Implementation of Environmental Policy in the Developing Countries: Regulatory Instruments and their Efficiency

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1. Introduction

This paper aims at analyzing the environmental problems and the relevant environmental policy to cope with those problems in the developing countries. This paper presents a critical review of the international development research in the 21st century. This makes clear the contemporary environmental issues and the directions to formulate the efficient environmental policy. Therefore, this topic has a broad spectrum and many approaches towards the main theme. Environmental economics targets the efficient implementation of the environmental policy. This 'efficient implementation' has a different perspective in the developing countries' context.

Researchers have discussed efficiency of the environmental policy: conventional regulatory instruments under command and control (CAC) including emission standard and technological standard, and market-based instruments (MBIs) such as pollution levy system and emission trading system [(1)]. The discussion is focused on the comparative analysis for CAC versus MBIs. The main hypothesis the contemporary researches suggest is that CAC regulations are inefficient, while MBIs are efficient regulatory instruments (Turner, Pearce, and Bateman 1993, Moran 1995).

Even in Japan, USA, and Europe the environmental policy is still mainly based on CAC. However, non-uniform and complicated regulations under traditional CAC has many limitations, which has led to introduce more efficient policy instruments known as MBIs (Kosobud and Zimmerman 1997, Sorrell and Skea 1999, Kosobud 2000). On the other hand, the developing countries, in order to implement efficient environmental regulations, are increasingly introducing MBIs (OECD 1993). This trend for an increasing proportion of MBIs reflects the role of private sector, deregulation of traditional economic infrastructure, and market-based policy in the developing and the developed countries.

One of the strengths of MBIs for the developing countries is that the monitoring capacity in those countries is not enough to effectively implement CAC (Huber et al. 1998). The government or public sector in the developing countries does not have enough capacity to implement CAC effectively; therefore, MBIs are more popular in those countries, in comparison to CAC. This discussion is based on the effectiveness rather than the efficiency, which could be measured through cost benefit analysis (CBA).

The World Bank report, analyzing 11 Latin American countries, has observed that it cannot be ascertained that MBIs are less costly than CAC; however, MBIs are effective due to economic inconsistency between various firms and individuals (Huber et al. 1998, p.vi). At this point, the paper focuses efficiency evaluation. However, before analyzing efficiency of environmental policy, we set the discussion on the effectiveness of environmental policy targets such as environmental standards.

At the same time, we discuss the efficiency of environmental policy, both in the developing countries and as well as in the developed countries. The efficiency of environmental policy, in context with the global issues, addresses the important questions. What is CAC and what are MBIs? What is the condition of actual policy implementation? The contemporary researches in environmental economics have so far discussed the theoretical aspects of the static and dynamic efficiency of the MBIs. Furthermore, they suggest the inefficiency of CAC by analyzing pollution abatement costs from theoretical point of view.

However, those researches have not yet given the answers to the questions mentioned above. Therefore, this paper analyzes the essential environmental problems and also discusses the efficient environmental policy for the developing countries. Moreover, this paper suggests the important directions of the environmental policy for the further industrial development in the developing countries.

In this section, I provide a general introduction and highlight the importance of this paper. I critically review of previous discussion on the environmental policy and the efficiency of administrative (CAC) and economic (MBIs) tools in section 2 and 3. I offer a critical analysis of mainstream research to make clear the major achievements and shortcomings of that research. I cover the research focused on CAC in section 2, while I analyze the research targeting MBIs in section 3. In section 4, based on the discussion in the previous sections, I discuss efficient implementation of environmental policy in the developing countries. This analysis leads to section 5, where I suggest standards of environmental policy for further industrial development in the developing countries.

In this paper, I focus on environmental problems such as industrial pollution and urban pollution including air pollution and water pollution.

2. Efficiency of CAC

2.1 Is CAC inefficient?

At first we critically analyze the discussions of the mainstream researches to obtain the answer to the question of CAC's efficiency. Many environmental economists suggest that either CAC is inefficient or it is not as efficient as MBIs. Although they mention various kinds of MBIs, it is not yet clear whether CAC is in fact inefficient. To obtain a clearer perception, we need to rethink what CAC is as most of the actual environmental policies are based on CAC.

Reconsidering CAC is also important in terms of supporting MBIs as an efficient tool for the environmental policy.

Amano (1997) mentions that "CAC is being criticized due to its statistical and dynamic inefficiency. The policy makers do not have enough information about the pollution abatement costs, and therefore they cannot set a system to minimize those costs. Emission regulations have often one standard across the board to check the pollution levels. However, this method increases the whole costs of pollution abatement practices. This mainly because every industry or firm has a different capacity and one can reduce the pollution at lower costs, while the other has to spend more to reduce same level of the pollution (p. 197)".

And Turner, Pearce, and Bateman (1993) mention two points about CAC's efficiency (p. 144). First, to implement CAC, the government needs the resources to gain the information, which polluters already have. For example, they know much more about the pollution abatement costs than the government knows.

Second important fact is that abatement costs are different among various industries and/or pollution sources. In CAC, all the industries or firms have to achieve the environmental standard with a certain technology. This is common in the USA and Europe. These CAC regulations do not target to minimize pollution abatement costs. This is one of the basic characteristic s of CAC.

This suggests that inefficiency exists with the CAC. The theoretical reason for that is based on the transaction costs to obtain the necessary information. Furthermore, this inefficiency is also due to the different marginal pollution abatement costs for various industries or firms.

Cropper and Oates (1992) observe that this kind of over-simplification does not provide a fair comparison of various policy tools. There are various kinds of CAC and also various levels and possibilities of efficiency for those CAC regulations. Hence, MBIs do no always achieve the cost minimization which theoretical discussions support. As Helfand (1991) and Oka (1997) suggest, environmental economists may need to categorize the regulations into several types in terms of economic efficiency in order to discuss CAC's efficiency.

Turner et al. (1993)'s argument is only based on CAC with technological standards. And Amano (1997) also discusses only a single standard type CAC. Therefore thes e discussions might not be applied to various types of CAC and to draw a relationship between theory and actual practice of various CAC types.

2.2 Various types of CAC

CAC is regarded as a public policy that regulates a prescribed behavior through a law with penalties for disobedience. There are the similar type of regulations, other than the environmental regulations, like anti-monopoly law under economic regulations or various laws under social regulations, traffic regulations, food regulations, and medicine regulations. CAC,

under environmental regulations, is based on the standards to improve environmental quality. These standards can be classified in three categories, viz. ambient standards, emission standards, and technology standards (Field 1997).

Environmental standards are set up in accordance with the various targets to maintain a safe environmental quality. Hence, first of all ambient standards have to be fixed. These are the average concentrations in certain period of time for a targeted pollutant in the environmental media like air, water, or soil. These standards are set in accordance with geographical location and conditions, concentration of population, and nature of the pollutants. Therefore, ambient standards for average concentration may vary from on place to another and also from one pollutant to another.

Thereafter, emission standards are to be set up. The pollutant, from each pollution source (for example industry or automobile), should be controlled at some desired levels to achieve overall environmental quality. These emission levels or standards indicate the amount of emissions permissible for the each polluter. These standards can be formulated in various forms, viz. amount of pollution during a certain time period (a unit weight of SOx per unit hour), emission concentrations (BOD in water), emission amount per unit of energy consumption, emission amount per unit production, and emission abatement rate (ratio of recycling).

Emission standards are based on the outcome of pollution abatement behavior by the polluters. This is also called performance standard. Various regulations are based on such type of performance standards like industrial pollution levels, residuals of agrochemicals in agricultural products, and maximum speed for driving a car.

On the other hand, the technology standards regulate production technology and/or abatement technology. Polluters are required to adopt standards that control technologies and methods, while the emission standards regulate the final outcome or results. Compulsory use of ter nary catalyst or seatbelts is a typical example of CAC based on technology standards. There are various regulations based on different types of technology standards. These include production regulation for vehicle gas emission processing technology, and input regulation to only use the coal and heavy oil with certain percentage of sulfur content.

Field (1997) mentions that it can be difficult to distinguish in regulations of input and production whether it is emission standard or technical standards (p. 213). The basic difference, however, is that emission standards (performance standards) are the standards (targets) towards the results of the behavior and it depends on the people which method to choose to achieve that emission target; while the technology standards regulates the behavior as well as the method.

In the next section we will examine how the differences in CAC types reveals as the differences in the efficiency.

2.3 Efficiency, emission standards, and technology standards

In environmental economics, efficiency is discussed in terms of static efficiency and dynamic efficiency (Lesser et al. 1997, Tietenberg 2000). The static efficiency does not consider change in time and remains constant over the time. It is important to note that static efficiency does not have technological change or improvement. On the other hand, the dynamic efficiency considers time change especially the decreasing pollution abatement costs over time with technology improvements. These two concepts of efficiency can be applied in MBIs and as well as in CAC.

Figure 1 shows static efficiency standard. Each polluter 'A' and polluter 'B' emits 'X_0' ton/month of pollution (let us say SOx) when there is no environmental regulation. Furthermore, marginal abatement cost (MAC) is different for both polluters because of the difference in technology levels. Hence MAC_A and MAC_B are the marginal abatement costs for respective polluters. It is evident that B's cost to reduce the pollution by the same amount or ratio is higher than that of A's cost. This also suggests that B's technology level is lower than that of A's (in case of the same type of industry).

When the ambient standard in this region were X_0 ton per month for each of those industries, there were two ways to achieve the standard. Polluters reduce either emission by the same ratio, or by the different ratio. If the regulation sets the pollution abatement ratio at one standard, requiring a cut of 50% for both polluters, then each A and B has to reduce $X_0/2(=X_1)$ ton of emission per month. This will cost A and B as X_0CX_1 *and* X_0DX_1 respectively and the total costs would be $X_0CX_1 + X_0DX_1$.

Now let us consider the case of applying different ratios for A and B. Therefore, when A's abatement amount is increased by some margin from its original requirement of X_1 and B's amount is decreased by the same margin from its original requirement of X_1 to achieve the same total abatement level (X_0). This will increase A's abatement costs and decrease B's abatement costs. However, this will reduce total abatement costs. The minimum total costs will be achieved when MAC for A and B is set at the same level. At this level, A reduces its emission to X_2 ton per month and B reduces its emission to X_3 ton per month ($X_2+X_3=X_0$). The total cost would be $X_0EX_2+X_0FX_3$. This is the theoretical minimum cost, based on the concept of static efficiency.

Figure 2 shows the concept of dynamic efficiency. MAC curve at an initial point (MAC_1) could shift to another point (MAC_2) due to technological innovation. Hence, when ambient standard is at X_2, pollution abatement costs will be equal to '*b*' after technological innovation in MAC_2, while the cost would be equal to '*a+b*' for MAC_1 without technological innovation. This shows that the costs '*a*' could be reduced due to technological innovation. The dynamic efficiency is decreased by ongoing technological innovation, and this innovation is led by the incentive of reduced abatement costs.

Based on this knowledge, we shall compare efficiency of emission standards with the efficiency of technology standard. In the latter case, pollution abatement rates would usually become uniform across the polluters in one industry, as they have been forced to adopt a particular type of technology. Also in the former case, a single pollution abatement rate would

give the perception that polluters are being getting a fair treatment and this would be easily acceptable for the society. This suggests that both technology standards as well as emission standards are not efficient as far as static efficiency is concerned.

In the actual situation, to fix emission standards, the regulatory authorities often obtain the pollution abatement information for each polluter through the various channels, such as investigation of polluters and informal negotiations. Furthermore, local governments often share the necessary information with firms in the case that the actual regulation is implemented by the local governments under the national regulation standard. This situation is not only common in Japan, where local governments have taken the initiatives in pollution control, but also in the United States, where the state and local governments have practically implemented the actual regulations under Clean Air Act and Clean Water Act.

When flexible emission standards, and not the one standard across the board, are settled for different polluters, CAC with emission standards can possibly reach closer to static efficiency.

Next we examine the dynamic efficiency. At this point, under the fixed technology standards, dynamic efficiency cannot be achieved as individual polluters cannot adopt more efficient technology at their own choice. In emission standards, on the other hand, incentives of reducing abatement costs can motivate individual polluters to adopt effective technology. Therefore, when the emission standards are strictly enforced, the incentives can create the strong dynamic efficiency [2].

So far, in the actual situations, CAC approaches have been adopted as the most common tools to implement environmental policies because they are simple and clear, and easy to plan the future achievement of an environmental standard or target. Usually economics interprets CAC with the idea of inflexible technology regulations and single standard, and emphasizes its inefficiency and the great implementation costs. However, CAC can be efficient when it is based on actual emission standard with flexibility.

In order to realize this possibility, regulatory authorities need to understand the actual and precise situation of pollution and the polluters as well as to steadily decentralize the implementation of the regulations. And they have to attain high systematic and technical capabilities along with financial confidence to implement the regulations. Moreover, we need to be careful that different emission standards for different polluters, in order to achieve the efficient regulation under CAC, can possibly make the regulation process unclear and also can weaken the idea of fairness.

3. Efficiency of MBIs

3.1 Various types of MBIs

The purpose of MBIs is to implement pollution reduction efficiently by giving people economic incentives with pricing the use of environmental resources and setting the right to use them, while CAC is the enforcement of behavior by public authorities. There have been such policy ideas since 1960's (Dales 1968), and European countries and the United States have adopted them since 1970's(OECD 1996, DECD 1997a).

There are various discussions what MBIs include. Stavins (2000) has a broad understanding that MBIs include four types of approaches; levy/tax, a tradable discharge permit system, reduction of market barriers, and reduction of government subsidies. Reduction of market barrier includes PL system, eco-labeling, information disclosure etc.. Although government subsidies are usually interpreted that they have the same effect as levy system, Stavins (2000) pays more attention to the practical characteristics.

Since this section aims to investigate the difference among CAC approaches in terms of conditions of function and efficiency, and to analyze the basic types of MBIs, I categorize MBIs into 2 types; an emission charge system, which is based on the price, and tradable discharge permit system, which is based on the amount.

An emission charge system, a centralized method based on tax charge rights of public authority, requires administration to deal with polluters directly and continuously. On the other hand, a tradable discharge permit system, a decentralized method, is expected that it work by itself through economic negotiations among polluters or between polluters and party involved once basic rules are settled. As cases in actual use of MBIs, European countries have used mainly an emission charge system, and the United States has adopted a tradable discharge permit system in the acid rain program under Clean Air Act Amendment in 1990 (Hahn 1995, Klaassen 1996).

3.2 Efficiency of an emission charge system

First, I will investigate the conditions in which emission charges work and their efficiency. Basically, polluters can emit any amount of pollutants instead of paying a certain amount of penalty charges per unit (e.g., SO_2 ton) for all of their pollutants. Once the charges are set, polluters begin to consider the cost of utilizing environmental resources and they will have economic incentives to save their environmental use (reduce pollution) just as they save labor and capital. I will explain a mechanism of an emission charge system by Figure I shown in the previous section. If an emission charge to a pollutant is set at Y_2 yen/ton, polluter A who produces at MAC_A can save the cost of the environmental regulation most when he emits pollutant by the amount of X_2, where the MAC is Y_2 yen. At this time, the pollution abatement costs are equal to X_0EX_2 and the amount of the emission charge is OX_2EY_2, and the total costs (environmental regulation costs) are $X_0EX_2+OX_2EY_2$. Even if the amount of emission is higher or lower than X_2, the total costs are higher than $X_0EX_2+OX_2EY_2$. For example, when a polluter increases the amount of emission to X_1, if compared with the most suitable case, the total costs will increase by the amount of CGE because the emission charge increases to OX_1GY_2 while the

pollution abatement costs decrease to X_0CX_1.

Under the emission charge system, if a polluter (company) is producing in a competitive environment and he knows his own MAC enough, his amount of emission will be decided at the point that the emission charge per unit and marginal abatement cost become equal by means of economic incentives. Therefore in case of Figure 1, polluter A will select the most suitable point X_2 and polluter B the most suitable point X_3 under the terms that the emission charge per unit is Y_2 yen. If the amount of emission, X_2+X_3 achieves the environmental standard (goal), emission charges can be statically efficient with the meaning of being able to achieve the goal at the minimum costs.

However, there is no guarantee that emission charges will work in accordance with theory when there exist legal natural monopolies by public enterprises such as gas and electricity, or when the business accounting system does not work, or a company does not know its own MAC curve appropriately because it has had only a few experiences of the pollution reduction. Furthermore, we cannot know in advance whether the total amount of pollution will achieve the environmental standard, even if all the polluters emit at the point where the emission charge per unit and MAC become equal (Helfand 1999). When the authorities try to set in advance the amount of emission charge to achieve the environmental standard, they have to know beforehand each polluter's MAC, as in the case of efficient CAC (emission standard) policy.

Against this, there is an optional idea of the 'Baumol and Oats tax' that the most suitable amount of emission charges to achieve the environmental standard is decided by the trial and error, but it is impossible to change the once-decided amount of tax frequently because taxpayers, who are voters at the same time, will not accept the repeating changes in tax levels. Besides, we still need to know the MAC curves for this trial-and-error method because they decide how much amount of pollution will increase or decrease when the regulators increase or decrease the charge. Furthermore, there might be available time for trial and error in the case of the eutrophication problem of rivers, lakes etc., but in case there is an adverse effect on human health (air pollution, e.g.), trial-and-error regulations can hurt people's reliance on environmental policies.

Moreover, emission charges impose heavier burdens on polluters when we compare the charges with CAC at the point of costs. In Figure 1, even if polluter A's emission is X_2 under CAC, he need to pay only the pollution abatement costs X_0EX_2. On the other hand, under the emission charge system, he has to pay tax OX_2EY_2 in addition to X_0EX_2. Therefore, polluters are likely to have a strong incentive to underrate and underreport their emission levels. To avoid this, a detailed monitoring system, on-the-spot inspections and so on are needed, and the government will have to pay more than they would for CAC.

Most of the emission charges that European countries and others have adopted are not used as a mean of achieving environmental standards more efficiently than CAC. Emission charges are means of raising revenue for administrative investment in the environmental field while CAC policies like emission standards play an actual role of achieving environmental standards (OECD 1996, OECD 1997a). In these cases, the amount of emission charge is decided by dividing the necessary revenue, which is already calculated, by the estimated amount of pollution.

In this sense, it is more difficult that an emission charge system achieves static efficiency than CAC based on emission standards does.

Next, I will explain dynamic efficiency by using Figure 2 previously shown. As I explained, under CAC (emission standards), the pollution abatement costs decrease from $(a+b)$ to only b, the reduced amount is a, because of the shift of MAC from MAC_1 to MAC_2 through technological innovation. In case of an emission charge system whose charge rate is t, the pollution abatement costs will decrease from $(a+b+c+d+e)$ to $(b+d+e)$ and the amount of the reduction will be $(a+c)$. Generally researchers discuss that the incentive to dynamic efficiency on emission charges is greater than on CAC (emission standards) because $(a+c) > a$ (Field 1997, pp.243-244).

However, when we see the cost decrement, the rate is $a/(a+b)$ under CAC (emission standards) and under emission charges, that is $(a+c)/(a+b+c+d+e)$ [3]. Therefore cost decrement of CAC is usually greater than that of emission charges because $\{a/(a+b) > \{(a+c)/(a+b+c+d+e)\}$. In addition, when the actual emission charges is used as a system for raising revenue, the absolute size of $(a+c)$ is quite small because the emission charge is set at a low price.

In this way from the viewpoints of both static and dynamic efficiency, we should not conclude that an emission charge system is preferable than CAC (emission standards) because actual emission charge system does not always give a strong incentive for efficient emission management.

In addition, there are some environmental taxes such as carbon tax and economical car tax system. These taxes can be applied in the condition that the most suitable amount of charge cannot be set when each polluter's MAC is not clear. These taxes are not imposed on the emission of pollutants itself but on the material inputs and products, and are different from emission charges at the point that the regulatory authorities can set the most suitable charge level if they know the price elasticity of demand for the goods concerned. Later in this paper, I will discuss these taxes in detail, focusing on environmental policies in developing countries.

3.3 Efficiency of tradable discharge permit system

Tradable discharge permit system is a decentralized system that produces a permits market by dividing pollution emission as tradable rights and recognizing individual polluters as permits owners, while an emission charge system depends on the government's administrative ability of setting levy rate, monitoring, and collecting levy. Tradable discharge permit system can be divided into credit program, which gives permits only to additional reduction from the

standard, and cap and trade system, which gives permits to all pollution emissions (Stavins 2000). Since the former is the limited type of the latter, here we discuss the cap and trade system.

Tradable emission permits is supposed to be the right certificates showing the pollution emission unit (e.g., ton) in a certain period, and polluters who have emission right certificate for 100 unit of emission can emit 100 unit of emission at most. The total amount of unit emission rights is the emission cap, which satisfies the environmental standard. Emission rights can be traded at the price which parties involved accept. Occasionally, however, this trading system has geographical limitation because of the different environmental standards. This could damage the efficiency of a tradable discharge permit system. This problem will be mentioned later.

In a tradable discharge permit system, a regulatory authority first settles the total emission amount, and divides it into individual polluters. As total emission amount is usually set lower than before, it is difficult how to distribute the permit to polluters. A single rate reduction to all polluters seems fair but this would give disadvantage to the polluters who have already cooped with pollution reduction.

Suppose emission permits are distributed by some means, next we consider efficiency of a tradable discharge permit system. Again in Figure 1, we suppose that polluter A and B have emission permits X_1 each, and A's marginal pollution abatement cost is Y_3, and B is Y_1. Since Y_1 Y_3, B can reduce pollution abatement costs (X_0DX_1) by increasing emission amount from X_1 with the purchase of emission permits if B can purchase emission permits at the lower cost than Y_1. On the other hand, A can make profit by reducing emission from X_1 and selling emission permits that it does not use if A can sell emission permits at the higher price than Y_3.

The optimal point is where two polluters have equal marginal abatement costs, and in that case A's emission is X_2 and B's is X_3 in Figure 1. The emission permits that A sold (X_1-X_2) and those B purchased (X_3-X_1) are equal and trade can be done at the price Y_2. A spends costs X_1CEX_2 to reduce emission by (X_1-X_2) but makes profit CGE by selling emission permits worth X_1CEX_2 at the price Y_2. B, purchasing party, can reduce pollution abatement costs by FDG in the same manner.

As trading centers or authorized brokers system are established, permit trade market is built and more parties participate in the market, there occurs merits of market economy and also more surplus for both buyers and sellers. When these market mechanisms start to work independently, a tradable discharge permit system starts to work efficiently and independently as well. Therefore, it is considered that a tradable discharge permit system can achieve static efficiency much more easily than an emission charge system. In order to make the emission permits trade market work efficiently, market rules should be simple and clear, and monitoring authority should not intervene the market strongly.

There are, however, various problems when we consider a tradable discharge permit system as an actual environmental policy. From the viewpoint of making use of market, it is better that one market covers broad areas as possible, but from the viewpoint of achieving an environmental standard, there can occur 'hot spots' that have severe pollution damage because of incoming emission permits to the upper stream of the air and river. In fact, the emission trading program in the United States does not permit the transfer of emission permits to upwind area in the New York state case (Field 1997). This geographical limitation is necessary for the purpose of environmental preservation but makes the permits market difficult to have active trade because of smaller size of the market (Schmalensee 1998). Moreover, a regulatory authority needs to monitor the emission permits amount of individual polluters and emission amount of each polluter.

In the point of dynamic efficiency, a tradable discharge permit system has the same effect as an emission charge system. In fact, a tradable discharge permit system is expected to have more dynamic efficiency than an emission charge system since it can set the total emission amount to achieve the environmental standard.

Therefore, a tradable discharge permit system can realize an environmental policy, which is the purpose of MBIs, much more (statically) efficiently. It would need, however, high costs of administration, especially monitoring as an emission charge system needs (this is to be discussed later in this paper). And we are not sure whether a tradable discharge permit system really achieves theoretical static efficiency as it might require limiting the efficiency in order to preserve environment in the actual process. And it cannot be determined to be superior to CAC (emission standards) though it is considered to be superior to the actual emission charge system in terms of dynamic efficiency.

4. Approaches to environmental policies in developing countries

4.1 Social capabilities for environmental management and the enforcement conditions of environmental policies

Environmental policies in developing countries are under various limitations such as the low monitoring technology, financial shortage for environmental management, inadequate systematic and personnel skills in related government agencies and so on. These factors which have been decided by the economic growth and social capabilities for environmental management cannot change in a short time [4]. However, developing countries have the advantages of so called 'latecomer's advantages' that they can make good use of lessons which developed countries have experienced from enforcing environmental policies during several decades.

The recent researches on environmental policies of developing countries have paid attention to the conditions and possibilities of MBIs from these points of view (O'Conner 1994, Krupnick 1997). Also, China and Central and South American countries such as Chili have learnt MBIs from their experiences (Huber et al. 1998, OECD 1997b, World Bank 1997).

In this section, firstly I will verify what kind of social capabilities for environmental management is needed when implementing environmental policies of CAC and MBIs. In either CAC or MBIs, it is necessary to make out the present situation of pollution and its damage, identify the pollution source, and disclose the information to the public in order to form the social agreement for regulations. Under the process of research, analysis and information disclosure, concrete aims and rules of pollution control must be laid down clearly. Monitoring the environmental quality is also important to evaluate whether the implemented rules are working correctly and can achieve the environmental standards.

It is social capabilities for environmental management that achieve this series of processes. It means the overall management capabilities which are composed of macro and micro groups of environmental management such as a national government, enterprises or citizens that is ruled by socio-economic conditions, law system and social moral. In the case of air quality management, capability of monitoring air quality is one of the most important roles (Matsuoka et al. 2000). Next I will examine how the actual efficiency of CAC and MBIs is related to monitoring function, and what the preliminary conditions of implementing efficient environmental policy in developing countries are.

The technical improvement of air quality monitoring is made up of two stages; manual operation stage that motoring staff take the records in the spots and analyze them in the laboratory, and automated monitoring stage that has automated monitoring equipments which collate the records and automatically send them to a monitoring center. One can categorize these two states further; in the first case, whether it employs the automatic sampling system, and in the second case, whether it employs the continuous monitoring system by telemeter etc..

Ideally, continuous monitoring would be most preferred but this requires a high level of technology that guarantees accurate measurement and also huge costs to install and maintain automatic monitoring equipments. Roughly speaking, the SO_2 reduction programme of the United States costs each company about $124,000 annually in total capital costs and maintenance costs (Schmalensee 1998), and in Sweden, the NO_x emission charge system costs each company $39,000 annually for maintenance costs alone (Lovgren 1994).

In 1999 our research group surveyed the total maintenance costs of the nineteen monitoring stations located in Hiroshima City which measure six pollutants. These costs amounted to about 50 million yen per year, excluding the personnel costs, and one monitoring equipment costs 2-3 million yen with 10 years of durable period [5]. Even though there are some differences between the cases (the cases in the United States and Sweden conduct emission sources monitoring and Hiroshima case ambient standards), anyway the continuous monitoring is quite expensive technology for developing countries.

If we compare emission standards based CAC and an emission charge system and a tradable discharge permit system of MBIs, as has been explained, in contrast to the general view, MBIs may require more implementation costs such as monitoring expenses (Blackman and Harrington 1999). This is because, in either emission charges or a tradable discharge permit system, the amount of pollution that polluters emit directly determines their costs, while emission standards regulation under CAC is not affected by the emission amount as long as polluters satisfy the standard. In the case of MBIs, without continuous and accurate monitoring, they never know how much emission charges they should pay or how much emission permits they can sell. More basically, accurate monitoring is necessary in order to attain public reliance to the system. Furthermore, society needs a fair and accurate monitoring system to accept MBIs.

Hitherto it has been said that CAC based on emission standards requires huge monitoring costs to inspect the polluters meet the standard. In actual implementation of emission standards, however, if there are enough general monitoring stations which monitor ambient standards, regular or spot check of individual polluters may be enough in consideration of the conditions of production facilities and pollution reduction equipments. Consequently, for emission standards to function effectively, it is necessary to have a system that monitors environmental quality. In relation to this, under the emission charges and tradable discharge permit systems, not only the monitoring of environmental quality but also the accurate monitoring of individual pollution sources is required.

The very effective Swedish NO_2 emission charge system and the similarly successful American anti-acid rain tradable discharge permit system both owed a large part of their success to the accuracy and wide-ranging nature of their monitoring systems and to the high level of management expertise shown by their relative administrative authorities (Blackman and Harrington 1999, p.27).

Conversely, in the cases of China's pollution levy system [6] which lacked many of these resources, and also Poland's atmospheric pollutant charge system [7], the setting of a charge level which was lower than the marginal abatement costs of their polluting enterprises has provided a source of financial revenue, but has not provided an incentive for environmental improvement (Blackman and Harrington 1999 p.18-23).

4.2 The implementation of indirect regulatory instruments

In order to overcome the problem of high-cost monitoring, in place of a continuous monitoring system, the adoption of a less expensive and simpler methods and the policy measures that do not depend entirely on monitoring is a possible alternative.

Former methods include:

i) identifying the principal target elements within pollutant emissions, estimating coefficients and generating a formula for the total emission amount, and calculating the amount of emission produced by a known input of fuel or the work rate of particular machinery;

ii) estimating total emissions from an examination of physical input and output.

However, in all of these methods there is a lack of accuracy, and even if they might be used to monitor SO_2, they are inappropriate for NOx and PM (Particulate Matter) because monitoring these two pollutants are sensitive to the difference in equipment maintenance and

operational techniques.

The latter methods include technology standards in CAC and an environmental tax in MBIs. These are the methods which attempt to control pollution indirectly and have been called indirect instruments (Eskeland and Jimenez 1992).

Technology standard attempts to control production technology and pollution-reducing technology, and this can achieve an environmental target if facilities are maintained and utilized properly. However, it is necessary for the regulatory organization to have detailed information relating to pollution technology and the polluters are required to have the ability to operate this equipment correctly. Fulfilling these requirements will be difficult for developing countries.

Another potentially effective method is taxing pollutant-containing production inputs and products that can emit pollution. This type of tax would focus on; fossil fuels which emit CO_2 (a carbon tax), coal or oil with a high sulfur content (a sulfur tax), leaded gasoline (a lead tax) or a fuel-economical car tax and so on. Basically these are called an ecotax (Sterner 1996). As has been explained regarding the emission charge system, in the case of an ecotax because the pollution emission and the amount of tax are not directly related, the effect of pollution reduction will be indirect, but the level of monitoring cost will be small. In the following discussion, bearing in mind that monitoring and environmental management capabilities is relatively low in developing countries, I will examine how the high costs of accurate monitoring technology can be avoided through the use of indirect instruments such as an ecotax.

There are three types of ecotax (Blackman and Harrington 1999):

i) a tax on the final goods that emit pollution, such as cars;

ii) a tax on the goods that emit pollution as input goods, such as coal;

iii) a tax on the pollutants, such as sulfur contents in coal.

An ecotax differs from an emission charge which is levied on pollutant emissions, and therefore it does not guarantee static efficiency and its dynamic efficiency would be lower when compared to an emission charge system.

The effect of an ecotax is to generate revenue for environmental improvement and also to reduce pollutant emissions, which also has a positive environmental effect. However, there is a tradeoff between the two effects of this tax, related to the price elasticity of demand for targeted goods. Namely, that in the case of a small elasticity of demand, even with the imposition of the ecotax, demand does not decrease significantly and so the effect on revenue is large but the effect on environmental improvement is small. Conversely, in the case of a large elasticity of demand, the imposition of the tax leads to a small effect on revenue and a large effect on environmental improvement. Accordingly, a tax whose aim is to reduce pollutant emissions, like that imposed on leaded gasoline, is more effective in terms of bringing about environmental improvement than a general tax imposed on all types of gasoline.

The major advantage of the implementation of an ecotax in developing countries, in contrast to an emission charge system or a tradable discharge permit system, is its ease of implementation and administration (Blackman and Harrington 1999). This is due to the following reasons:

Firstly, in comparison to the monitoring for pollutant emissions, that required for an ecotax is far easier to achieve. Secondly, in many cases an ecotax is implemented not by an environmental regulatory body but by the normal tax administration, and in many developing countries the level of organizational ability in the tax administration is higher than that in environmental regulatory bodies. Furthermore, taxes on fuels such as petroleum and coal are already in place in developing countries. Thirdly, in comparison to that required for an emission charge system, the specific information necessary to set an appropriate level of ecotax is quite limited. As mentioned earlier, a fair emission charge system requires information about the marginal abatement costs of individual polluters, but for an ecotax only information about demand elasticity is required, and this can be drawn from market data.

Along with the aforementioned advantages of implementing an ecotax, the relative lack of an incentive contained in it to reduce emissions, since they are not the objects of the tax, represents a disadvantage. Also the taxing of basic essentials like fuel could have a serious effect on poorer people, which raises problems in terms of equity. However, the negative effects on poorer people could be mitigated by taxing the highly-polluting coal with high sulfur content and by financing ecotax revenue to implementation of poverty alleviation programs (OECD 1996).

In a similar way to the above, in developing countries with less than perfect environmental management capabilities, instead of directly making pollutant emissions the focus of policy through emission standards (CAC), an emission charge or a tradable discharge permit system, it could be more realistic and effective to implement "second best" approaches, here, indirect instruments such as technology standards (CAC) and an ecotax. Furthermore among indirect instruments, if an ecotax is well designed, in terms of the object of the tax and the revenues use, it could have significant positive effects on environmental improvement (Eskeland and Jimenez 1992, Huber et al. 1998).

At the same time, however, it is important to consider the following points in order to implement an ecotax effectively in developing countries (Blackman and Harrington 1999).

Firstly, even though it is necessary for environmental improvement to set a high level of tax, in many cases political pressure from the industrial groups makes this problematic. In particular, in developing countries in which local residents' campaigns, environmental NGOs and other groups are relatively weak, it is quite severe. Secondly, if there is a lack of social acceptance of, and also trust in, the tax administration that will oversee the imposition of the ecotax, its introduction may be difficult and its effectiveness undermined. In developing countries somewhat lacking in administrative expertise, there is the possibility that the introduction of an ecotax could exacerbate problems distortions in the tax system and "moral hazards" such as tax evasions. Thirdly, when seeking to maximize the efficacy of environmental policy, the tradeoff between environmental improvement and potential revenue increases, so the

regulatory agency needs to pursue the revenue for environmental policy separately from ecotax. In developing countries where environmental countermeasures are not a high priority in budgetary terms it is easy for environmental improvement to be sacrificed in exchange for the provision of revenue.

4.3 The Direction of Environmental Policy in Developing Countries

More than twenty years ago, Baumol and Oats had already explained that there were good and bad points of CAC and MBIs as policy instruments and appropriate policy should be chosen according to the conditions, and emphasized their conclusion that effective environmental policy is achieved by various types of policy measures (Baumol and Oats 1979, pp. 230-231). More recently, in Stavins review of various MBIs in many countries, he found that the hitherto pattern of the replacement of CAC policies with MBIs was now no longer the case, and the hope that MBIs would bear good fruit in future was one that should be viewed with caution (Stavins 2000).

In the following discussion of the direction for environmental policy in developing countries, I would like to emphasize two points which underline the above.

Firstly, in policy making it is most important to consider one country's socio-economic situation and the condition of its legal system and so on. This approach was taken in a study carried out by our research group into social capabilities for environmental management (Matsuoka et al. 1999, Matsuoka et al. 2000). The results of these studies showed large differences in the formation of environmental management capabilities in developing countries. An examination of continuous monitoring systems in Southeast Asian countries gave a strong indication of levels of economic growth. In Singapore, a fully equipped monitoring system has been set up and running; in Malaysia and Thailand the equipment was in place, and the next priority is to improve the levels of accuracy and effectiveness of measurement; Indonesia had reached the stage of extending its monitoring system from the capital's metropolitan area to other regional centers (Matsuoka et al. 2000).

The difference between the monitoring capabilities of these developing countries reveals the difference in choosing policy measures and designs. If the monitoring system is fully equipped, and is properly used and maintained, there is an increased likelihood of the successful application of emission standard-based CAC and even the application of MBIs such as emission charges or tradable discharge permit systems [8]. In developing countries with less extensive monitoring networks, the use of a technology standard CAC policy alongside the use of the indirect instrument an ecotax is a more appropriate approach. Of course all of these policy measures are also being used in developed countries, and so we should not fall simply into economic development stage theory or determined condition theory.

Secondly, to ensure the effectiveness of environmental policies which achieve environmental standards, the design of a mixed regulatory system for CAC and MBIs is most important (Bates et al. 1994). Sweden's highly regarded sulfur tax (ecotax) and NO_x charge system is strengthened by the parallel implementation of CAC policies.

Due to the lack of monitoring and administrative capabilities and also the political situation in many developing countries, the provision of revenue for environmental countermeasures depends mostly on an ecotax and an emission charge system, and achievement of environmental goals owes to CAC. I hold that in terms of efficiency, the use of MBIs will give assistance in the achievement of these goals. Particularly in comparatively industrialized developing countries like China, where the principal sources of pollution are the small-scale town and village enterprises, it is hard to target such enterprises with an ecotax or a emission charge system. Also the level of tax is often set lower than the marginal abatement costs of large enterprises and in cases where they are exempted from the tax burden, there is little incentive to reduce emissions. In order to make up for these weaknesses of MBIs, the use of CAC is necessary.

From their analysis of the Polish atmospheric emission charges, Bates et al. (1994) propose that the use of high sulfur fuel should be banned for small enterprises, and the mixed regulatory system of CAC and emission charges and tradable permits should be used for large ones. They think that within the mixed regulatory system, it is important to keep the tradable discharge permit system separate from CAC in order that this market instrument should work effectively. However, the reality in most countries is one of a combination of environmental taxes, charge systems and CAC all implemented together, which is suitable for a mixed regulatory system. For this discussion, the important point is that when the introduction of MBIs and the strengthening of CAC occurs in parallel, there is an increased chance of efficiency that a reduction in pollution and a reduction in the social costs of pollution can happen at the same time.

5. Conclusion

This paper has investigated the fundamental problems associated with the direction for the efficient implementation of environmental policy, the different levels of efficiency of different types of CAC and MBIs, and also matters relating to their actual working conditions and potential environmental effects, and what this means for developing countries in the 21st century. For developing countries with limited administrative capabilities and resources, reflecting the policy direction of international organizations such as the World Bank, the introduction of MBIs in a similar or more extensive way to that carried out in developed countries is recognized as a commendable approach. However, it is not always the case that the actually implemented policy instruments in developed countries have been sufficiently analyzed and have aided the learning process [9]. The main focus of this paper has been to highlight the fundamental problems of these instruments in relation to their economic characteristics, at the same time as investigating the condition of environmental policy in developing countries. The

conclusions from this paper are as follows:

Firstly, for emission standard-based CAC, when implemented in a decentralized way applying a non-uniform emission standard, they can be efficient both statically and dynamically. Technology standards are efficient neither statically nor dynamically, but the comparatively simple implementation of these indirect instruments gives scope for their effective use in developing countries. CAC are directed towards achieving environmental goals, and so their effectiveness in terms of degree of success in achieving these goals can be easily verified.

Secondly, static efficiency can be achieved with an emission charge system, but achieving environmental goals is difficult with this system and it also can't be said to excel in terms of dynamic efficiency. Furthermore, it is possible that the costs of regulation implementation for monitoring and so on could be excess of those for CAC. However, if the actual use of an emission charge system were in conjunction with strengthening CAC, environmental improvement could progress more efficiently.

Thirdly, a tradable discharge permit system is one which can achieve environmental goals efficiently both statically and dynamically, but there are some situations an environmental improvement effect and efficiency are incompatible with each other. In addition, in a similar way to an emission charge system, the costs of monitoring and so on within regulation implementation could be more than those for CAC. Further, a tradable discharge permit system is not appropriate within a mixed regulatory system.

Fourthly, as regards the choices of environmental policy available for developing countries, the two important areas that should be taken into consideration relate to:

i) the fact that the socio-economic situation and condition of the country in questions' legal system, etc. should provide the basis for its environmental policy choices;

ii) a mixed regulatory system.

In developing countries with relatively low capabilities in monitoring and administrative matters, the use of an indirect instrument such as an ecotax, which does not require accurate monitoring, may be an appropriate policy. However, similar to the experience in developed countries and maybe even more so in developing countries, the setting of a tax rate to facilitate efficient and effective pollution reduction will be quite difficult. A means to overcome this problem could be through the combined use of CAC and MBIs in a mixed regulatory system. In order to address the situation at hand, under this system, one could change policy measures according to the amount of pollution discharged, or could combine emission standards, an ecotax and emission charges as. This system sees CAC to ensure the achievement of environmental goals. The financial resources are provided by the revenues raised by the ecotax and emission charges, and these MBIs act to increase the efficiency of the achievement of the environmental goals.

Following on from these conclusions, especially in terms of the proposed set up of environmental policy described in the fourth point, it is not to say that this is the one and only efficient and effective policy approach for developing countries. This paper has discussed environmental policy in developing countries with an assumption that there is a lack of monitoring and administrative capabilities. However, the important points are the process of formation of environmental management capabilities, and the choice of policy measures that meet the conditions in a country. Through the implementation of appropriate policy measures, monitoring and environmental management capabilities can be promoted and the choice of policies increased, creating a virtuous circle in environmental management. A further supporting factor would be environmental cooperation from developed to developing countries that will help stimulate this dynamic formation of environmental management capabilities.

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Notes

1) Today's environmental policy consists of more than just economic instruments like CAC and MBIs. There have been the independent and voluntary ways such as the United States TRI (Toxic Release Inventory) and the Japanese PRTR (Pollutant Release and Transfer Register), which have been aimed at motivating the activity of businesses by the introduction of publicly available information and accounts and also there have been the ways made to motivate consumers through the growth of eco-labeling and environmental education.

Recently much importance has been attributed to various voluntary activities, which represent a third wave of action, following CAC and MBIs (Tietenberg, 1998). Attention has been paid to supporting a volunteer approach, which could help make up for the lack of capabilities in public administration matters existing in developing countries (Pargal and Wheeler 1996). In any case, it is certain that in future in place of the former government-focused "macro-environmental management", there will be an increase of popular people-focused "micro-environmental management". However, in relation to this, it is necessary that there be a reconsideration of the roles shared by government (nation) and citizens (people); further discussion on CAC and MBIs is also important from this point of view.

2) Emission standards originally do not specify the emission-reducing technology, however, the real emission standards in the United States have a strong incentive to adopt the publicly approved-technology, and each pollutant actually adopts the acceptable technique and does not try to use the innovative technology. Therefore, there is the view that emission standards are the same with technology standards and have no possibility of being efficient statistically and

dynamically (Blackman and Harrington 1999, p.6).

3) This is an explanation of the relationship between the large and small cost reduction rates that accompany technological innovations in CAC (emission regulations) and a emission charge system. To simplify matters, the marginal abatement cost curves have been drawn as straight lines. On this graph the environmental standard is e_0 and the charge rate is t_0. The revised charge rate introduced after technological innovation to satisfy the environmental standard is t_1. The CAC (a emission standard) cost reduction rate is ABD / ABe_0. In the case the charge rate for the charge system, again after the technological innovation, cost reduction rate at point t_0 is ABC / Abt_0O. When the charge rate is revised from t_0 to t_1, the cost reduction rate is $(ABD + Bt_0t_1D) / Abt_0O$. At this time: $\{ ABD / ABe_0 \} = \{ (ABD + Bt_0t_1D) / Abt_0O \}$, and $\{ (ABD + Bt_0t_1D) / Abt_0O\} > \{ ABC / Abt_0O \}$, and thus $\{ ABD / ABe_0 \} > \{ ABC / Abt_0 \}$.

Therefore when the charge rate doesn't change, the cost reduction rate under CAC (a emission standard) is larger than that under the emission charge system.

4) Concerning the relationship between economic growth and the formation of social capabilities of environmental management, environmental economics have mainly discussed the issue of Environmental Kuznets Curve (EKC) approach. Our research group analyzed SOx, NOx, CO_2, accessibility to safe water and sanitation, and forest degradation, and found that it is only SOx that forms EKC at present (Matsuoka et al. 1998).

5) This data is from the interview in Environmental Protection Center in Hiroshima city on June 9, 1999.

6) There are several discussions that Chinese pollution levy system plays an important role in the reduction in pollution (Wang and Wheeler 1996). Our research group verified the model of Wang and Wheeler with the latest data. However, our group could not find the statistic significance constantly that pollution levy system worked effectively (Lu et al. 2000).

7) An emission charge system in Poland has two types of fee. One is normal fee imposed to emissions below the standard, and another is penalty fee imposed to emissions, which exceed the standard (China has the same system). At present, penalty fee revised after 1991 is evaluated as having one of the highest rates in the world, but the level of normal fee is low (Anderson and Fiedor 1997, Stavins 2000).

8) Although tradable permit system has been tried in Mexico City (Mexico), Santiago (Chile), Korzof (Poland), Almaty (Kazakhstan), evaluation of the effects is not quite good (Blackman and Harrington 1999). Krutilla also doubts the implementation itself of tradable permit system in developing countries from the point of transaction costs (Krutilla 1999).

9) This paper has discussed approaches of environmental policy in developing countries from the aspect of various instruments of environmental policy and their efficiency, which are fundamental problems concerning theory and practice in environmental economics. From this discussion of environmental policy, I would like to underline three remaining problems related to the efficiency evaluation of environmental policy.

The first relates to the various past evaluations of environmental policy. A large number of recent environmental economics studies are in existence, for example Tietenberg (1985), Oates et al. (1989), Portney (1990) and also Burtraw (1998), but no consensus exists about the quantitative scope of costs and benefits or evaluation methods across these studies. Moreover, research into the evaluation of the efficiency of environmental policy in Japan is decidedly limited. This is due to problems relating to the confirmation of the seriousness of pollution damage and its related compensation, and also to the loss of harmonious agreement between environmental protection and economic growth in relation to basic policy measures employed to tackle pollution. This situation has caused a growing trend of negative feeling towards the efficiency evaluation of environmental policy.

However, emphasizing the change in environmental policy towards that related to the risks associated with chronic long-term low release pollution, (which has come from the use of countermeasures to tackle urgent pollution problems), and in order to cope effectively with the various risks associated with the effective use of finite resources, the efficiency evaluation of environmental policy has become more important. From this viewpoint, our research group has undertaken an evaluation of the efficiency of Japan's policies to tackle atmospheric pollution (Kochi et al. 2000).

The second problem relates to the position in the decision-making process that discussion about the efficiency evaluation of environmental policy should hold. For example, Davies and Mazurek (1998) adopts five key evaluation criteria as follows and places efficiency at the second criterion:

1. Effectiveness – this being I) the evaluation of the level of achievement of objectives, and II) the appropriateness of these objectives.
2. Efficiency.
3. Social values – this includes consideration of whether environmental policy promotes popular participation, information dissemination and empowerment; whether environmental regulation infringes upon people's rights both public and private, and also in terms of privacy; and what influence environmental policy has on issues relating to fairness and justice.
4. Comparison with other countries – meaning the distinctive features and areas in need of improvement in one's own country's system can be made clear through comparisons with other countries.
5. Ability to meet future problems – not only the level of achievement in meeting current environmental objectives, but also the importance of the formation of capabilities to cope with future problems.

The third problem relates to issues which will become significant in future, and asks how the efficiency of environmental risk management should best be evaluated (Nakanishi 1995, Oka 1999, Kochi and Matsuoka 2000). One focus of environmental policy in terms of environmental risk management will be how to control the health risks caused by pollution from chemical substances with long-term, low release rates.

In relation to the implementation of this type of environmental risk management, there are two important points that relate to efficiency evaluation. The first point is which environmental risk is to be the object of control, and by how much is that risk to be reduced and the second is what level of priority is to be set for the various types of social risk management (such as labor safety regulations or product safety standards) and environmental risk management, as the object of public policy. The former relates to a comparison of the efficiency of risk reduction policies among various types of environmental risk. The latter relates to a comparison between the efficiencies of environmental risk reduction policies and those related to other risk reduction.

In relation to this point, a series of moves has been made recently in the United States: In 1981 during the Reagan administration, following Executive Order 12291, a cost-benefit analysis was carried out into social regulation policy; this was revised in 1993 during the Clinton administration, under E.O. 12866. The Republican Party leadership conventions of the 1990s saw moves made towards formalizing in legislation the use of risk and cost-benefit analyses in policy decision-making. In addition, efficiency evaluation in terms of cost-effectiveness analysis and cost-benefit analysis is in the process of being implemented for the risk management policies of the Environmental Protection Agency (EPA) and the Food and Drug Administration (FDA) (OMB 1996 and 2000).

Reflecting the trend of actual policy, various active research has been carried out recently into comparative risk analysis (Davies 1996, Viscusi 1996), the economic analysis of regulation (Hahn 1996, Morgenstern 1997), and estimations into the benefit evaluation of risk reduction – the Value of a Statistical Life (Fisher et al. 1989, Viscusi 1992 and 1993, Revesz 1999, Hammitt 2000), and so on.

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Figure 1: Static efficiency

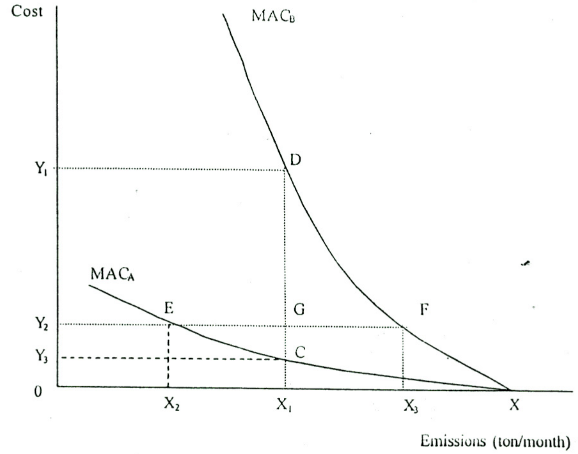

Figure 2: Dynamic efficiency

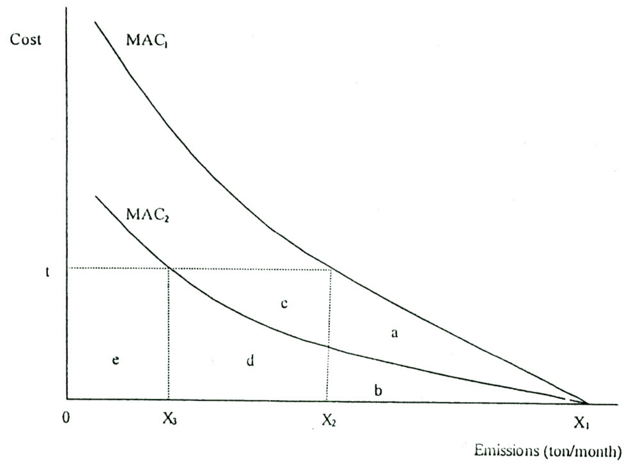

Figure 3: Dynamic efficiency and cost reduction rate