following prerequisites should be met for an economic instrument to be successfully applied in practice:

- evidence that a significant environmental problem exists, or is likely to arise, which otherwise would not be adequately addressed;
- strong public and/or industry support for action to address the problem;
- availability of appropriate expertise to help design, implement and monitor the use of the instrument;
- capacity to establish an effective and efficient administrative and legal framework to implement the instrument;
- measures in place for reviewing, adapting and refining the approaches to changing the circumstances; and
- clear goals against which effectiveness can be evaluated (IC, 1997).

4.1.4 Closer Looking at The Practice of Economic Instruments in the Developed World

Since economic instruments are intended to modify production and consumption patterns, they can be used to contribute to environmentally sustainable

development (Schlingemann, 1993). They can provide an incentive to the policy-makers to integrate the environmental concerns into their everyday decisions. Normally, the instruments of the environmental policy are not used in pure, isolated form. Typically, economic instruments are part of wider combinations, often used together with certain regulatory instruments (OECD, 1994a). Nevertheless, these market-based instruments do have their specific functions over the direct regulations, and are considered to be capable of providing strong incentives for technological innovation and behavioral change, and to offer good prospects for achieving environmental objectives in a cost effective manner (OECD, 1991b). They could play an important role in gaining the most environmental benefits at the least costs.

First, economic instruments can increase the flexibility of the response of decision makers to the need to reduce the environmental damage (IC, 1997). That is, they do not dictate a particular technology but allow the polluters to choose the method that is best in their particular circumstances for meeting a given environmental outcome. By doing so, they will allow the producers and/or consumers to achieve the environmental objectives in the most cost effective manner. Moreover, economic instruments can make the costs of meeting the environmental standards more transparent.

Second, since the actors are left free to respond to certain stimuli in a way that they themselves think most beneficial, economic instruments can be relatively flexible, acceptable and operable when used in conjunction with other approaches.

Third, economic instruments tend to have over direct regulations is that they provide incentives for ongoing innovation. That is, there are continuing incentives to seek out and adopt less polluting technology to address the environmental problems because by doing so a firm can lower its costs (IC, 1997).

Fourth, economic instruments can promote resource conservation and transmission to the future generations in the same way that resource-pricing does (OECD, 1991a).

Fifth, economic instruments may be less vulnerable than the regulatory instruments to manipulation and influence by established interests and thus less liable to serve protectionist purposes (OECD, 1994a). Domestic firms usually play an important role in the development of the environmental policies, which naturally reflect the environmental concerns and capabilities peculiar to the implementing country. The design of the regulatory instruments, particularly product standards, can be used to shelter the domestic firms from foreign competition or give them certain trade advantages. Economic instruments, especially the environmental charges and taxes, on the contrary, are thought to be more straightforward in their design and implementation and less capable of being manipulated to just serve the domestic interests, either directly or indirectly.

Sixth, in some cases, such as taxes, charges and tradable permits, economic instruments may raise revenues which may allow other taxes to be reduced, or can be used to finance environmental policy measures or other government spending (OECD, 1997a).

Nevertheless, economic instruments may have some potential disadvantages. For example, the subsidies (grants, soft loans, tax allowances, etc.) can have weak beneficial effects on incomes, growth and employment in the intended recipient sector, whilst having strong adverse effects on the environment. Since many environmental improvements are strongly dependent on the technological change, subsidies may block the development that are crucial for achieving the environmental objectives. This can be especially detrimental for the progress in the reduction of emissions from the non-point sources, which must be addressed primarily using the measures that influence the levels of the resource use (OECD, 1998). Particularly, because subsidies represent a net payment by the government, they may have the undesirable effect of rewarding those who have been poor environmental performers prior to their introduction, and this may distort the charge system and does not satisfy the Polluter-Pays-Principle as well.

Economic instruments appeal to the market mechanisms to discourage pollution. A second issue raised by these instruments is the impact of uncertainty on the pollution outcome and costs of abatement (OECD, 1997a). Using a pollution tax, for instance, the amount of pollution is the result of the individual's decisions in response to the incentive provided by the tax, and this turns out to be more or less than envisaged when the tax rate was set.

In addition, the concerns about the level of the financial pressures that certain types of the market incentives may place on the polluters are attached to implementing economic instruments (OECD, 1997a). If the heavy tax burden is induced by the environmental taxes and charges, it may delay the further development of the enterprise by reducing the source of its reserve fund, and this may encounter the intensive objections from the firm and its relevant shareholders, ultimately leading to the ineffective implementation of the instruments.

All in all, economic instruments are the important environmental policy measures in addressing the environmental issues. They have both potential advantages and disadvantages. Therefore, they should be put in place and be carefully designed, implemented, enforced and examined so that they can effectively and efficiently have the aid of the market incentives to complement other environmental policies and satisfy the environmental objectives. The ideas can be simply described in the following causal-loop diagram (Figure 1).

On the one hand, the increase in the industrial pollution issues (i.e., environmental, social and economic costs, etc.) will lead to the increase in the demand for all kinds of environmental policies for preventing and controlling the pollution (signed with a “+” in the diagram); accordingly, as the environmental policy tools, the use of economic instruments will be increased (also signed with a “+” in the diagram); optimally, the effective application of economic instruments will help to prevent and control the industrial pollution, decreasing the industrial pollution issues (signed with a “-”), in other words, the more and better use of economic instruments, the less the industrial pollution issues. As a result, a negative feedback loop, loop A, is formed (signed with a “⊖” in its center) because its implied goal is keeping the issues of the industrial pollution under control.

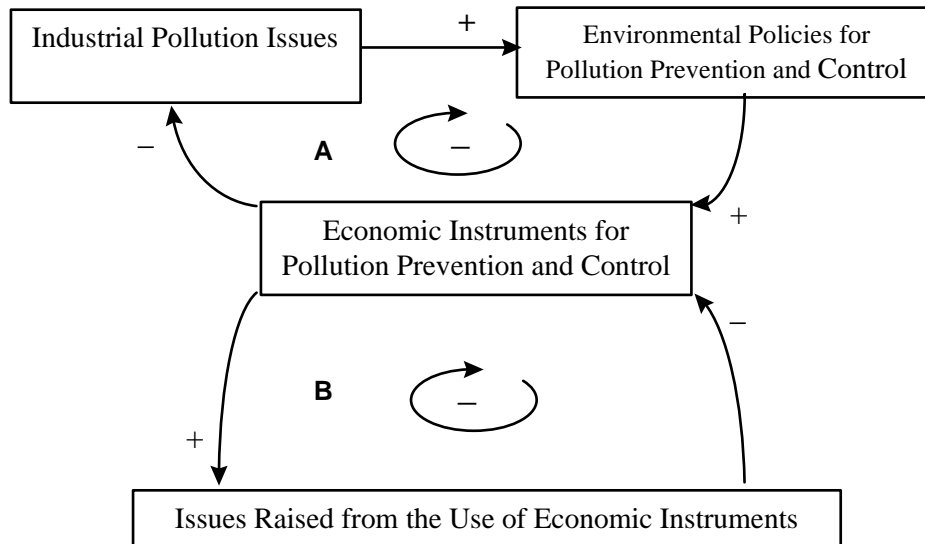


Figure 1. The Relationship between Industrial Pollution, Environmental Policies, Economic Instruments and Issues from Using Economic Instruments

On the other hand, the use of economic instruments is not easy: many aspects should be taken into account, and this may even result in some problems (signed with a “+” in the diagram); undoubtedly, these problems will constrain the effectiveness and further use of economic instruments (signed with a “-” in the diagram); here another negative feedback loop, loop B, is formed (also signed with a “↻” in its center) because it implies that there are some limitations in applying economic instruments for the industrial pollution prevention and control.

This feedback system indicates that the effective and efficient application and use of economic instruments can substantially contribute to preventing and controlling the industrial pollution, but there may be some drawbacks which can not be ignored. Therefore, the practical application and use of economic instruments for the industrial pollution prevention and control should balance the pros and cons in order to achieve the expected environmental objectives.

4.2 The Application of Economic Instruments for Preventing and Controlling the Industrial Pollution in the Chinese Context

The application of economic instruments for the industrial pollution prevention and control can be dated back to the trial implementation of the pollution charges in Suzhou City, Jiangshu Province, in 1979. At present, China is mainly taking into practice three types of economic instruments, including pollution levy system, financial, tax, investment and credit incentives, and compulsory fines to the violators (NEPA, 1995). Nevertheless, the last ones are often attached to others, and often regarded as the regulatory instruments instead of the economic ones.

In principle, economic instruments in China may comprise two functions: raising revenues and providing incentives for behavioral modification (Wang & Lu, 1997). They have become the important measures to supplement the environmental policy for managing the industrial pollution in China.

4.2.1 The Existing Economic Instruments for the Industrial Pollution Prevention and Control in China: An Outlook

All the currently used instruments for environmental protection in China are relative to and most are directly aimed at the industrial pollution. Table 1 shows the existing economic instruments for environmental protection in China.

Table 1. Economic Instruments for Environmental Protection In China (1996)

Economic Instruments	Implementing Authorities	Initial Date	Target Groups	Implementation Coverage
Pollution Exceedance Charge	Local EPBs	1982	Firms and Individual Businessman	Nationally
Volume-based Effluent Charge	Local EPBs	1991	Firms and Individual Businessman	Nationally
SO ₂ Charge	Local EPBs	1992	Industrial Boilers and Coal-burning Power Plants	Two Provinces and Nine Cities
User Charge for Sewage Network	Local UCBs	1993	Firms and Individual Businessman	Nationally
Wastewater Treatment Charge	Local UCBs	n.a.	Dischargers and Households	Six Cities
Favorable Tax for Treating, Reusing and Recycling Waste	Tax Authorities	1984	Firms Reusing Waste	Nationally
Resource Tax	Tax Authorities	1986	Resource Developers	Nationally
Mineral Resource Compensation	Local Mineral Authorities	1986	Mineral Extractors	Nationally
Ecological Destruction Compensation	Local EPBs	1989	Resource Developers	Seven Provinces
Tradable Permits	Local EPBs	1985	Trading Companies	Two Cities
Waste-trading Market	Local EPBs	1989	Firms Using Waste	Two Cities
Deposit for the Three Synchronizations	Local EPBs	1989	Newly-built Projects	One City and One Province
Deposit for Clean-up Operations	Local EPBs	1995	Firms with Pollution Abatement Equipment	One City
Deposit for Solid Wastes	Material Departments	n.a.	Firms	Nationally
Financial Pipeline for Environmental Protection	Planning, Fiscal and Financial Authorities	1984	Firms Required to Abate Pollution	Nationally
Subsidies	Local EPBs and Fiscal Authorities	1982	Firms Required to Abate Pollution	Nationally

Notes: 1) This table is mortified according to Wang & Lu (1997).

2) EPB refers to the Environmental Protection Bureau, and UCB refer to the Urban Construction Bureau.

3) Pollution Exceedance Charge was first tried out in Suzhou City in 1979, then nationally popularized in 1982.

The items of economic instruments listed in Table 1 can be roughly classified as pollution levy system (charges and taxes), compensations, tradable permits, deposit refund systems, financial funds for environmental protection, and subsidies, etc..

(1) Pollution levy system (charges and taxes)

The first generation of economic instruments for environmental protection in China are the pollution exceedance charges, which were experimented in 1979 and have been in nationwide use since 1982. These charges are levied only when the pollutant emissions exceed the national or local environmental standards. In effect, the system is operated in the form of non-compliance charges. In 1991, the effluent charges based on the volumes of the pollutant discharges were carried out across the country. Afterwards, the user charges for urban sewage network, wastewater treatment charges and SO₂ charges were successively put into practice. Furthermore, the SO₂ charge system will be extended beyond the acid rain control areas and the SO₂ discharge control districts after analyzing the trial experience.

At present, the pollution charges have become the most important and fundamental economic instruments in China, covering five fields and 113 items related to the resources and the environment, including the discharge of wastewater, waste gases, solid wastes, noise and low-level radioactive wastes (Wang & Lu, 1997). The administrative fees are also included in the charges. As to the target groups, the state-owned industrial enterprises are the main body, and the majority of the village and town owned firms, the private industries as well as the foreign companies are seldom charged up to now.

In China, the initial function of the charges is to raise the revenues for the clean-up of the priority pollution sources. For instance, in 1995, the charges were applied to 368,200 firms and raised 3.713 billion yuan in revenues, representing 0.6% of the national financial income of this year (Wang & Lu, 1997; NEPA, 1996b). The pollution charges as the percentages of the national financial incomes from 1979 to 1995 are illustrated in Figure 2.

What is worthy of note is that the percentages of the charge revenues to the national financial incomes had remained between 0.53% and 0.61% since 1986 although the charge revenues had increased year by year. It is commonly believed that the charge rates are too low to provide sufficient incentives for reducing the industrial pollution. For instance, it is estimated that the current charge for the industrial-relative COD is less than 50% of the average treatment costs (Wang & Lu, 1997). It is obvious that the current pollution charge rates should be reconsidered in light of the actual industrial pollution situation.

Generally speaking, although they are used nationwide, taxes have not taken the main part in the pollution levy system due to their relatively narrow definitions. Moreover, they are primarily conducted by the tax authorities, and the tax revenues are much less than that from the pollution charges. China is discussing the possibility for shifting some charges towards taxes although it reformed its tax system in 1994. Indeed, an environmental tax system, the proposed second generation of economic instruments in China, is necessary for achieving the environmental goals.

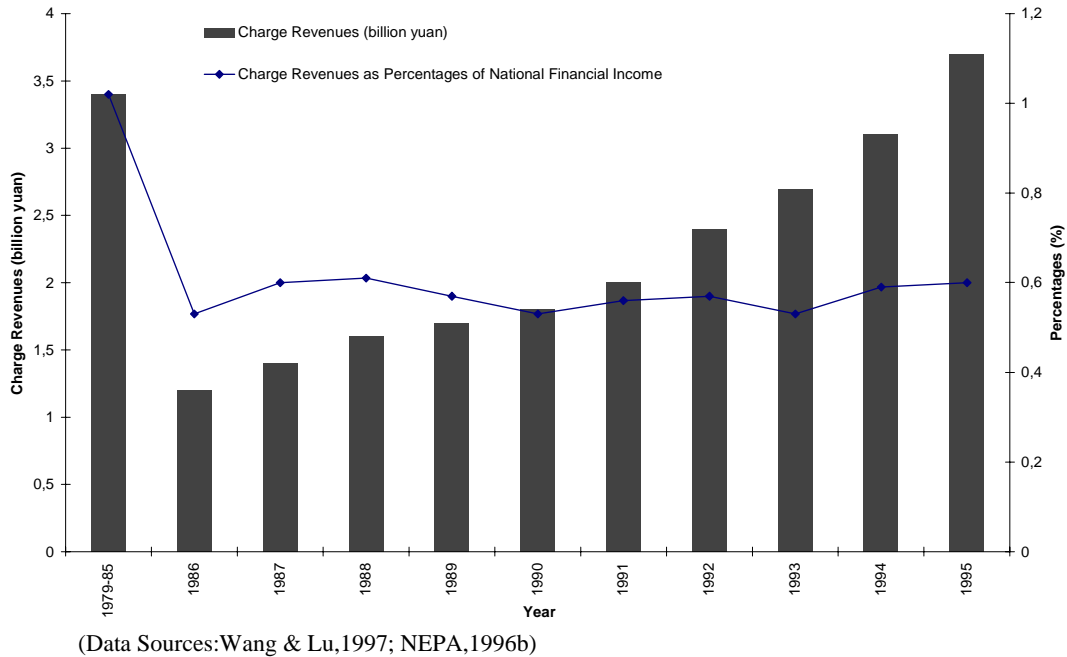


Figure 2. The Pollution Charge Revenues as the Percentages of the National Financial Incomes (1979-1995)

(2) *Compensations*

According to the principles of “Polluter Pays” and “Treat whoever polluted”, the system of mineral resource compensation and the system of ecological destruction compensation was introduced in 1986 and 1989 respectively. The ecological destruction compensation system is mainly expressed in the form of a product charge (Wang, 1994), and has not been implemented in the whole country.

(3) *Tradable permits*

Tradable permit schemes are concerned with the property rights and market creation. Based on the standards for the environmental quality control, if its discharge is lower than the allowable emission amount, the enterprise can sell out its surplus emission amount to another firm or trade it in the market so that other firms can obtain extra emission. This deal can be made within the firm, between firms and even trans-boundarily (NEPA, 1995). At present this system is still being experimented by the trading companies in two cities. In 1996, the Plan for Controlling the Total Quantity of the National Main Pollutants was formulated (NEPA *et al*, 1996), and this will promote the further application of the tradable permits system.

(4) *Deposit refund system*

Under this system, an extra fee must be paid for the products with potential pollution. Once the residual of this product is recollected to the recovery system, the deposit will be refunded to the buyer.

In the case of the deposits for the Three Synchronizations System and for clean-up operations, if the firm fails to accomplish the regulated goals, the deposit will not be refunded. Moreover, the firm may be fined. This is a typical supplement to the regulatory instruments.

(5) Financial funds for environmental protection

This system forces the polluting industries to pay part for pollution abatement. The collected funds are managed by the planning, fiscal and financial authorities instead of environmental protection departments. In the future, it may be transferred to the environmental fund which is being proposed.

(6) Subsidies

Subsidies mainly include grants, long-term low- or non- interest loans, loan forgiveness, tax abatement, tax exemption and so on. It may provide financial incentives to the firms which are taking the environmental standards but facing with the financial embarrassments, or the firms with good environmental performances.

4.2.2 The Practice of Economic Instruments for Preventing and Controlling the Industrial Pollution in China: The Cases of the Air Pollution Charges and the Water Pollution Charges

The economic efficiency theory suggests that the polluter should pay the full cost of the environmental damages caused by its activity. This would create an incentive for the reduction of such damage, at least to the level where the marginal cost of pollution reduction is equal to the marginal cost of the damage caused by such pollution (Turner *et al*, 1994). In this point, the regulatory instruments can not work effectively; on the contrary, the pollution charge system can find its way to achieve cost-effectiveness through its indirect control over the pollution activities. It represents a straightforward manner to price the use of the environment and pay for the cost of environmental damage.

In China, the pollution charge system is established according to the Polluter-Pays-Principle and “Treat whoever polluted” principle as well as the corresponding environmental protection laws. Environmental Protection Law of the People’s Republic of China (tried in 1979, formally promulgated in 1989), Water Pollution Prevention and Control Law (1984) and Air Pollution Prevention and Control Law (1987) have specified that pollution charges should be paid according to the qualities and concentrations of the pollutants released (NEPA, 1993). In 1982, the State Council issued the “Provisional Regulations for Collection of Pollution Charges” to start the nationwide implementation of the pollution charge system (NEPA, 1995). Through the practice of nearly twenty years, this system has formed the following characteristics:

- Charges do not exempt the responsibility for pollution treatment: The polluter pays the pollution charges, but he has to assume the responsibilities for pollution treatment, damage compensation and other legal requirements.

- Charges are compulsory: If the polluter does not pay the pollution charges after the deadline, he has to pay the daily overdue fine. If the polluter refuses to pay the charges, he will be fined, and may even face the lawsuit.
- Charges are progressive: If the polluter has not met the discharge standards after paying the pollution charges, the charge rates will increase 5% per year from the third payment year.
- Charges are stricter to the new polluters: If the newly-built or reconstructed projects exceed the standards for the pollutant discharges, the pollution charges will be doubled.
- Fine on mistakes and violators: If pollution accident is caused due to the mistakes or the discharger violates against the environmental laws and regulations, fine will be paid by the relevant polluters.
- Pollution exceedance charges and effluent charges must be levied at the same time: Any firm should pay the effluent charges if it discharges pollutants to the environment. Moreover, the pollution exceedance charges must be paid if the concentrations of the pollutants exceed the relative discharge standards.
- Charges can be calculated in the form of cost of production: Only the pollution exceedance charges and effluent charges can be included in the cost of production. Other charges, such as fines, can not be placed in the cost of production.
- Charges are earmarked: The pollution charges are put into the budget, earmarked mainly for pollution prevention and control. In addition, the charges can be partially extracted as an deposit for pollution treatment, and the deposit is managed by a bank and used as a refunded loan for pollution treatment.
- Subsidiary functions: The polluter can apply for subsidy from the pollution charges if he can actually not afford the cost of pollution treatment, but the subsidy will not be more than 80% of that he paid for pollution discharge (NEPA, 1995).

Among the currently-used pollution charges, the air pollution charge system and the water pollution charge system are the first economic instruments for environmental protection in China. They are the most important components of the pollution levy system, and they are briefed respectively as follows.

1. Air Pollution Charges

The air pollution charge system has been operated in China for nearly 20 years, undergoing three stages of development, that is, trial introduction, national implementation and refinement. Now it is a national pollution charge system covering more than 300,000 enterprises and more than 20 atmospheric pollutants. Since 1979 the total charges collected under this system is 5.93 billion yuan (Yang, Gao & Wang, 1997). The pollution charges first go to the State budget, and the money is then disbursed in proportion to the amount received and in the form of subsidies such as grants or loans to cover the expenses for treating pollution and for funding the operation of the environmental departments.

The charges are mainly based on how many times the pollutant exceeds the set concentration standards with an exception for the SO₂ charge, which started in 1992 and is calculated on the total volume. The present charge rates were set in 1982. This system has two features: first, the charges are payable for the exceedance of the set limits; second, for any emission, the charge is calculated according to the pollutant for which the maximum charge is paid, i.e., a single determinant for collecting the charge (Yang, Gao & Wang, 1997). For the gaseous pollutants such as SO₂, NO_x, etc., the charge rate is 0.04 yuan per kilogram (NEPA, 1996c). Due to the experiment of the SO₂ charge in two provinces and nine cities, the charge rate of SO₂ within these areas is changed to 0.2 yuan per kilogram. Figure 3 shows the trend of the air pollution charge collections from 1985 to 1995.

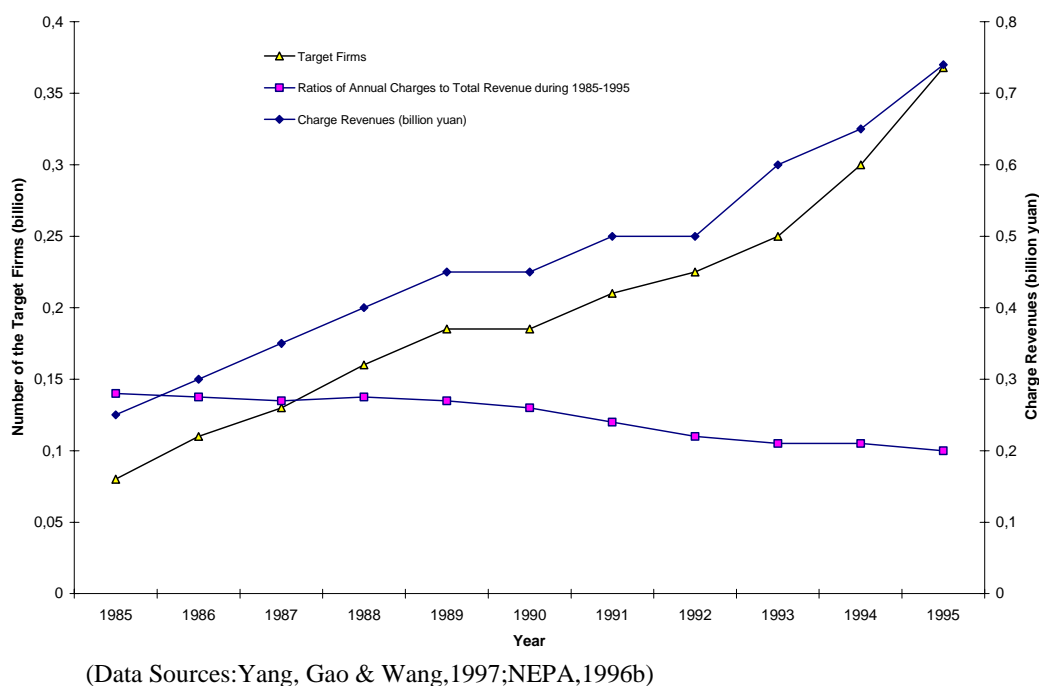


Figure 3. The Trend of the Air pollution Charge Collection (1985-1995)

Figure 3 shows that both the annual charge revenues and the number of the firms subject to the system are increasing year by year, but the ratios of the annual charge revenues to the total revenue during 1985-1995 is tending down. This may be explained from several aspects: (1) insufficient management capacity of running the charge system; (2) the limited criteria and pollution parameters against which the charges are collected (Yang, Gao & Wang, 1997); (3) in contrast to the former two reasons, it might imply that the target firms have had some substantial ameliorations in reducing the pollutant discharges, thus the payments have not raised proportionally.

Although much remains to be improved, the implementation of the air pollution charge system has promoted better treatment of the air pollutants. Following this system, the target firms have enhanced their environmental awareness and paid more attentions to pollution prevention and control. According to a national survey, both the treatment rates of air pollutants and the annual treatment capacity have raised in recent years (Yang, Gao & Wang, 1997).

II. Water Pollution Charges

Since the early 1980s water pollution charges have been implemented throughout the country. At present the system comprises two categories: charges on wastewater and user charge for sewage network.

The charges on wastewater include concentration-based water pollution exceedance charge and volume-based wastewater effluent charge. The concentration-based charge is levied according to the charge rates which are set according to the Integrated Wastewater Discharge Standards, and this is the main part of the water pollution charge system while it gives different rates for the different water pollutants. For instance, the charge rates for BOD, COD and TSS vary from 0.04 to 0.30 yuan per ton of wastewater according to the times the pollutants exceed the concentration standards (NEPA, 1996c). It may be termed pollutant-specific charge, and is calculated by multiplying three elements together: a unit fee, the volume of discharged wastewater, and the ratio of effluent concentration to the standard concentration. Moreover, unit fees escalate with the ratios. For plants with multiple pollutants, the maximum concentration ratio is used for charge assessment. Differently, the volume-based charge is the fee for the wastewater discharge, which is currently fixed at 0.05 yuan per ton of wastewater (Wang & Lu, 1997). Table 2 indicates the changes of the wastewater charge during 1991-1994.

Table 2. Wastewater Charges in China 1991-1994

Year	1991	1992	1993	1994
Levied Firms ($\times 10^4$)	20.59	22.32	25.42	30.04
Concentration-based Water Pollution Exceedance Charges (million yuan)	996	1181	1228	1319
Volume-based Wastewater Effluent Charges (million yuan)	62	83	126	201
Total Wastewater Charges (million yuan)	1058	1264	1354	1520
Total Pollution Charges (million yuan)	2006	2380	2681	3097
Costs of Wastewater Treatment (million yuan)	2921	2981	2942	3470

(Data Sources: NEPA, 1992-1996; Zhang *et al.*, 1997.)

Table 2 indicates that both the number of levied firms and the wastewater charges were increased during this period, and that total wastewater charges made up over half of the total pollution charges. It is notable that the total pollution charges are still less than the costs of wastewater treatment.

As a lately-added item, the user charge is consolidated into a fund which is used to subsidize the operation and maintenance of the wastewater treatment facilities, and is carried out by the local municipal construction departments based on the different standards and the specific conditions. At present the charge rate is generally between 0.05-0.25 yuan per ton of sewage. About 70% of the state investment for constructing and maintaining the drainage pipelines comes from the user charges (Zhang *et al.*, 1997).

Similar to the air pollution charge system, a large proportion of the water pollution charges is used to subsidize the prevention and control of the key water pollution sources. This has provided a main fund source for preventing and controlling the industrial wastewater discharge. Although it is not perfect, the water pollution charge system could be regarded as an effective economic instrument for

preventing and controlling the industrial pollution in China. In recent years, the total amount of the industrial wastewater discharge has gradually decreased, while the treatment rate and treated amount of the industrial wastewater have increased (NEPA, 1992-1996; NEPA, 1997). This could be, to quite a certain extent, attributed to the implementation of the water pollution charge system because industries often exhibit more responsive than other sectors to the economic signals (OECD, 1994c): no matter how much the charges are, most enterprises themselves have to respond to them, and then they have to take some actions to treat their wastewater. In fact, there are several industrial companies that have gained striking economic and environmental benefits by treating their wastewater, such as Lianhua Gourmet Powder Group in Henan Province. Through the comprehensive treatment of the wastewater, this big state-owned industrial enterprise has not only met the wastewater discharge standards, but also decreased the cost of production and extracted useful materials for the derivative products as well (People's Daily, 1998).

By and large, as the main components of the pollution levy system, the air pollution charges and the water pollution charges have been working better than have been supposed. They have played an active role in preventing and controlling the industrial pollution and improving the environmental quality in China. However, a number of factors impede the further application and use of these systems as well as other economic instruments which are highlighted above.

4.2.3 Barriers in the Use of Economic Instruments for the Industrial Pollution Prevention and Control in China

Both the external and internal limitations exist in the application and use of economic instruments for preventing and controlling the industrial pollution in China, as discussed below.

A. Conceptual Problems

- The existing environmental policies do not fully reflect the relative scarcity and total value of the environmental sources. The idea that pollution is the price of development still remains in the minds of many decision-makers. The effects of the market forces on the environmental resource allocation have not been truly understood and recognized. Therefore, the payable prices of most environment-related resources are lower than their full values, leading to a great wastage of the resources and extra pollution (Wang & Lu, 1997). In the case of the pollution levy system, the charge/tax rate is too low to stimulate the polluting industries to change their behaviors. When most charge rates were set ten years ago, the industrial fiscal consideration was given excessive emphasis without carefully checking the present and future environmental outcomes. Consequently, many enterprises put their economic interests before the environmental results, and prefer to pay the pollution levy rather than take more positive activities to reduce their pollution. Moreover, the subsidies in the form of loan forgiveness and tax exemption are not consistent with the Polluter-Pays-Principle because they will induce the inequality in distributing the

costs for pollution prevention and control, and eventually create the distortion in the resource prices.

- The scope and coverage of the current economic instruments need to be adjusted. The species of the pollutants are increasing, and they should be included in the control scope. As to the target enterprises, the state-owned units are the main body, and this is obviously unreasonable. The village and town-owned enterprises, the private firms and the foreign companies have had an increasing pollution share in recent years, and all of them should pay the relevant costs imposed by them on the environment.
- The inherent difficulty of changing the status quo is another major external barrier to successful implementation of economic instruments. This resistance often derives from the misconceptions that implementing the market-based instruments will result in little environmental gain, weaker regulatory controls, and legitimate pollution by giving a license to the polluters (Izmir, 1994). These misconceptions also exist in many Chinese decision-makers' minds. This highlights the need for an extensive and effective information dissemination, educational and consultative process of how economic instruments work and what benefits they have over other instruments. Meanwhile, it hints at the wider problem of raising the awareness of environmental issues and their impacts on the environment, the wider economy and the society as a whole.

B. Legal Problems

The lag of the environmental legislation limits the timely and effective development and implementation of economic instruments for preventing and controlling the industrial pollution. Without the sufficient supports from the environmental legislation, the environmental policy measures including economic instruments can not be brought into full play in the arena against the industrial pollution. However, most currently-used economic instruments can not be given the corresponding legal interpretations. On the other hand, despite based on the environmental policy, administrative penalty sometimes can not press enough warnings on the polluters.

C. Institutional Problems

Although the environmental management system in China is characterized as unity of management and division of responsibility, the current policies are fragmented across several government agencies with different policy mandates. Under this situation, the National Environmental Protection Agency (NEPA) and its subordinates do not hold enough power although they are the environmental administrators in the different-level governments. This institutional structure increases the complexity in the implementation of the environmental policies. It leads to the incoordination in implementing the existing environmental policies, sometimes it even weakens the enforcement of the relative policies because the different departments only consider the immediate interests of their own and the enterprises under the command of them. For instance, in some cities, all the departments in relation to the water resource management attempt to broaden their sources of income by imposing a charge on the water users. As a result, the enterprises in some cities

have to pay the charges on fresh water and wastewater according to 11 parameters and the collected revenues go to six government departments (Wang & Lu, 1997). It is clear that some of the charges overlap the others and are inconsistent, leaving a charge system which is inefficient and resulting in extra administrative costs.

Another institutional problem is that cross-border difficulties may arise when trying to expand economic instrument schemes between different areas. Indeed, the so-called local protectionism exists widely in China. The main industrial polluters are usually the main contributors to the local economy, and therefore they are often the key enterprises supported and even shielded by the local governments. When the local governments in different areas are unable to reach agreement, economic instruments can often not be effectively carried out in time.

D. Information Problems

The environment-relative information is not collected and transferred in time. The information deficiencies can impair the effectiveness of the existing schemes involving economic instruments, restrict the potentials for the existing schemes to expand and limit the further application of economic instruments into new areas. In a word, the lack of information on the nature of the environmental problems can weak the potentials to implement economic instruments.

In addition, the spatial and temporal complexity of some environmental problems can certainly limit the potentials to apply economic instruments since implementing economic instruments requires the understandings of the costs and benefits of the particular actions. Even if adequate information is available, the optimal policy mix may vary between the regions or through time. Indeed, the enforcement of the environmental policies in different areas of China has shown different results: the relatively developed coastal areas have performed more effective than the underdeveloped central and western areas (The World Bank, 1997).

E. Valuation Problems

Valuation problems occur when trying to assess the magnitude of the environmental problems. For many environmental issues, valuation problems of intergenerational risk and irreversibility pose difficulties for the policy-makers. Intergenerational risk problems arise when the future consequences of the present environmental problems, and thus the costs imposed on the future generations are unclear. The irreversibility of some environmental problems causes the similar difficulties. Therefore, the valuation problems mean that making decisions pertinent to tradeoffs between environmental and community interests can be difficult (IC, 1997). This is often exacerbated by the informational, the institutional and the manpower problems, acting as a barrier to the implementation of economic instruments. At present, few environmental cases have been assessed in this aspect although the environmental impact assessment is universally required for the newly-built industrial projects in China.

F. Manpower Problems

The overall level of environmental management in China is still backward. Quite a part of the environmental problems are caused by the inefficient management (NEPA, 1995). In reality, the lack of diversity in skills and expertise has formed an obstacle to better design and implement economic instruments in China. In order to scientifically design and effectively implement economic instruments, the environmental policy, legal and communication skills are needed, and the technical and operational expertise as well as the economic skills is also expected. The human resource constrains is an crucial factor affecting the ability of the environmental protection agencies to use economic instruments for the industrial pollution prevention and control in China.

5. The Improvement in Applying Economic Instruments for the Industrial Pollution Prevention and Control in China: Strategies and Perspectives

Economic instruments bring the market signals closer to the socially desirable levels, and have important roles to play in preventing and controlling the industrial pollution in China during and after the transition to a market economy. In order to effectively apply economic instruments in China, many aspects should be taken into account and further improved so as to overcome the above-enumerated obstacles.

5.1 Environmental Policy and the Application of Economic Instruments

Environmental degradation has its roots in the economic process (notably, its relation to types and levels of the economic activities, and their development), but also in the way that decision-making on the economic activities and policies has been institutionalized (OECD, 1994a). In the context of continuous economic growth, increases in the pollution sources will tend first to offset, then there has been a growing awareness of the limits of the environmental policies centered around end-of-pipe measures. This requires the environmental policies be shifted towards the prevention-oriented ones, within which economic instruments will play a specific role.

Basically, in the process of designing and implementing a policy instrument, one may discern external and internal elements. External elements are those that are important in the social, political and economic circumstance of that process, including the operative national and international economic, fiscal and environmental policies. Internal elements are those that are important in understanding how an instrument might effectively function or operate within a given economic process and administrative context. Internal elements have to do with source-related aspects as well as features of the environments and of the receptors therein (OECD, 1994a). The environmentally-sound policies should put these external and internal factors together since environmental policies are the guide to the use of economic instruments.

The main emphasis of China's environmental policies is to bring environmental protection in line with national economic development and social

advancement, maximizing the economic, social and environmental benefits. On the macro scopes, China has definitely made a series of policies for environmental protection, and the policies have been kept abreast with the country's and the world's development. The pollution control programs in China are probably the most extensive in the developing world (Dasgupta *et al*, 1996). Since its Sixth Five-Year Plan (1981-1985) for the national economic and social development, China has embodied environmental protection in the state plan (SDPC, 1991). Shortly after the Rio Conference in 1992, China put forward the "Ten Policies" for further promoting environmental protection and sustainable development, including the specific provisions of "taking effective measures for the industrial pollution prevention and control" and "applying economic instruments for environmental protection" (The State Council, 1992). These policies were again clarified in Chapter 4 of China's Agenda 21 (1994). Additionally, China has announced that the environmental spending will be raised from 0.8% of national GDP now to over 1% of GDP by 2000, and in some cities like Beijing and Shanghai, the spending is expected to top 3% of local GDP (China Economic News, 1996). Nevertheless, the environmental economic policies in China should be further improved in order to provide an explicit guide for the application and use of economic instruments for preventing and controlling the industrial pollution.

Generally speaking, the environmental economic policies should cover a set of factors to ensure that they can be operational and appropriately reflect the real prices of the environmental resources.

- 1) Environmental protection involves all socioeconomic domains. Thus the comprehensive economic policy system tailored to environment and development is needed. The environmental policies should be integrated into the national macro economic policy system (such as finance, tax, fiscal and banking), and the macro economic policies will also have to be scrutinized for their consistency with concerns over the environmentally and economically sustainable development.
- 2) Environmental policies should set the priorities of environmental protection on a national level or a geographic basis. This is of great significance for designing and implementing economic instruments because China is a huge, diverse country with highly varied environmental, economic and social conditions.
- 3) Environmental policies should be in concordance with the sectoral policies. Moving towards a prevention-centered approach means that the structural changes in every sector of the economy will have to come under consideration, and there is no single type of measure best suited to address such a wide range of issues; instead, the environmental policies will have to become increasingly diversified and flexible (OECD, 1994c). For this reason, the sectoral policies should have to be reviewed in the light of the Polluter-Pays-Principle and User-Pays-Principle so as to present the full prices of the involved goods and services to those who enjoy them (OECD, 1994a). Integration of the environmental concerns into the sectoral policies needs to be further reinforced. It will be necessarily involved in the activities of the environmental protection agencies and other institutions with interests or responsibilities in such sectors in order to induce them to place the environmental objectives on their own agendas. At the same time,

the collection between ecological impacts and pollution management, or what has been termed “internal” integration must receive attention, with a view to realizing a better coordination of policies between the departments involved in pollution control and the protection and management of natural resources (OECD, 1991c).

- 4) The design and implementation of economic instruments should consider the policy transition and be at the appropriate scale. Changing the industrial mix from high- to low-polluting industries is one of the desirable outcomes of an effective pollution control instrument. However, structural change takes time since investments made under the “pollution heaven” conditions will take time to depreciate. Therefore, for both fairness and efficiency (as well as acceptability to industry), allowance for adjustment during the transition period must be made. The stability and predictability of the policy is critical if the industrial investment is to be gradually shifted from high- to low-polluting industries. It is preferable to take a gradualized scheme because: (i) it is easier to get accepted and introduced; (ii) it allows time for adjustment, thus minimizing resistance and cost; and (iii) it gives the correct signals to the investors and the innovators (Theodore, 1993).
- 5) The role of economic instruments in the overall environmental policy system is not overwhelming. Economic instruments alone will not effectively and/or efficiently deal with the environmental problems, whether national or international ones (OECD, 1994a). In reality, economic instruments appear to operate best in combination with, or in support of, other instruments such as direct regulations.

Given the above-mentioned considerations as well as the references from the practice of the developed countries, the conceptual environmental economic policy system in China is summarized as follows.

5.1.1 Pricing Policies for Natural Sources

Perhaps the most environmentally significant of the policy failures are those which drive a wedge between the true social cost of resource use and the cost to the individual user — the private cost of resource use (OECD, 1994a). Generally, the prices of the major products in China are determined by demand and supply. There are, however, some fiscal, exchange rate, price and income policies which result in low prices of or even non-charges for natural resources, and actually have the effects of encouraging the over-utilization of the environmental resources. The reasonable prices should “tell the truth” on the costs of producing and consuming goods and services (Weiszaeker, 1989), that is, natural resources should be priced in such a way that the cost of extracting or harvesting the resource, as well as extraction-associated externalities and “user cost” elements is met (Pearce & Turner, 1990). Therefore, the pricing system in China should be adjusted so as to ensure the leverage of the prices for facilitating the rational utilization of environmental resources and strengthening environmental protection. This may include

- i) determining the product prices according to the full costs in production, transportation and disposal;

- ii) ensuring that the investment for the exploitation of the natural resources should be based on the full cost prices instead of the prices that are lower than the long-term marginal cost (Wang & Lu, 1997);
- iii) gradually abolishing those subsidies which virtually encourage over-utilization of resources and environmentally-damaging production;
- iv) applying pricing differentiation according to the variations of geographical areas, seasons, product qualities and the environmental benefits;
- v) linking the pricing policies with the industrial policies, and encouraging the development of the environmentally-friendly industries.

5.1.2 Environmental Charges and Taxes

Theoretically charges need to be differentiated from taxes while the two operate in a similar manner on a practical level. According to OECD, charges are associated with return flows of goods or services whereas taxes are not (OECD, 1994a), that is, charges are payments for which the payer receives a benefit in return, in direct proportion to the amount paid, and taxes are unrequited payments (i.e., no direct and exactly equivalent benefit is available in return). However, in practice, the distinction is difficult to make and remain, and they are often used interchangeably.

Environmental charges and taxes are commonly levied on the polluting activities so as to internalize the externalities. Thus they are thought to result in the achievement of the environmental objectives in an economically efficient manner, because those who are able to reduce environmental damage at a lower cost than the set rates of charges and taxes will do so, but those who can not will pay the charges or taxes instead (IC, 1997). In practice, charges may take the forms of user charges, product charges, administrative charges, clean-up or restoration levies, etc.(IC, 1997). Taxes may be classified as measured emission taxes, indirect taxes on goods and services and tax allowances (OECD, 1993b).

Generally, charges and taxes may have an incentive impact and a revenue raising impact (OECD, 1994a). The incentive impact depends upon the cost and price changes brought about by the charge, and encourages the polluters to introduce the new technologies and cleaner production processes, improve production efficiency, and continually find least cost ways to reduce pollution and thus avoid payments. On the other hand, if charges and taxes are too low to provide an incentive impact, they may mainly serve to raise revenues. In such cases, the revenues are usually intended for collective treatment of the environmental problem, research on new abatement technologies or subsidizing new investment by the polluters in such technologies (OECD, 1994a).

In the past, environmental charges and taxes in China have been heavily used for fiscal policy purposes. Undoubtedly they will still contribute much to the expected expenditures for environmental protection. If they are used to induce substantial effects on behavioral changes, several considerations should be put on the agenda.

A. Increasing the charge rates

The current charge rates are too low to help change the behaviors of the industrial polluters, and even much lower than the costs of abating pollution (as shown in Table 2). Therefore they need to be adjusted to higher levels so as to lower the current pollutant emissions and to finance the large investment required to achieve the desired environmental quality.

Although the marginal costs for reducing pollution vary by industrial types, sizes, scales, pollutants and abatement rates, Dasgupta *et al* suggested that water pollution charge rates as low as \$1.00 per ton of wastewater would be sufficient to induce substantial abatement of TSS for cost-minimizing factors, in particular, charge rates of \$3.00, \$15.00 and \$30 per ton of wastewater would be sufficient to reduce 90% of TSS, COD and BOD, respectively (Dasgupta *et al*, 1996). Supposing \$1.00 equals 8.30 yuan (The official exchange rate of dollar to yuan has been remained at around this level in the past several years), these charge rates are obviously much higher than the current rates.

There is no doubt that China will continue its economic and policy reforms, and attempt to handle the industrial pollution as well. Given this fact, The World Bank proposed three scenarios of potential impacts of policy reforms for pollution abatement from the regulated industries for 1997-2020, as summarized in Box 1.

Box 1. Three Scenarios for Industrial Pollution Abatement in China (1997-2020)

1. *Economic reforms and the regulatory status quo (Reform-only)*. Economic reforms have accounted for much of the decline in the air and water pollution intensities since 1987. Even if the regulations were not tightened, economic reforms will still drive the changes in industrial composition, scale and ownership. But economic reforms may not be sufficient to achieving China's objectives of holding the industrial pollution to 1995 levels because the industrial base will have nearly quintupled by 2020. For instance, COD load and SO₂ emission may have a modest increase, and TSP may have a slight decrease and then remain constant.
2. *Tighter regulation: "Polluters pay some"*. Tighter regulations would create incentives to reduce pollution intensities and would complement the effects of economic reforms. Under this scenario, air and water pollution charges would increase by 5% a year. This may lead to a dramatic effect on COD emission. Projected COD emission would fall by more than half, from about 7.0 million tons in 1995 to 3.3 million tons in 2020. A 5% annual increase in the air pollution charges would also cause a third falloff in SO₂ emissions and 50% reduction in TSP, respectively.
3. *Strict regulation: "Polluters pay more"*. Under this scenario, pollution charges would increase by 10% a year. By 2020, charges will be thirteen times their current levels. This will result in the remarkable effects: SO₂, TSS and COD emissions would each fall by three-quarters.

(Source: The World Bank, 1997.)

Certainly, the key points for achieving the three scenarios should be the increases in the current pollution charge rates as well as the extension in the charge scope (including pollutants and the target industries). However, the charge rates should be set at the appropriate levels. In theory, there exists an optimal charge rate: it is the intersection of the marginal benefit and cost curves (where the marginal benefit equals to the marginal cost), since a lower charge would leave the socially profitable pollution abatement opportunities un-exploited while a higher charge would impose

an abatement cost higher than the social gain from the further pollution reduction (The World Bank, 1997). The practical charge rate should approximate the intersection.

B. Systematizing the charge systems

This involves three aspects. First, all the identified pollutants should be included in the charge systems, and all industrial polluters should pay the charges. Second, while the charge rates are gradually increased, the local charge standards should be uniformed and should not be lower than the national charge rates. Third, only the environmental protection agencies are in charge of collecting all kinds of the pollution charges, and the charge revenues should be earmarked for environmental protection, but the collection and distribution procedures of the charges should be monitored by a joint board consisting of the representatives from other government departments, the industries and the corresponding People's Congress.

C. Implementing the environmental taxes

Environmental taxation induces the producers and consumers to economize on products or emissions constituting the tax bases, and reflects the principle of internalizing the external costs (OECD, 1994d). Put another way, the environmental taxes (or ecotaxes) force the producers and consumers to consider the costs of pollution or other externalities in their economic decisions. If the tax rate is high enough, the producers and consumers may switch to less polluting products or alternatives (OECD, 1996). The theoretical arguments for the environmental taxes are given in Box 2.

Box 2. The Potential Advantages of the Environmental Taxes

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| <ul style="list-style-type: none">i) <i>Static Efficiency</i> If fixed at the appropriate levels, the taxes on the polluting emissions have a potential to minimize the overall cost of achieving a given pollution control target, as the polluters with lower marginal abatement costs will abate the emissions more than those facing higher costs.ii) <i>Dynamic Efficiency</i> Since the polluters have to pay a tax on each unit of the remaining emissions, there is a permanent incentive to reduce pollution and to develop more efficient control techniques.iii) <i>Self-regulating</i> When applied to the products, the environmental taxes increase the relative price of these products, thus providing a continuing incentive to use and manufacture less polluting ones. They leave the economic agents free to adapt to market signals in the most efficient way that they can (OECD, 1997c).iv) <i>Responsibility-shouldering</i> Since the producers only produce those goods which are demanded by the consumers, the consumers can be seen at least partly responsible for any pollution which such production creates (Turner <i>et al</i>, 1994). The environmental taxes force both groups to share the environmental responsibilities by lowering the producer profits and raising the consumer prices. |
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Since the pollution charges in China are supposed to cover all pollutants and target groups in the nearer future, the environmental taxes should not overlap the pollution charges, instead, they may aim at the specific environmental problems. At the same time, full coverage of environmental taxes will need to consider both:

- a) taxes which have been introduced to achieve a specific environmental objective, and which have been explicitly identified as the “environmental taxes”; and
- b) taxes which were introduced initially for non-environmental reasons, but which impact on environmental objectives, and which may be increased, modified or reduced for environmental reasons (OECD, 1993b).

The ecotaxes are concerned with the specific intention of altering patterns of behavior in a direction that could reduce the environmental damage. What is important, they should preferably be in accordance with the accepted policy objectives and with the taxation principles such as simplicity, equity, neutrality and administrative efficiency so that they can make the relationship between the taxes and the environmental objectives clear, and achieve the functions of raising revenues and promoting environmentally-motivated changes. Meanwhile, if the environmental objectives are long-term and the taxes are mainly used for revenue raise, the taxes should be set at the lower rates; if the environmental objectives are short-term and the taxes are mainly used for incentives so that the pollutants can be phased out in short time, the tax rates should be higher. Over the years OECD member countries have accumulated many practical experiences in applying the environmental taxes (OECD, 1993b; OECD, 1996; OECD, 1997c), and they are useful references to China.

Implementation strategies for the environmental taxes will differ when pollution arises from either consumption or production, or both, when their use is more common and their rationale familiar to the public, and when many trading partners implement the tax at the same time (OECD, 1996). For a successful implementation of the environmental taxes, all these factors should be carefully taken into account.

In theoretical terms, the appropriate tax level is one which equates the marginal social cost of reducing pollution by an additional unit with the marginal social benefit of a one unit reduction in pollution. However, both of these magnitudes are subject to considerable uncertainty and wide margins of error (OECD, 1993b). Particularly, in the light of China’s actual conditions of geographic diversity, differences in regional environmental quality, and uneven development levels of different areas, the moderate rates of the environmental taxes may be non-linear, and tax differentiation should be take into practice. Currently, many industries (especially the state-owned firms) are facing severe financial hardship, a step-by-step environmental tax system could be more easily accepted by the industries and the departments concerned. That is, the ecotaxes are first experimented in certain areas at the low rates; then based on the experience from the trial implementation for a certain period (say one to two years), the ecotaxes could be expanded to other areas and the tax rates could be gradually increased to the expected levels.

In addition, implementing the ecotaxes needs to amend the Tax Law. Although tax reform occurred in 1994, there is no provision specifying the environmental taxes in the current Tax Law. The ecotaxes should be added to the Tax Law so that they can be consistent with the tax system. In the long run, the green tax reforms (i.e., integrating the environmental considerations into the design of the tax systems) should be pursued, that is, introducing new ecotaxes, restructuring the

existing taxes and reducing the existing distortionary subsidies and tax provisions. As to institutional aspect, the tax authorities should be responsible for collecting the ecotaxes, assisted by the environmental protection agencies and other departments for information. Also, the tax revenue will go to the general government budget, and should be earmarked for environmental protection, and yet should not be used to finance the administrative costs of the tax authorities.

Like other economic instruments, the environmental charges and taxes operate not in a vacuum, but in the context of complex “packages” combining a series of policies instruments, such as regulations, voluntary agreements, education and information campaigns. Within the framework of certain restrictions and limitations, the environmental charges (as well as the ecotaxes) will provide the steering (market) signals that can, to a considerably greater extent, ensure the cost-effective measures (Lars, 1997).

According to the above discussions, besides the present Resource Tax (belonging to the above b-type ecotax) and Favorable Tax for Treating, Reusing and Recycling Waste (belonging to the above a-type ecotax), the possible ecotaxes in China may have other forms of Coal Tax (b-type ecotax), CFCs Product Tax (a-type ecotax) and Chlorinated Solvent Product Tax (a-type ecotax), and so on.

Coal Tax Most of the environmental problems in China come from the energy use, and the industries account for about two-third of final commercial energy demand (The World Bank, 1997). Moreover, coal is used in almost every part of China’s economic life, supplying around 75% of the country’s total energy demands, and the industrial sector is the largest consumer (EIA, 1998), and this trend will continue in the forecast future. At present China has no so-called energy tax or fuel tax. While China is supposed to reform the coal allocation and distribution system which distorts the market and obscures the pricing signal for coal quality, a Coal Tax can be separated from the Resource Tax and becomes a single ecotax so as to improve the efficiency of coal use, increase the use of washed coal and promote the development of clean coal technology as well as alternative fuels. In practice, the tax can be levied on raw coal, and may have different tax rates according to the sulfur-contents if the acid rain issue is taken into account. Since China has the second largest CO₂ emissions in the world (EIA, 1998), while China has no CO₂ charge or tax, the Coal Tax may involve the consideration for CO₂ emission charge/tax.

CFCs Product Tax Since China is one of the signatories to the 1987 Montreal Protocol on Substances That Deplete the Ozone Layer, it assumes the responsibilities for phasing out the ozone depleting substances such as CFCs. But up to now CFCs have not been included in the pollution charge systems. Therefore, a CFCs product tax should be reasonable in China (Yuan, Yang & Huang, 1998), and the producers should pay the tax.

Chlorinated Solvent Product Tax Chlorinated solvents comprise a range of use in dry cleaning, metal cleaning, paint stripping and aerosols. Their effects depend on the particular products, including harm to eyes and skin, possible carcinogenic effects and damage to central nervous system from direct exposure to people, and contribution to smog formation and harm to other living organisms once they are

carelessly discharged into the environment. But they also have varying potentials for recovery and reuse. The chlorinated solvent products are widely in today's China. The implementation of Chlorinated Solvent Product Tax can help to create an incentive to reduce emissions, increase recycling and develop the environmentally-appreciative substitute products. In practice, the tax should also be paid by the producers.

5.1.3 Investment and Credit Policies

As mentioned early, preventing and controlling the industrial pollution in China requires enormous fiscal inputs. Moreover, economic, social and environmental returns for the investment in environmental protection programs are usually mid- or long-term. Following these points, the investment and credit policies should provide continuous signals to encourage resource conservation and pollution prevention and control, and to avoid short-term speculative actions.

- *Encouraging various investment for the industrial pollution prevention and control.* The investment sources can include government appropriations, industrial inputs, private and foreign investments. The priorities of the investments should be put on the projects which already or potentially have large-scale environmental impacts, for example, the Trans-Century Green Projects and the Prior Programs for China's Agenda 21.
- *Reforming the existing credit system.* In 1995, the People's Bank of China (the central bank) issued "The Notice on Implementing Credit Policy for Strengthening Environmental Protection" (the People's Bank of China, 1995). This is the policy base for environmental credits, and should be fully put into effect to reform the current loan system. The environmentally-beneficial projects could be granted prior loans, low-interest or interest-free loans, or the repayment time could be prolonged. The environmentally-unfriendly industries should be provided with high-interest loans, less loans or no loans. The National Environmental Protection Agency and the Agricultural Bank of China jointly announced that, from January 23, 1997 and forward, the enterprises with hazardous pollution problems would not be granted loans, and only the enterprises that strictly abide by the State policies on industry and the environment would receive loans (China Daily, 1997). Since the village and town-owned enterprises are the main industrial customers of the Agricultural Banks, this action largely cuts off the bank loans for these industries which have an increasing share in the national economy and also cause the increasing environmental pollution. If all the banks take the similar measures, the loans will help to prevent and control the industrial pollution, and show their environmental and social benefits.
- *Restructuring the environmental protection funds.* The environmental protection funds are institutions designed to channel earmarked revenues for environmental protection purposes (OECD, 1995a). Since the State Council promulgated "The Tentative Measures for Charging the Use of the Special Funds for Pollution Prevention and Control at Sources" in July 1988 (NEPA, 1993), the environmental protection funds of different scales have been established in China. The main sources of these funds are the revenues raised by the pollution levy system, and a small part come from the government inputs or the loans supplied by some international fiscal

organizations (e.g., the World Bank) and from the interests on loans provided to the industries. At present, more than 20 provinces and municipalities have launched the pilot projects in establishing the environmental investment companies to operate the funds (Wang, Zhang & Wu, 1997). However, these funds are too scattered and small. Therefore, these funds need to be restructured, and should be centralized to establish a national environmental protection fund and a limited number of the provincial funds so as to strengthen the government capabilities in the macro-control of pollution prevention and control. The sources can include the government appropriations, the revenues from the environmental charges and taxes, the industrial contributions, the public and institutional donations, and the international loans or donations. The funds will be managed by the specific institutions such as the environmental investment companies, but the uses of the funds must be approved and monitored by the corresponding-level environmental protection agencies and financial authorities. The funds should mainly be used for investments or loans in the key projects for pollution prevention and control, but a small part can be used as commercial or even capital investment if approved by the government authorities. Overall, establishing the environmental protection funds suited to China's practical situation is an important measure to fund the projects for the industrial pollution prevention and control, but the operation and management of these funds needs further considerations in order to ensure the expected functions of the funds.

5.1.4 Ecological Environment Compensation Policies

Ecological environment is the source of the natural capital and a sink of the by-products generated by the anthropogenic activities. It is necessary to clearly measure the crucial role of the environment in economic development, and to put into practice the ecological environment compensation policies. However, as a traditional indicator for the national economy, the present GNP does not reflect ecological damage, environmental degradation and resource loss caused by the economic growth (China's Agenda 21, 1994). Therefore, an integrated accounting system involving the resources, the environment and the economy should be gradually built up in order to measure the performance of the entire national economy. The new accounting system will enable more rational and more economical use of the resources, make the product prices reflect the environmental costs, improve the industrial policies and coordinate the economic development and environmental protection as much as possible.

5.1.5 Pollution Trading Policies

Based on the set standards for the environmental quality and the levels for pollution control, pollution trading policies could give the polluters another chance, that is, as long as the polluters have different abatement costs, there is an automatic market with low-cost polluters selling permits and high-cost polluters buying them. By doing this, the total cost of pollution abatement to some predetermined acceptable level, is minimized. In addition, tradable emission permits could be more compatible

with the standard economic practice (e.g., industry) than pollution charges: permits allow a total pollution level to be set and trading ensures a cost-effective total abatement result, while charges establish the marginal cost of abatement but do not control the actual level of pollution abatement (OECD, 1994a).

Over the years many developed countries have experimented the tradable permits for preventing and controlling the environmental pollution. The U.S. emissions trading programs are the well-known examples. From the mid-1970s the U.S. has implemented the emissions trading programs such as Offsets, Bubbles, Netting and Banking (OECD, 1994d). All emissions trading programs start with an underlying set of operating regulations, initial allocations of baseline emissions as well as monitoring and enforcement programs. These programs have brought millions of dollars of cost savings, and the industry itself has tended to prefer emissions trading programs in which it could voluntarily decide to participate or not as opposed to fee-based programs (e.g., pollution charges) which have to be inclusive and are viewed by some industries as forcing them to “pay twice” (once to control and a second time for any remaining emissions) (Barry, 1997). The America’s experience does demonstrate that such programs can be effectively and successfully employed for the pollution prevention and control.

At present, the tradable permits in China are still being tried in two cities by the trading companies. They should be expanded to large scales. The permits can be traded in the market, and can also be conducted directly between the industries or within the industry. The pollutants which are “traded” can be the same pollutant, or the pollutants with similar environmental damage. For example, both SO₂ and NO_x contribute to acid rain, thus the permits can be traded between the SO₂ and NO_x emissions as done by Canada (OECD, 1994a). Meanwhile, the buyers can be the industries, and can also be other institutions or even individuals who want to hold the permits and force the polluters to reduce their pollution emissions through more active measures such as improving the efficiency of resource use and installing cleaner production technologies.

5.2 Environmental Legislation and the Implementation of Economic Instruments

Environmental legislation play a vital role in environmental protection. The implementation of economic instruments should be under the way of the corresponding laws.

In China, except the term of pollution charge, the currently-used economic instruments have no legal provisions to support. Moreover, pollution emissions which exceed the official standards are not treated as legal violations according to the present regulatory systems. These have greatly limited the effectiveness of economic instruments. For example, some enterprises intentionally delay to pay the pollution charges or even fines, but usually they are not subjected to the court because of the lack of the legal provisions. Furthermore, some local regulators have considerable discretion in judging both compliance and appropriate penalties for non-compliance, therefore the polluting cases under-reported and under-assessed are quite common (Dasgupta, Huq & Wheeler, 1997). Obviously, for effectively implementing the

environmental policies, it is necessary to legalize some key environmental policy measures (including economic instruments). In the short term, the contents of economic instruments should be clearly reflected in the corresponding laws directly concerning environmental protection and resource utilization. In the long run, jeopardizing the environment must be made a criminal offense, and the legal provisions concerning environmental protection should be added to other laws such as Tax Law, Civil Procedural Law, Administrative Procedural Law and Criminal Procedural Law. With the wide legal guarantees, economic instruments can be implemented more effectively and efficiently.

5.3 Evaluating Economic Instruments for the Industrial Pollution Prevention and Control

Any policy instrument should be systematically analyzed so that it could function as well as possible. This may consist of *ex ante* analysis (i.e., forecasting and simulation studies) and *ex post* evidence (i.e., evaluation). Generally, *ex ante* analysis of the costs and benefits of employing economic instruments is based either on the given assumptions about the way in which the polluters and other individuals involved in the process will respond, or on the inferences drawn from the analogous episodes (OECD, 1997a), and often predicts the optimal results. However, the practical application may vary due to the uncertainties in both *ex ante* work and the real world. In this respect, *ex post* evaluation will show its important sense because the practical experiences have been observed.

Similarly, the costs and benefits may be central to evaluating economic instruments. Briefly, the criteria of evaluation may include: i) environmental effectiveness, i.e., the environmental impact and performance of the selected economic instrument; ii) economic efficiency, i.e., the extent to which the instrument has enabled a more cost-effective achievement of the policy objectives; iii) administrative and compliance costs; iv) revenue effects; v) wider economic effects, e.g., impacts on the prices, technical innovation, income distribution, employment, trade, etc.; vi) soft effects, i.e., various possible effects of such instruments working through the changes in environmental attitudes and awareness, capacity building, the generation and diffusion of information, etc.; and vii) dynamic effects, i.e., the stimulating functions for innovation in pollution prevention and control technologies (OECD, 1997a).

Greater efforts to evaluate economic instruments in actual practice would greatly help to improve the future policy by identifying the circumstances in which economic instruments are most likely to prove effective, and by providing information on the advantages and disadvantages in practice of employing the various different forms of economic instruments. Moreover, evaluation may contribute to better communication with the stakeholders and the public on the purposes, operations and effects of the implemented policy measures. Effective and efficient evaluation will, in turn, contribute to effective and efficient environmental policy (OECD, 1997a). Particularly, in light of the present conditions of China's industries and the environment, effective evaluation can help to identify and reject the arbitrary

contents in initiating economic instruments and to overcome those early-mentioned barriers which have negative functions in applying economic instruments.

Recently, OECD has conducted several studies on the evaluation of economic instruments, including the collection and dissemination of comparative information and assessments regarding the role played by economic instruments in OECD member states (OECD, 1994a), the analyses of their potential and application in particular areas such as waste management (OECD, 1992), climate change (OECD, 1994b) and taxation (OECD, 1993b; OECD, 1995b; OECD, 1996), and the comprehensive valuation of economic instruments (OECD, 1997a). Following these experiences as well as its own practice, China could give the comprehensive evaluations about the application and use of economic instruments in the field against the industrial pollution. Recently, some evaluation projects have been conducted in China (OECD, 1997b). Under the general criteria for evaluation, China should pay special attention on assessing the responsiveness in the practice of the industries and the difference in different areas, because the industry-specific and area-characteristic measures usually work more effectively and efficiently. The evaluation can then contribute a lot to the improvements in revising, designing and implementing economic instruments in China in the future.

5.4 Information Campaigns for the Application of Economic Instruments

Extensive information about individual costs and circumstances would be required for a regulatory authority to allocate pollution abatement efficiently across individual polluters (OECD, 1993b). Prevention-oriented environmental policies will have to draw on information concerning the entire cycle of energy consumption, production, use and disposal surrounding different kinds of polluting activities (OECD, 1994c). Finding the best and most economically feasible opportunities to prevent pollution before it occurs also entails importance to information gathering and analysis. Particularly, to be cost-effective, economic instruments must be drawn on a wide base of information relating to the environmental problems and feedback on the results of the existing pollution prevention and control measures and their costs. Therefore, information campaigns is a basic element and an indispensable step to the application of economic instruments for preventing and controlling the industrial pollution.

In general, effective and timely information collection, analysis and diffusion can promote to deeply investigate the environmental issues, help to better understand the role of economic instruments in pollution abatement, and also provide the feedback from the stakeholders. In particular, the information measures concerning the application of economic instruments can ensure that the price signals are being clearly received by the consumers, and then ensuring that the consumers possess the information necessary to react to the price signals (OECD, 1994c). The consumers' reactions will surely force the producers' behaviors to be changed towards the environmentally-benign manners. Overall, information campaigns can contribute to removal of the barriers affecting the application of economic instruments.

On the other hand, information should be comparable and consistent. Thus information campaigns need cooperation between the different stakeholders, and also require the assistance from education, science and technology. The coordination of the stakeholders can ensure the truthfulness of information, especially the response from firm to firm. Education as well as training can accelerate the capacity building and enhance the insights of the management personnel in designing and enforcing economic instruments. Progress in science and technology will inevitably make information campaigns easier and more realistic than in the past.

At present, the information campaigns in relation to the environment in China are still insufficient. Given the trends of large-scale, sustained application of economic instruments for preventing and controlling the industrial pollution, China should widely launch the environment-related information campaigns.

5.5 The Assistance of the International Community for the Application of Economic Instruments in China

Given the recognition that the use of economic instruments and the market mechanisms for the industrial pollution prevention and control is relatively recent, China has a growing need for the extensive and effective cooperation and the necessary assistance from the international community.

Firstly, the international community, especially the developed countries, have accumulated a large amount of successful experiences in applying economic instruments. They can help China to create an inventory of effective use of economic instruments for the industrial pollution abatement, so that China can assimilate and apply these experiences to refresh the ways of preventing and controlling the industrial pollution according to its actual situation. Secondly, China still has relatively low development levels of education, science and technology. The international community can assist China in improving education, training personnel, transforming information, providing the technical and financial supports to the application of economic instruments, and launching the cooperative programs relating to the application of economic instruments.

5.6 “New” Economic Instruments for Preventing and Controlling the Industrial Pollution in China

According to the practice of economic instruments in the international community and in light of the China’s actual situation, there are other economic instruments that could be used for the industrial pollution prevention and control in China. The examples of these economic instruments are recommended below.

a) Environmental Performance Bonds

This is a type of financial enforcement incentive. In practice, they are the pre-payments made to the authorities for potential environmental damage, where the amount of the payment generally varies with the level of potential damage (IC, 1997).

There are various ways in which such finance may be provided. One is the provision of upfront capital funding where the money is held in trust, and is refunded once the compliance with certain regulations has been satisfactorily achieved. Nevertheless, it may place severe constraints on the cash flow position to the industries. In the future, this instrument can be compounded with the existing deposit-refund system, or can be used to those cases which have not been covered by the deposit-refund system, such as new product in old plants. Another form of the bonds may be a component of a fee-based emission licensing system. For example, the bonds can be attached to the air pollutant emission license which is aimed at reducing the total amount of atmospheric pollutants. Overall, the environmental performance bonds are best suited to the situations where there is one source of potential environmental damage and that damage can be reasonably estimated (Young *et al*, 1996).

b) Environmental Liability Insurance

Such a system involves making the polluters legally liable for the environmental damage they cause. It may lead to creation of a market in which the risks of bearing liability for uncertain environmental damage are transferred to the banks or insurance companies (OECD, 1994a). For instance, the financial sector will take into account the possible cost and likelihood of the environmental damage from an industry when assessing and renewing the loan applications and charging the insurance premiums. In some countries, such as the U.S., the institutions who finance the activities of the industries with environmental degradation may themselves be liable for some or all the associated damage costs (IC, 1997). Either way, the needs for capital and insurance, and the benefits of lower interest rates and premiums in some cases, may provide strong incentives for the industries to take necessary steps to reduce the environmental risks.

c) Environmental Performance Disclosures

This system is designed to reward the good environmental performance and call public attention to the polluters who are not in compliance with the regulations. Armed with the information disclosures, the local communities can negotiate better environmental arrangements with neighboring factories, the industries with good environmental performance can advertise their status and earn market rewards, the investors can more accurately assess the firms' environmental liabilities, and the regulators can focus their limited enforcement resources on the worst performers.

At present, such actions as Program for Pollution Control, Evaluation, and Rating in Indonesia and Ecowatch in Philippines have made striking achievements in the struggle against the industrial pollution, and Colombia and Mexico are moving rapidly toward their own public disclosure programs (The World Bank, 1997). Recent studies from both the developed and developing countries suggests that the environmental reputation matters for the firms whose expected costs and revenues are affected by the judgments of their environmental performance by customers, suppliers and stockholders. Drawing on the cases from American and Canadian studies, Lanoie, Laplante and Roy find that the capital markets do react to the release of the information about the firms' environmental performance (Lanoie, Laplante & Roy, 1997). Through investigating the capital markets in Argentina, Chile, Mexico and the

Philippines, Dasgupta, Laplante and Mamingi report that the capital markets react positively (increase in the firms' market value) to the formal announcement of rewards and explicit recognition of firm-specific superior environmental performance (Dasgupta, Laplante & Mamingi, 1997).

So far, China has more than 800 companies on the domestic and overseas stock markets at Shanghai, Shenzhen, Hong Kong and New York, and most of these companies are industrial enterprises which are key representations in their professions. In the future there will be more and more industrial enterprises with signboards on the capital markets. If the industry-specific environmental news is published in time, the similar reactions from the capital markets can be expected, and these will stimulate the industries to take active activities to abate their pollution and improve their environmental performance as well.

d) Accredited Licensee Scheme

Under this scheme, the industries that demonstrate a commitment and capability for environmental protection receive a number of benefits related to licensing and works approval. These may include reduction in licensing fees, no additional approval requirements for most new projects and the ability of the firms to manage their own environmental performance within the broad performance criteria so that they can have the flexibility to achieve the environmental goals in the most cost-effective manners (IC, 1997). On April 1, 1997, the National Standards of Environmental Management of China were formally put into practice, and the ISO 14000 standard is also equatively adopted by China. In May 1997, the Authentication and Guidance Committee of Environmental Management System of China was established. All of these have provided the bases for introducing the accredited licensee scheme. So far, a few firms have obtained their licenses. In the future, this system should be further improved and expanded.

6. The Role of the Stakeholders in Applying Economic Instruments for the Industrial Pollution Prevention and Control in China

The environmental responsibility rests with various aspects of the society. Implementing the environmental policy thus needs the participation from all stakeholders. The application of economic instruments for preventing and controlling the industrial pollution in China mainly involves the following actors:

1) The Governments

“Environmental management relies on the government” states that the governments have significant responsibilities for the practical implementation of the environmental policies and measures. Where the government action is warranted, the question of which level of the government should have the responsibility for a particular environmental problem is an important one (IC, 1997). Therefore, the effective implementation of economic instruments to address the industrial pollution issues requires devolving the responsibility and authority to the different levels of the

governments, and calls for an increasing coherence and harmony between the objectives of different levels and divisions in the governments at the same time.

The Central Government The central government (The State Council) is responsible for national environmental protection planning and policy making. It has a crucial role in establishing a scientifically-sound system for decision-making, consultation, implementation and monitoring, and ensures that all stakeholders can participate the decision-making process at different levels.

With particular reference to economic instruments, the central government has a role in facilitating the introduction of the effective and efficient economic instruments when information and technology become available, and ensuring that the mechanisms are in place which allow the instruments to be reviewed and refined as the circumstances change. It should also encourage scientific research and information analysis in relation to the environmental, economic and social implications from the application of economic instruments.

For the environmental problems of a national or global nature, the central government may have a direct role in administering economic instruments to address those problems. For the local or regional environmental problems, the role of the central government is to empower the relevant departments, local government organizations to combat the problems as appropriate. Since irregular “discounts” in enforcing the environmental policy is often a problem in China due to the so-called local protectionism, the central government should supervise and urge the local governments to strictly enforce economic instruments so as to ensure the practical functions of these instruments. In practice, the authorities of the National Environmental Protection Agency and local Environmental Protection Bureaus should be further reinforced.

The Local Governments The local governments have the capacity to play an important role in dealing with the local or regional environmental problems. Actually, the engagement of the local governments in implementing the environmental policies and measures is an important guarantee for the success of the policy. Under the set environmental goals, the local governments are able to enforce economic instruments at cost-effective manners according to the local conditions.

2) The Industries

The industry involvement in applying economic instruments is crucial. As mentioned previously, there are uncertainties in designing economic instruments. The continuous feedback from the industries is essential and it provides a good basis for in-course corrections. Since the governments sets up the mechanisms which facilitate the industry involvement in the decision-making process, then the industry has a responsibility to participate and provide the true data. The industries themselves have the local knowledge which can be provided at low cost, and the opportunities exist to learn from the industries’ experience with respect to the use and application of economic instruments.

3) The Communities

The evidence from Asia, Latin America and North America indicates that neighboring communities can have a powerful influence on factories' environmental performance (Afsah, Laplante & Wheeler, 1996). The community involvement can help to overcome the credibility gap which exists when decisions are made by the governments in the face of uncertainty and limited information, and can also provide valuable leverage to the government funds in terms of community input of time and resources (Young *et al.*, 1996). Moreover, the community can use various manners to influence the tightness of enforcing the environmental policies.

4) Other "Players"

Other "players", such as the investors, the consumers and the educational and research institutions, have their own roles in the application of economic instruments for preventing and controlling the industrial pollution.

When making their investment decisions, the investors can avoid the industries with large environmental liabilities through assessing the corporate environmental behavior. The consumers can choose the less polluting products and reject the high polluting ones according to the relevant environmental policies and information. Obviously, both the investors and the consumers can directly or indirectly affect the industries' environmental behavior, and force the industries to reduce the pollution and assume the responsibility of damaging the environment, thus this indirectly enhance the functions of economic instruments in behavioral changes.

Since there will be increasing uses of economic instruments in China, but the manpower is still a weak factor that limits the further application of these instruments, the educational and research institutions, especially academics and higher institutes, have an important role in capacity building. They can help to educate and train the management personnel, analyze the information and provide technical supports in relation to the environmental problems and the application of economic instruments. Moreover, there is a need for further research particularly into the longer-term, cumulative and more indirect effects, not only on the short-term and direct impacts, from the application of economic instruments. In this respect, these institutions are responsible to assist by launching considerable programs and delivering messages in relation to the application of economic instruments. Meanwhile, the educational institutions could add the contents of economic instruments into the curriculums concerning the environment and economy so that the students can possess the general understandings of the relative ideas in advance, and this will provide the reserve human resources who may go in for the relevant work in the future.

7. Conclusions

While industry takes dominant part in China's national economy, it brings about severe environmental pollution, leading to vast economic, social and environmental losses. The effective prevention and control of the industrial pollution is urgent and will contribute much to the comprehensive improvement of China's

environmental quality so that it can achieve the harmony of social effects, economic outputs and environmental benefits. China has made great progress in the arena against the industrial pollution, but it still has a lot of arduous work to do. Given China's actual situation, a comprehensive system for preventing and controlling the industrial pollution is needed, within which economic instruments have an increasingly significant role to play.

The experiments of economic instruments by the developed countries have proven that economic instruments are a cost-effective means of achieving the environmental goals via the market forces. For preventing and controlling the industrial pollution, economic instruments have the main advantages of static efficiency (i.e., minimizing the cost of achieving a given pollution prevention and control target), and of dynamic efficiency (i.e., encouraging continuing innovation and permanent incentives to prevent and control pollution). The international practice of economic instruments can be used by China as important references.

However, economic instruments are not a panacea for the industrial pollution, and need to be tailored to the specific situations. They are one of a suite of policy tools available to manage the industrial pollution. In practice, the best that can be hoped for is a mutually-reinforcing mix of economic instruments, regulatory instruments, suasive instruments and other measures designed to stimulate the changes across a wide range of fundamentally different activities in relation to economic growth, resource utilization and environmental protection. Within such preferable "policy cocktail", economic instruments will manifest their own unique functions for China to prevent and control the industrial pollution. Furthermore, governments, industries, communities and other stakeholders all have a role in progressing the application of economic instruments. Although economic instruments have been used for preventing and controlling the industrial pollution in China for a couple of years, there are still much work to do for improving and extending the application of economic instruments.

The difficulty coexists with the hope, and the challenge displays with the opportunity. American poet Longfellow once wrote: "But to act that, each tomorrow finds us farther than today. Act, act in the living present." Looking to the future, as long as China persists its efforts in harnessing the industrial pollution, reforming the environmental policies, strengthening the environmental legislation, seeking for necessary international cooperation and assistance, accelerating capacity building, and eliminating the obstacles which limit the application of economic instruments, there exist win-win opportunities for China to effectively prevent and control the industrial pollution by means of economic instruments, substantially improve its environmental quality, and eventually achieve its sustainable future with a fine prospect of "Clear Water, Blue Skies".

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