環境関連財政支出および企業の環境対策による
マクロ的経済効果に関する日中比較研究

課題番号１２４３０００８

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はじめに

新興工業国は、経済発展の初期段階から一般の公害対策に加えて地球規模での環境問題への対応が迫られている。この点で先進工業国が、当初主として局所的な環境問題（公害）への対応することで経済成長を成し遂げてきた発展過程と大きく異なる。先進工業国は経済成長を成し遂げた後に地球規模の環境問題への対応が迫られるようになったことで、先進工業国の側に、新興工業国が現在抱える環境・経済問題解決のための十分な理解があるとは言えない状況にある。経済成長とともに加速する新興工業国の環境問題解決のためには、先進工業国は、環境汚染の内部化に成功したプロセスにおける政府・企業の役割（対策）を明らかにし、新興工業国がとるべき環境対策の方向を示して行く必要がある。

現代の新興工業国（中国およびアジア NIES）は、国際市場における工業製品の飽和を考慮すれば、いっそう厳しい経済条件下で環境保護を進める必要にさらされている。この現実をふまえ、本研究は、新興工業国側の要請に基づき、環境政策がそのマクロ経済全般にもたらす効果を明確にすることを試みたもので、経済成長の維持と地球規模での環境保全を合わせた持続的経済成長のための政策立案に対し有効な情報提供を通して、新興工業国が自らの環境対策を進めていくため指針の提供を目指してきた。

この報告書は、大きく二つの部分からなっている。第一部の「**Economic Development : Environment Perspective**（経済発展：環境の視点）」は、主としてこの研究に携わった研究者の経済発展と環境保護にかかる研究成果をまとめたものである。ここでは、2000 年にこの科研プロジェクトの一環として開催した国際シンポジウム「**Environment and Our Sustainability in the 21st Century: Understanding and Cooperation between Developed and Developing Countries**」において報告いただいた中国国家環境保護総局司長（部長）の彭 近新氏およびシカゴ大学経済学部のジョージ トーリイ教授の論文をプロシーディングスから再録させて頂いた。

第二部の「**Economic Growth: Regional Perspective**（経済発展：地域の視点）」は 2000 年に寧夏大学と共催した『中国西部経済発展国際シンポジウム』において報告された論文のうち地域開発の視点から経済発展を分析した研究を収録している。地域開発の論文を同時に収録したのは、環境問題の解決にはその地域それぞれの政府と民間の地道な取り組みがわけても重要であると私が考えたことに他ならない。発展途上国の環境問題を解決に導く鍵が、地域の経済発展パターンの厳密に分析を通して得られる可能性が高い。

第二部にも、シカゴ大学経済学部のトーリイ教授が『中国西部経済発展国際シンポジウム』に出された論文を収めさせていただいた。この論文は、寧夏大学の呉教授や私が、シカゴ大学でトーリイ教授の主宰されている中国の西部開発に関する研究会のメンバーに加えて頂いていたことから、このシンポジウムのために書いてくださったものである。また、名古屋大学大学院法学研究科の加藤久和教授、同経済学研究科の塚田弘志教授は、この科

研のメンバーではなかったが、それぞれご専門のお立場から中国の環境問題と地域開発に資するためということで論文を用意してくださるとともに本報告書への掲載を快く了承してくださった。

本報告書の構成にかかる話に加えて、寧夏大学と『中国西部経済発展国際シンポジウム』を共催するに至った経緯、この科研プロジェクトがもたらした思わぬ波及効果およびこの報告書が英語で編集された理由について簡単に触れさせて頂きたい。

現在の中国の重点政策である「西部開発」と「環境保護」の研究を進めるべく寧夏大学西部発展研究センターが2001年10月に設立されたことから、寧夏大学副学長で同センター主任（当時　現寧夏省社会科学院院長）の呉 海鷹教授からの強い研究協力要請があった。この要請に対し、研究分担者の大分大学の薛 進軍教授と相談の上、この科研プロジェクトの最終報告会を寧夏大学の『中国西部経済発展国際シンポジウム』に併せて開催することにした。中国の環境問題への貢献姿勢を明確できかつ我々の研究成果を公開できる絶好の機会ととらえ、積極的な協力を行うこととなった。もともと我々の研究は、先にも述べたとおり、先進国の公害克服の経験を経済学的に明らかとすることで環境問題に直面している新興工業国の環境政策に寄与することを目的としたものであることから、寧夏大学においてこのような形で我々の研究成果を発表する機会が与えられたことは、誠にうれしいことであった。

この研究プロジェクトでは、2002年度に西安市、桂林市、南寧市、2003年度には寧夏省で、政府の環境政策と企業の対応に関する質問票調査を実施した。この調査では、国家環境保護総局の彭 近新司長および北京大学環境科学研究所の楽 胜基教授の研究協力をお願いし、楽先生の大学院生をそれぞれの環境保護局に派遣してもらい、その院生が現地での調査員の指導を行うという形で企業調査を進めることができた。３人の北京大学の院生が協力をしてくれた。寧夏大学でのシンポジウムに楽先生がこの３名の大学院生を伴っていらしたが、驚いたことにはこの院生たちが、集めたデータをもとに自分たちですでに企業の環境対策に関する分析を始めており、その成果をシンポジウムで報告してくれた。寧夏大学の呉先生も、寧夏省での質問票調査のデータをもとにこの報告書の第７章に収録した研究をまとめられていた。

私は、この瞬間まで、中国において、研究者自らがデータを採りそれをもとにして自らが環境政策と企業の対応に関する分析を行い自らが政策提言を行うようになるには今しばらくの時間がかかると考えていた。このゆえに、「公害先進国・環境先進国」の日本が主導する形で、中国の環境をテーマとする研究プロジェクトを進めた。ところが、研究成果の公刊においても、寧夏大学の呉教授に先を越されてしまうというううれしい誤算が生じた。我々の研究チームの報告を含む『中国西部経済発展国際シンポジウム』での報告論文は、中国語に翻訳され《中国西部経済発展理論と実証研究》として一足先に中国経済出版社から出版された。

出版の計画段階から、この科研プロジェクトに対して研究協力をしてくださった多くの方々、さらにはこの科研の研究分担者や研究協力者から、一連の研究成果を英語版として編集してほしいとの希望が出されていた。特に、中国の研究者に、この要望が強かった。この要請に応えるべく、また我々の研究のいっそうの国際化を図るという目的を兼ね、この報告書は英語で編集することとなった。本報告書が、表紙と前書きを除き、英語版となったのはこの事情による。

この文部科学省科学研究費補助金『環境関連財政支出および企業の環境対策によるマクロ的経済効果に関する日中比較研究』を終えるにあたり、このプロジェクトに対しさまざま形でご助力をくださった方々に対して、研究チームを代表しお礼を申し上げたい。わけても、名古屋大学名誉教授飯田経夫先生、中国国家環境保護総局司長彭　近新氏、シカゴ大学経済学部名誉教授ジョージ・トーリイ氏、韓国エネルギー経済研究所所長李 相駿氏、中国寧夏省社会科学院院長呉 海鷹氏からはなにものにも代え難い貴重なご助言と多くの支援を受けた。この方々のご理解なしにはこの研究プロジェクトはけっして成立しなかったといっても過言ではない。

最後に、名古屋大学経済学研究科事務局の効率的にしてかつ心のこもった研究サポートに対して感謝の意を表したい。事務長の鈴木宏治氏（ご退官）、同古田牧夫氏、庶務掛長の中山聖英氏、会計掛長の小林雪子氏（ご退官）、同林 光治氏、会計掛主任の伊藤 誠氏、会計掛事務官大場 亮氏、同小椋友明氏ほか大勢の方々の研究支援に対し感謝申し上げたい。

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Chapter 3

Environmental Policies and Their Effectiveness in China: Log-linear Analysis of Firms' Recognition and Response

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Kazuki TAKETOSHI[††]

1. Introduction

According to the survey concerning firms' recognition about the effectiveness environmental regulations conducted in 1995, firms clearly answered that direct measures which can reduce emission of pollutant is more effective than emission surcharges. This result can be a big clue to explain the mechanism of the observed Environmental Kuzunets Curve. Economic theory on environmental policies generally emphasizes the loss of economic efficiency resulted from the existence of economic externality, however, this classical approach to externality is not able to bring sufficient reasoning toward evolution of environmental protection.

This paper will be organized as follows. First section will introduce firms' recognition about the effectiveness of environmental measures taken by Chinese government based on the 1995 survey. Second section summarizes the result of loglinear analysis on policy effectiveness. Third section will investigate which policy was contributing for the improvement of environment. Simple economic reasoning will be given in the final section. The last section overviews Data Envelope Analysis measure for current environmental efficiency by regions and clarify production efficiency including environment for western regions compared with national averages.

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2. Summary of the 1995 Survey

1) The Overview of the Survey

Questionnaires were distributed completely through the local environmental protection bureaus. The numbers of questionnaires collected by the environmental bureaus are 110 (Qingdao), 85 (Weihai), 97(Hebei), and 34 (Tianjin) respectively, and total number of questionnaires collected is 326.

The major results of the survey are summarized as follows; 1) firms and the attributes of respondents, 2) firms and trade, 3) energy sources and environment, 4) recognitions on environmental problems and firms' response, 5) effectiveness of environmental policies, and 6) environmental policies and economic growth.

2) Firms and the Attributes of Respondents

Diagram 1 shows that the share of state owned enterprises (SOEs) reaches to 52%, followed by 21% (urban group enterprises) and 16% (township enterprises). The share of SOEs is the highest in Hebei and the lowest in Weihai. On the other hand, the share of local group enterprises is the highest in Weihai and the lowest in Hebei. According to industrial classification, 13% belongs to machinery and electric appliances, 12% to food processing, and 10% to spinning. The share of food processing is high in Qingdao, the share of spinning and food processing is high in Weihai, and the share of machinery and electric appliances is high in Hebei and Tianjin. The share of firms with 100-999 employees is 66% of total firms, and 1,000-4,999 is 32%. Especially in Hebei province, the share of firms with 1,000-4,999 is high due to the higher share of SOEs. About 44% of the firms were established during 1970-90. However, more than half of the firms were established before 1970 in Tianjin where manufacturing was developed in the early period.

The 1995 survey limited the respondents to the person who was responsible to firms' environmental administration, e.g., director, vice director, and manager of environmental administration. As for the positions of the respondents, 33% of the respondents are managers of environmental administration, and 23% are directors of the firms. 79% of the respondents are males. As far as the age distribution of the respondents, the share of the person whose age is 40- 49 years old reached to 40%, 30-39 years old are 27%, and 50-59 years old are 21 %. About 33 % of the respondents are the graduates of junior college, 23% are the graduates of professional school, and 17% are

the graduates of university.

3) Firms and Trade

The share of firms that have technical cooperation with foreign firms is 26%. The share is highest in Tianjin, followed by Qingdao, Weihai, and Hebei. The countries with which these firms cooperate are Japan in Tianjin (50%) and Qingdao (46%), Korea in Weihai (50%), and Hongkong in Hebei (54%). The share of the firms that have introduced joint venture with foreign firms is 23%. The share is the highest in Qingdao (35%) followed by Tianjin, Weihai, and Hebei. It is very common to have joint venture with firms in Hongkong, and the share has reached to 42%. Joint venture with Japanese firms is also popular in Tianjin.

The share of firms that are exporting their products to abroad is 41%. The share of firms exporting products to abroad is the highest in Tianjin, followed by Qingdao, Weihai, and Hebei. Firms located in Tianjin are exporting their products to Europe (47%), Japan (41%), and United States (35%).[2] Firms in Qingdao are exporting their products to Japan (43%), Hongkong (43%), and the United States (41%). Firms in Weihai are exporting their products to Korea (56%), Japan (42%), and Hongkong (39%). Firms in Hebei are exporting their products to Japan (61%), the United States (58%) and Europe (55%). There are no big differences in the distribution of the country to which firms in China are exporting their products.

As for the imports, 23% of firms are importing production materials from abroad. The share of firms that are importing the production materials is 32% in Tianjin, followed by Qingdao, Weihai, and Hebei. The share of firms importing the production materials from Japan is the highest (45%) in Tianjin, Qingdao and Hebei. An import of the production material from the United States is also ranked highestly in Hebei. The share of firms importing the production materials from Korea is the highest in Weihai.

The share of firms importing industrial parts is 19%. The share reached to 29 % in both Tianjin and Qingdao. 51% of the import of the industrial parts is occupied by Japan. Firms in Tianjin and Qingdao are especially depending their demand for the industrial parts on the import from Japan.

About 29% of the firms are importing production equipments from abroad. The share of firms importing the production equipments is 44% in Qingdao, followed by Tianjin, Weihai, and Hebei. 51% of firms in Qingdao and Weihai are importing the

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[2] Multiple answers were allowed for this question.

production equipment mainly from Japan.

The relationship between Chinese and foreign firms can be summarized as follows; 1) Firms in China are heavily involved in exporting their products to abroad; 2) Firms located in industrialized regions (e.g.,Tianjin and Qingdao) have stronger linkage with foreign firms; 3) Firms depend on Hongkong firms for finance, however, on Japanese firms for technologies, production materials, parts supply, and production equipments.

4) Energy Source and Environment

A large number of firms are using electricity as their energy source (66%).[3] On the other hand, 46% of the firms depend on coal. Coal is still one of major energy source even in the developed regions. Inland region depend more on coal for energy source compared with coastal region.

It is well known that Chinese government is going to abolish the subsidy on coal production to save the consumption of coal and to induce more efficient energy consumption. 8% of firms answered that this will not affect to their activities, 57% that this will affect to their activities to some extent, and 32% are afraid of being affected by this policy. This abolishment of coal subsidy is recognized to give some effect to firm activities. It is interesting to note that the response to this question did not vary from the region that depends heavily on coal for their energy source and other region. 85% of firms are preparing to take some actions to save energy costs when the subsidy is abolished. Even if the subsidy on coal production was abolished, the prices of alternative energy sources are still expensive compared with the price of coal. Therefore, it is not plausible to consider that major energy sources shifts from coal to the others due to the abolition of coal subsidy.

The firms which answered to save more energy when subsidy on coal is abolished, named "reduction of energy loss & efficient use of heat (55%)" as a mean of energy saving. Other popular answers are "use energy efficient equipments" and "recycling of heat."

As for desirable energy policies, 43 % of the firms named nuclear power plants and 28% thermal power plants. In Hebei, the share of firms that named thermal power plants exceeds slightly that named nuclear plants since Hebei province is geographically close to coal fields, and vice versa in other tree regions. It should be

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[3] This question was defined to get single answer. But we allowed multiple answers when we aggregate the results, since many firms answered electricity and coal at the same time.

noted that firms in China are affirmative to depend on nuclear power plants that are conceived as "clean" to their environment. At this moment, there are only two nuclear electric power plants in China. However, if China starts constructing more nuclear electric power plants in the near future, it might have domestic and international environmental problems related to nuclear power plants.

5) Recognitions on Environmental Problems and Firms' Responses

Recognitions on Global Environmental Issues

The share of the respondents who answered as "there are serious problems" or "there are some problems" for industrial wastes reached to 56 %. The share for air pollution is 49%, for noise & vibration is 46%, and water pollution is also 46%. On the other hand, the share of the respondents who answered as "there are no problems" or "there are almost no problems" is the highest for water pollution, followed by air pollution, noise & vibration and industrial wastes. As far as the regionality concerns, the share of the respondents who answered as "there are serious problems" or "there are some problems" for noise & vibration is the highest in Qingdao, followed by Tianjin, Hebei and Weihai. That for industrial wastes is the highest in Qingdao followed by Tianjin, Weihai and Hebei. That for water pollution is the highest in Qingdao, followed by Weihai, Tianjin and Hebei. That for air pollution is the highest in Qingdao, followed by Weihai, Tianjin and Hebei. Qingdao is occupying first place for all four environmental problems.

Activities for Environmental Protection

The largest numbers of firms are taking some measures for water pollution (68%), followed by air pollution (63%), noise & vibration (53%) and industrial wastes (48%) as is shown in Diagram 2. The share of the firms which are taking some measures for water pollution and air pollution is high in Tianjin followed by Qingdao, Hebei and Weihai, that for noise & vibration and industrial wastes is high in Qingdao followed by Tianjin, Weihai and Hebei.

By comparing the recognitions on environmental problems in each region and the share of firms taking some environmental measures for the environmental problems, we can see the following two points; First, the share of firms which are taking some measures for environmental protection in the regions (Qingdao and Tianjin) where the recognition on their environmental problems is higher than other regions (Weihai and Hebei). Second, the share of firms which are taking some measures for water pollution and air

pollution are higher than for noise & vibration and industrial waste, however, the share of respondents who answered as "there are no problems" or "there are almost no problems" for these environmental problems is higher in some regions. On the contrary, the share of the respondents who answered as "there are serious problems" or "there are some problems" for the problems of industrial wastes is higher but the share of the firms which are taking some measures for industrial wastes is lower.

The above-mentioned puzzle can be explained by the facts that it is relatively easier to facilitate some equipments to reduce water and air pollution so that many respondents answered as "there are no problems" or "there are almost no problems" for these environmental problems. However, firms and local governments can do almost nothing for the problems of industrial wastes that have been increasingly accumulated as the economy grows. This explanation can be supported by the fact that the share of firms which are going to take some measures to the problem of water pollution is the highest, and followed by air pollution, noise &vibration and industrial wastes.

6) Effectiveness of Environmental Policies

The Requirement for three-synchronization

As is indicated by Diagram3, The share of the firms which have been applied the requirement of three-synchronization for air pollution is 51%, the highest, followed by for water pollution (49%), for noise & vibration (40%), and industrial wastes (29%). The share of the firms that have been applied the requirement of three synchronization for air and water pollution is the highest in Tianjin and followed by Qingdao, Weihai, and Hebei.

Firms are considering that the requirement of for three-synchronization is the most effective for water pollution. 77% of the firms replied that the requirement of three-synchronization is effective for water pollution, followed by for air pollution, noise & vibration, and industrial wastes. Even 61 % of the firms are considering that the requirement of three-synchronization is effective for industrial wastes. It is interesting to know that this figure is much higher than the share of the firms that were actually applied by the requirement of three-synchronization. The share of firms that consider the requirement of three-synchronization is higher in Tianjin and Qingdao compared with other two regions, but regional variations are not so large as the regional variation for the share of firms that actually applied by the requirement of three-synchronization.

It is also interesting to recognize that 52% of the firms answered, "There are no

problems for the requirement of three-synchronization." According to Diagram 4, 22% of the firms pointed out the high cost of attaining the requirement, and 20% emphasized their insufficient level to attain the requirement of three-synchronization. We also observed regional variations; the share of firms which pointed out high cost to attain the requirement exceeded the share of firm which emphasized insufficient level of technology as a problem of the requirement for three-synchronization in Tianjin and Qingdao, on the other hand, the share of firms which emphasized the insufficient level of technology exceeded the share of firms which pointed out high cost in Hebei. This regional variation reveals that there are the differences in technology level in each region.

Emission charge

The share of firms that have paid "emission charge." 72% of the firms have paid "emission charge (charge for quantity)" for water pollution. 49% of the firms have paid "emission charge" for air pollution, 38 % have paid "emission charge for above standard" for water pollution, 26% for noise & vibration, and 17% for industrial wastes. Since "emission charge (charge for quantity)" is imposed on the quantity regardless of the density of hazardous materials, it is conceivable that the share of firms that have paid the charge is high. The share of firms that have paid "emission charge (charge for quantity)" is higher in Qingdao and Weihai, but that is lower in Tianjin. The share of firms that have paid emission charge for noise & vibration and industrial wastes is also high in Weihai.

66% of the firms are considering that "emission charge (charge for quantity)" is effective for environmental protection, 58% of the firms are considering that "emission charge (charge for quantity) for air pollution is effective, 52% are considering that "emission charge for above standard" for water pollution is effective, 46% are considering that "emission charge" for noise & vibration is effective, and 45 % are considering that "emission charge" for industrial wastes is effective. It should be noted that this order is corresponding to the order of the share that has paid "emission charge" in each category. The share of firms that are considering that " emission charge is an effective measure for environmental protection is high in Qingdao and Tianjin. Furthermore, the share of firms that are considering that "emission charge" is effective exceeds the share of the firms that have actually paid the charge.

As for the problems concerns, 38% of the firms answered that "there are no problems" in "emission charge for above standard" for water pollution, and 48% also answered that "no problems" in "emission charge (charge for quantity)" for air pollution

as is shown in Diagram 6. Diagram 7 shows that 22% of the firms considered that "charge fee is too much" in "emission charge for above standard" for water pollution, and 17% responded similarly in "emission charge (charge for quantity)" for air pollution. 10% considered that "standard is too strict" in "emission charge for above standard" for water pollution, and 9% responded similarly in "emission charge (charge for quantity)" for air pollution.

Subsidy for Environmental Protection

The share of firms that have received subsidies for water pollution is 34%, followed 27% for air pollution, 13% for noise & vibration, and 8% for industrial wastes. The share of firms that have received subsidies for water and air pollution is the highest in Qingdao, followed by Hebei, Tianjin, and Weihai. Namely, half of the firms in Qingdao have received subsidies for water pollution. The share of the firms that have received subsidies for noise & vibration is also the highest in Qingdao, on the other hand, that for industrial wastes is the highest in Hebei.

71% of firms considered that subsidies for water pollution are effective. Similarly, 64% considered that subsidies for air pollution are effective, 56% for noise & vibration and 54% for industrial wastes. It should be noted that the share of firms which answered that subsidy is effective exceeds the share of firms which have actually received subsidies in order to promote environmental protection in their firms. It is also interesting to know that there is only small variation in the share of firms that consider that subsidy is effective among regions or among categories of environmental problems.

Loans from Government

The share of firms that receive loans from government is 17% for water pollution, 16% for air pollution, 6% for noise & vibration, and 5% for industrial wastes. The emission charges collected by the local environmental bureaus were returned to the firms that applied for it. Recently, this rule was revised and market mechanism came to be introduced. Collected emission charge is going to be redeemed to finance the need for environmental protection when firms applied for it. It has turned out that the share of firms that have received this redemption of payment is still remaining small at this moment.

The share of firms that have used loans for water and air pollution from government is highest in Qingdao, followed by Tianjin, Hebei, and Weihai. The share of firms that received subsidy for environmental protection is roughly equal to that of firms that have received loans for the purpose in Tianjin. On the other hand, the shares

of firms that have received subsidies are higher than that used loans in Hebei. This difference might indicate that there is some regional difference in the shift from government subsidy to loans to finance for environmental protection.

The share of firms that considers that government loan is effective to promote environmental protection is 58% for water pollution, 54% for air pollution, 47% for noise & vibration, and 45% for industrial wastes. Although these figures are lower compared with the share of firms that responded that subsidy is effective to promote environmental protection, these figures are much higher than the share of firms that have actually utilized government loans for their environmental protection. Furthermore, the share of firms which consider that government loans is effective for environmental protection is high in all regions, so that, this policy is widely expected to work by firms.

Technological Transfer

The share of firms that have received some transfers of environmental technology remained 2- 3%. In Tianjin, the figure is 12% for technologies to reduce water pollution and 9% for technologies to reduce air pollution. On the other hand, the share of firms that consider that transfers of technology are effective is 39% (highest figure) for water pollution and 34% (lowest figure) for industrial wastes. These high figures indicate that firms are expecting that transfers of technology can reduce their environmental problems rather effectively.

Different form other policies, there is large region variation in the share of firms which consider that transfers of environmental technology is effective measures. More than 50% of firms are considering that transfers of technology is effective, but only 20% in Hebei. Since many firms have been exchanging technologies (including environmental technologies) with foreign companies in Tianjin compared with in Hebei, so that the recognition on transfers of technology might be more common in Tianjin than in Hebei.

Most Effective Environmental Policy

What is the most deniable policy for firms to promote 1) energy saving, 2) reduction of water pollution, 3) reduction of air pollution, or 4) recycling of industrial wastes?

First, 25% of firms consider that "subsidy and loans for facilitating energy effective equipment and R&D for energy saving technologies" are the most desirable policy to promote energy saving. 10% of firms named "rationing of energy consumption

(emission rights) ", also 10% consider that "education for energy saving" is an effective policy. In Tianjin, firms are emphasizing "financial assistance and technology transfer from abroad." Second, 34% of firms consider that "the requirement for three-synchronization" is the most effective policy to reduce water pollution. 12% of firms named "subsidy and loans for equipment and R&D for technologies to reduce water pollution." Third, 37% of firms replied that "the requirement for three-synchronization" is the most effective policy to reduce air pollution, and 11% named "emission charge." Finally, 25% of firms answered that "the requirement for three-synchronization" is the most effective policy in order to promote recycling of industrial wastes, and 14% named "subsidy for recycling industrial wastes."

It is also noticeable that the share of firms that emphasized "subsidy for recycling industrial wastes" is high in Qingdao, where the disposal of industrial wastes has been a serious problem for a long time.

Summary for Effective Environmental Policies

Many firms are considering that "the requirement for three -synchronization" is the most effective policy measure to improve environmental situation in China. On the contrary, "emission charge," one of the major active environmental policies in China, is not considered as effective. Instead of "emission charge," subsidy and loans to facilitate environmental improvement and transfers of environmental technology are accepted as effective.

"Emission charge" has a long history and a well-organized measure to promote environmental protection, and serves as one of major environmental policies in China. However, this policy is not considered as effective to reduce environmental problems in the standpoint of firms.

7) Environmental Policies and Economic Growth

Firms in China do prefer stronger environmental policies since they believe that strict environmental policies can contribute to accelerate China's economic growth in the future. 54%of the respondents consider that "China should have more restrictive environmental policies," 38% considers current situation is satisfactory, and only 2% are insisting, "China should have less restrictive environmental policies." It is not easy to distinguish whether these answers are the firms' or the respondents.' Therefore we interpret this result as people in China consider that environmental restrictions are not sufficient enough at this moment. Namely, in Hebei province where the environmental control is slightly less restrictive, the share of people who prefer more restrictive

environmental control is larger compared with other regions.

Furthermore, 76% of respondents answered that "China should avoid economic growth at an expense of environment." 12% are admitting some sacrifice environment in order to attain rapid economic growth. Only 1% of respondents are insisting to have rapid economic growth at an expense of environment.

As for the effect of introducing more strict environmental regulations, 74% of respondents answered that introducing more strict environment policies can accelerate the economic growth in the future. On the other hand, only 5% considers that strict environmental policy reduces the economic growth. Many respondents consider that more strict environmental policy can bring economic benefits to China in the future.

79% of respondents answered that more strict environmental policies can strengthen international competitiveness in the future. Only 6% considered that introducing more strict environmental policies would reduce the future international competitiveness. It is not easy to interpret this results, however, ISO standard and other environmental requirement imposed by foreign countries might have induced firms in China to recognize the importance of promoting more strict environmental standard.

3. Three-synchronization vs. Emission charge

This section analyzes firms' awareness concerning the three-synchronization and emission charge by means of log-linear analysis. Three dimensional cross analysis can control regional differences and could specify characteristics that make concerning the three-synchronization and emission charge effective respectively.

1) Firms' characteristics that make the three-synchronization effective

The first two columns of Tables 1 indicate characteristics that make the three-synchronization for water and air emission effective respectively. SOEs and urban group enterprises tend to consider the three-synchronization effective compared with TVEs or private enterprises. Firms that have implemented or are planning to have environmental protection measures for any of noise & vibration, industrial wastes, water, or air emission tend to consider the three-synchronization effective. Similarly, firms that have the section for environmental protection tend to consider the three-synchronization effective. Not surprisingly, the firms that have implemented the three-synchronization tend to judge the three-synchronization effective compared with the firms that the requirement has not been applied for.

2) Firms' characteristics that make emission charge effective

The last three columns of Tables 1 show the characteristics that make emission charge effective. Contrary to the characteristics that make the three-synchronization effective, firm types have nothing to do with the judgment on the effectiveness. Firms planning to implement measures for environmental protection tend to consider emission charge effective, but firms that had already implemented measures for environmental protection hardly consider emission charge as an effective protection measure. Surprisingly, the firms that have implemented measures for industrial wastes are denying the effectiveness of the emission charge. Furthermore, whether firms consider that emission charge is an effective measure for environmental protection or not does not show any significant effect to the evaluation for the effectiveness of emission charge on industrial wastes.

3) The three-synchronization and emission charge

Firms' recognition of the effectiveness of the three-synchronization is clearly different from that of emission charge. The firms that had implemented the three-synchronization approved the effectiveness of the requirement affirmatively. On the other hand, the firms that had paid emission charge did not approve the effectiveness of the charge. The emission charge system has been playing a major part of Chinese environmental policies. Environmental Protection Agency regulates very details of the emission charge including the redeem plan when firms implement pollution suppressing equipment. Regardless of this status of emission charge in China, firms have not given affirmative judgment to this.

There are some reasons why emission charge is not considered as an effective policy measure for environmental protection. First, the charge itself has not been high enough to suppress pollution. Economic burden of emission charge have been mitigated due to the inflation along the economic growth. Second, emission charge could have been treated as a part of cost for firms. Third, firms considered emission charge payment as the deposit that could be redeemed to innovate their equipment for environmental protection due to the redeem plan involved in emission charge scheme. Fourth, firms operating less than their full capacity are in increasing return situation can be benefited by increasing their output while paying emission charge because they can lower the average cost by increasing their production at a cost of far small discharge payment.

4. Production Efficiency Including Environment for Western Regions

The purpose of this section is to measure the change of production efficiency including emission of pollutant by means of Data Envelope Analysis (DEA). Data consist of regional averages of firm's output, wastewater, SO2 as LHS variables, and capital and labor as RHS variables between 1992 and 1999.

Diagram 8 reports efficiency loss by east, central and west regions, where efficiency loss was calculated under two difference assumptions, weak and strong disposability. Needless to say, strong disposability means that inputs and outputs can be increased or decreased without cost of regulation and weak disposability assumes input and output adjustment under cost constraints due to environmental regulations. Due to the limitation of DEA, we cannot get absolute estimate of efficiency loss. We could observe only relative position of each province from the provinces that had attained the most efficient production.

Average efficiency loss for east region is very close to that of national average. Central region have been achieving highest efficiency loss. Efficiency loss for west region has been worst throughout the whole period. Ningxia's position is showing the lowest efficiency loss. This is a little bit tricky to understand, however this could be happen due to the low GDP level produced in Ningxia[4]. We can conclude rather safely that production efficiency including emission of pollutant in Ningxia can remain unity simply because the limited number of polluting firms in its border. It is most striking to know that efficiency loss of the western region will be worsen further by another 0.1. The DEA might have revealed possibility that environment in Ningxia would be worsen along her economic development. This conjecture is based on the fact that efficiency of production of other west region is still remained low compared with other regions. Therefore, this finding is sending serious signal to the direction of future regional development and environmental policies especially for Ningxia.

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[4] Wu, Arayama and Miyoshi (2002) is showing that capital accumulation in Ningxia is behind to east and central regions and that correlation between capital accumulation TFP is lower compared with other provinces. Namely, capital accumulation did not necessarily induce technological transfer as was observed in other provinces.

References

Arayama, Yuko, Zenpei Gen and Kazuki Taketoshi, *Environmental Issues in Open Economies: Environmetal Policies and Firms' Response in China*, Graduate School of International Development Report Vol 11, 1997, Nagoya University (in Japanese and Chinese)

Coelli, Tim and D.S. Prasada Rao, An Introduction to Efficiency and Productivity Analysis, Kluwer Academic Publishers, 1998.

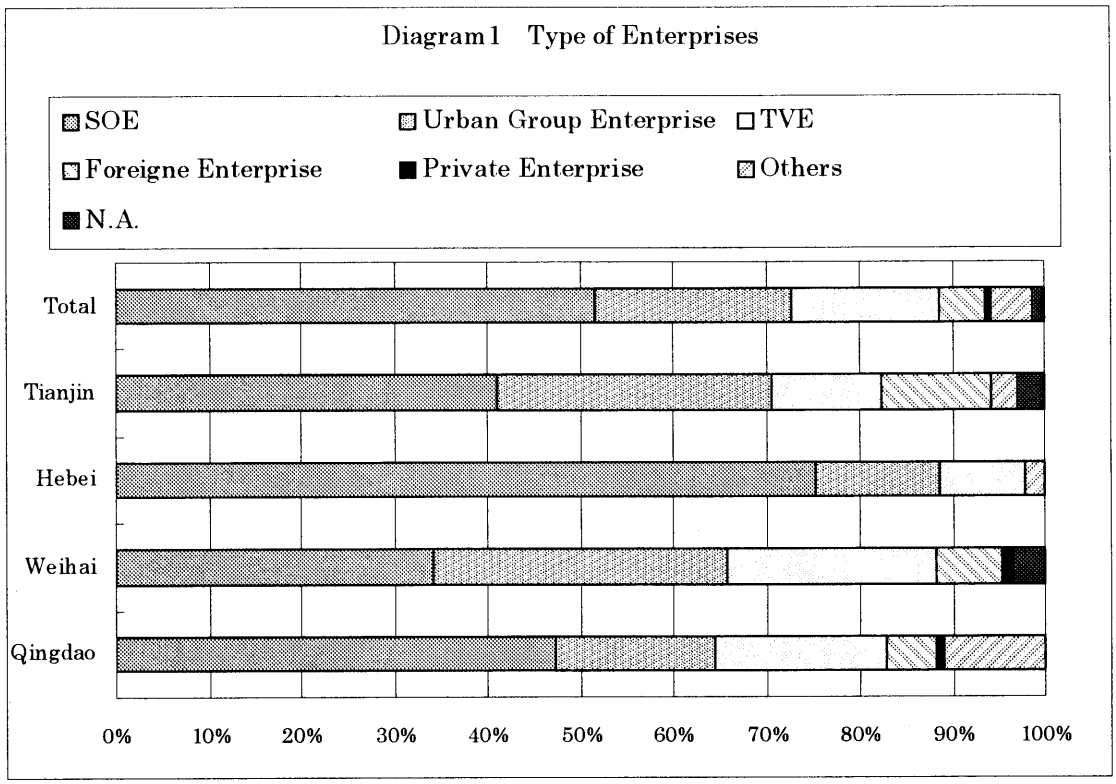
Baumol, W.J. and W.E. Oates, The Theory of Environmental Policy, Cambridge University Press 1988.

Wu, H., Y. Arayama and K. Miyoshi (2002), " Can Ningxia Catch Up to East Regions?: Capital Accumulation, Technical Progress, Labor Migration and Regional Economic Growth in Ningxia and China." Proceedings in International Symposium on Economic Development in Western China, Ningxia University, 2002.

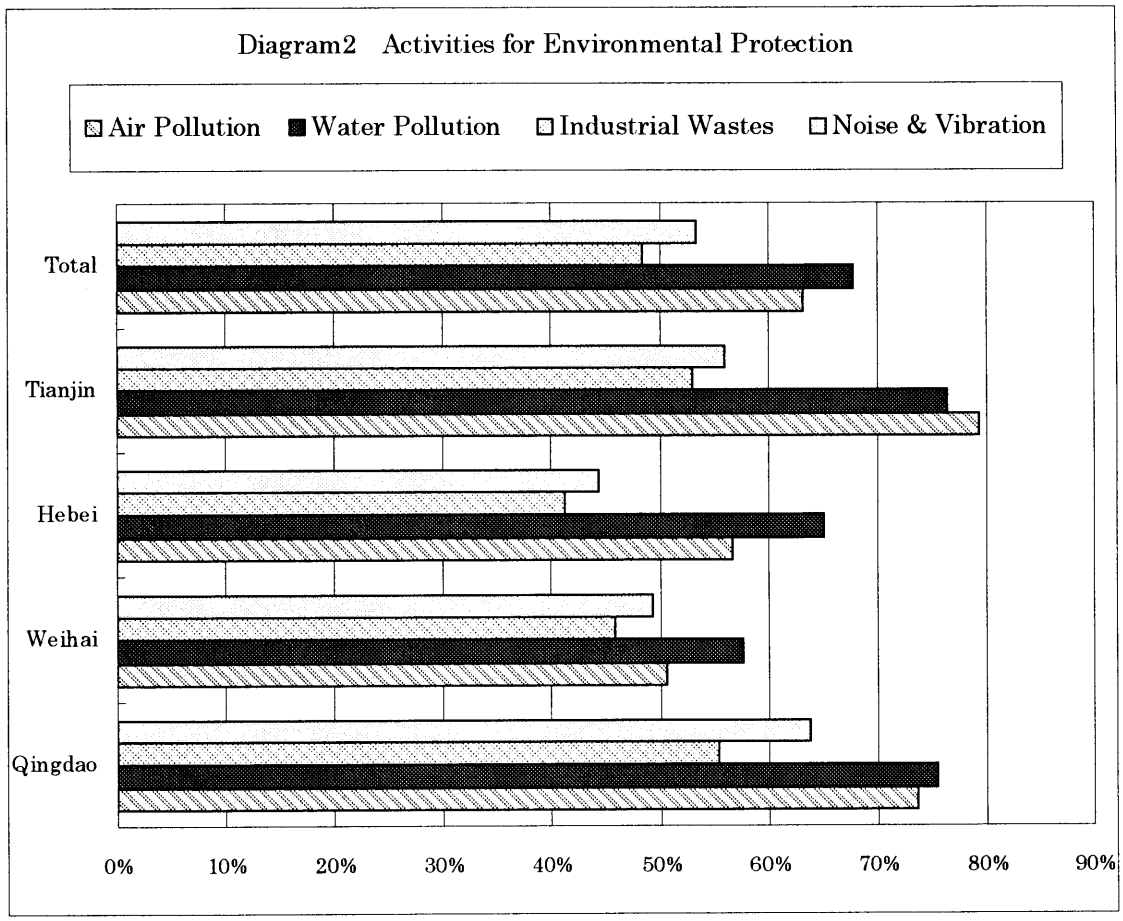
Xia, Guang *An Economic Estimation for Environmental Pollution Losses in China*, China Environmental Science Press, 1988

Statistics

China Statistical Year Book
Statistical Year Book (each province in China)
China Environment Year Book



Source: Arayama et. al. 1997.



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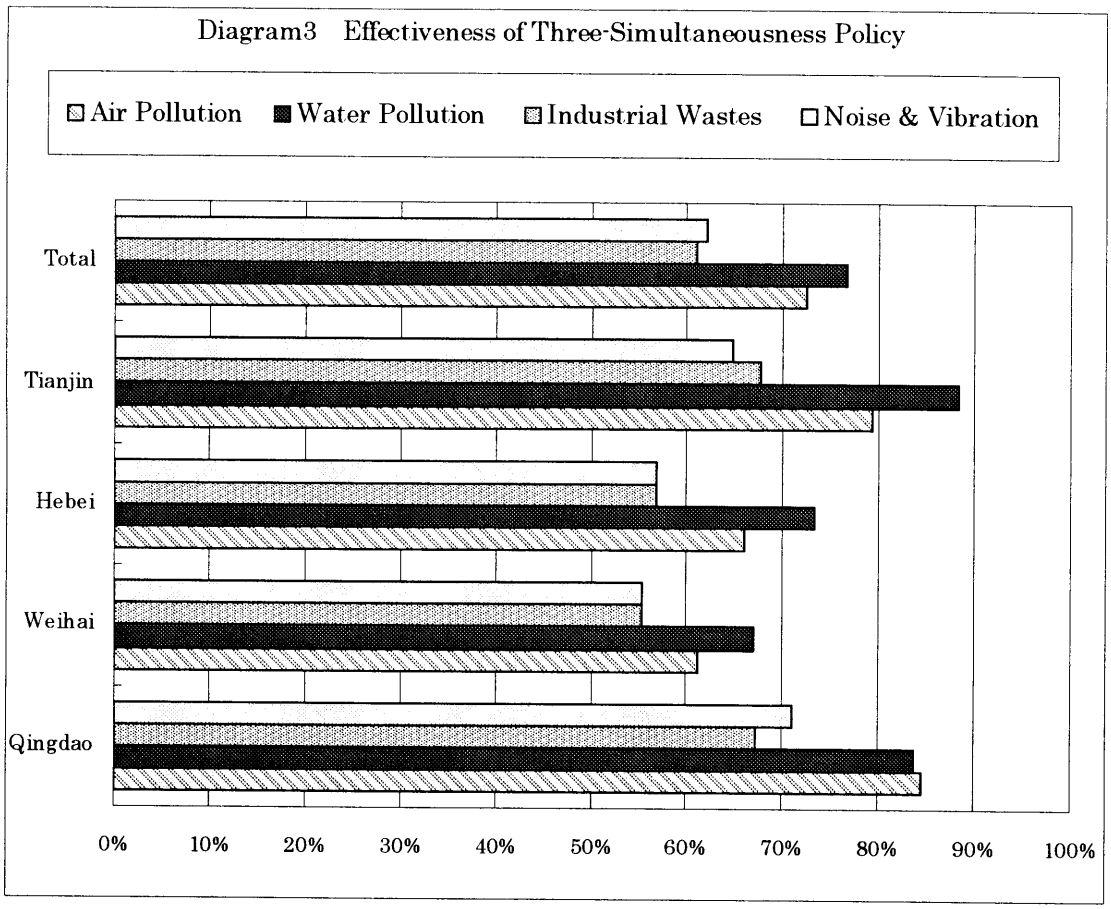

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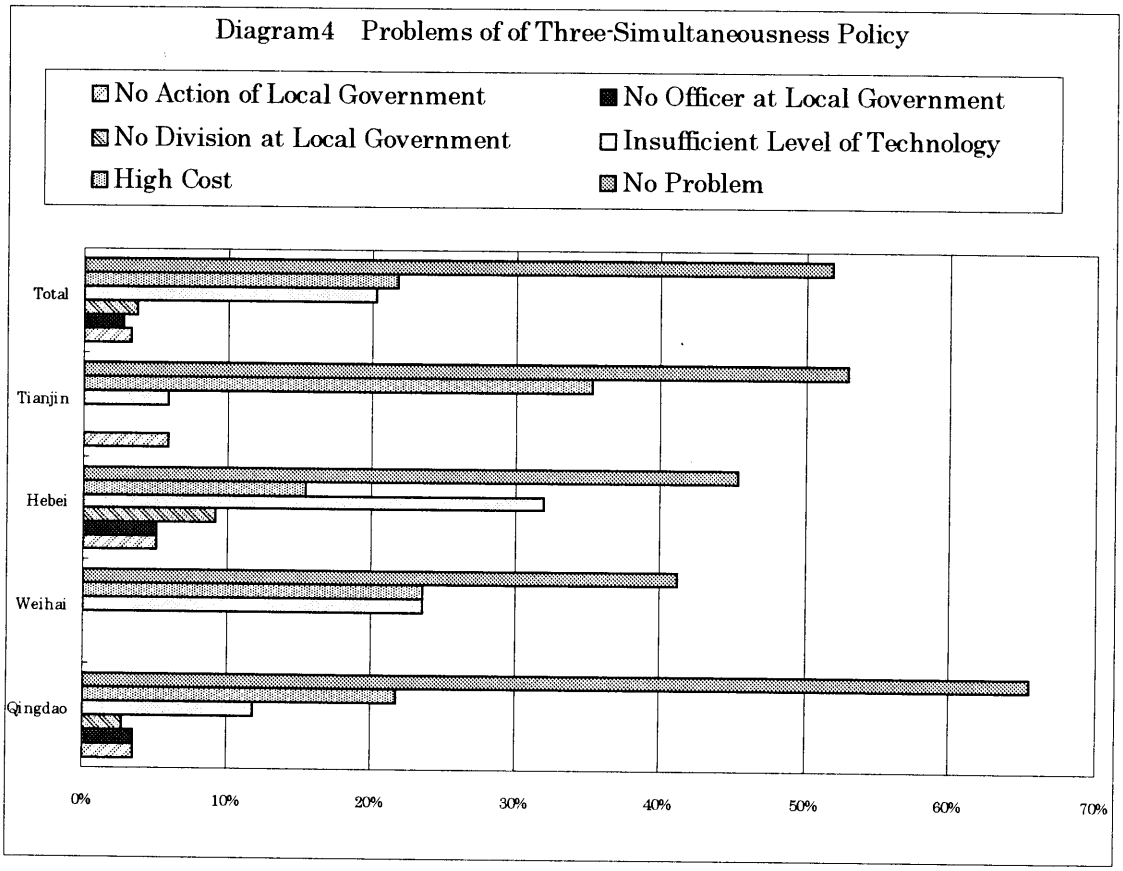

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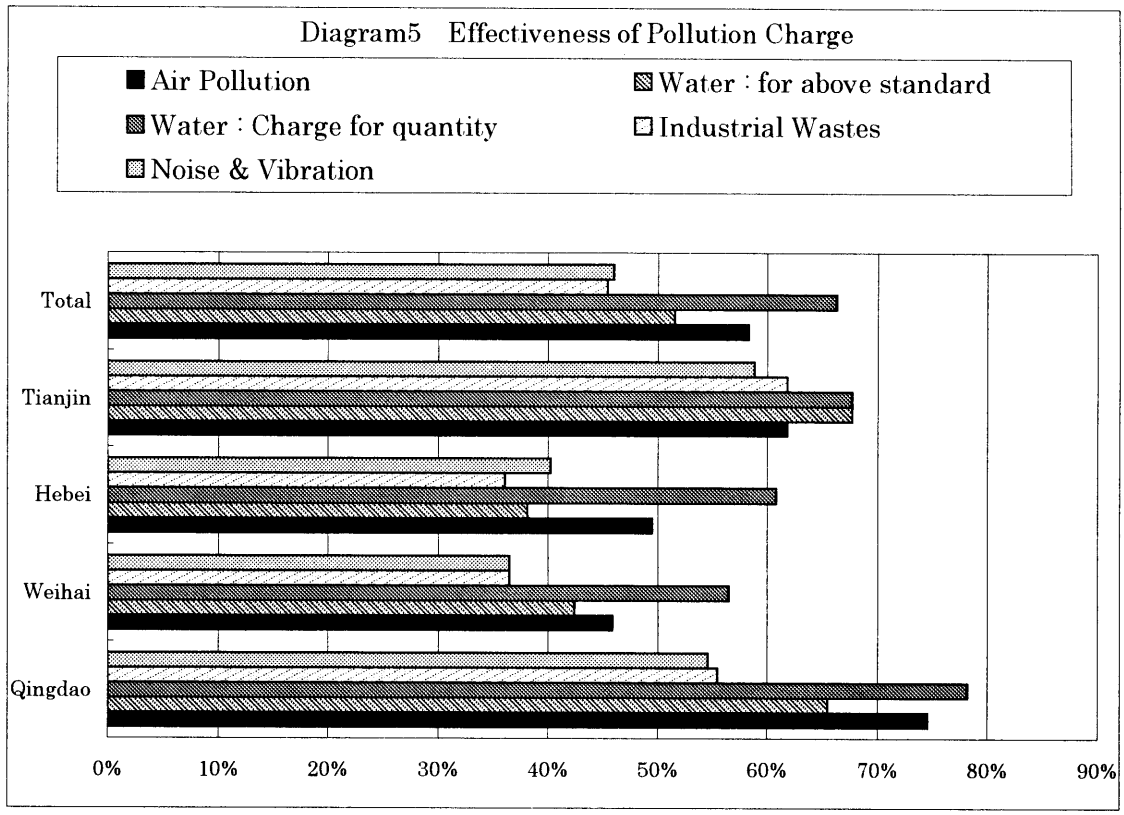

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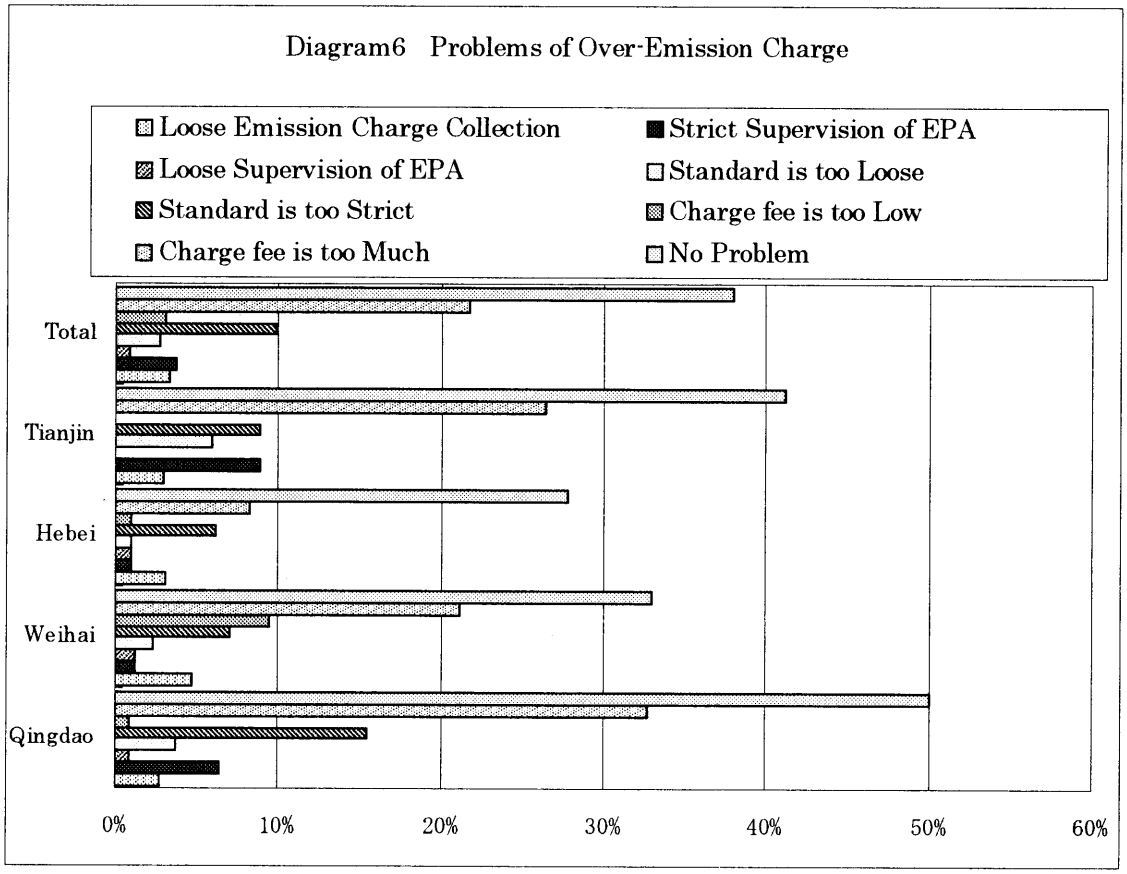
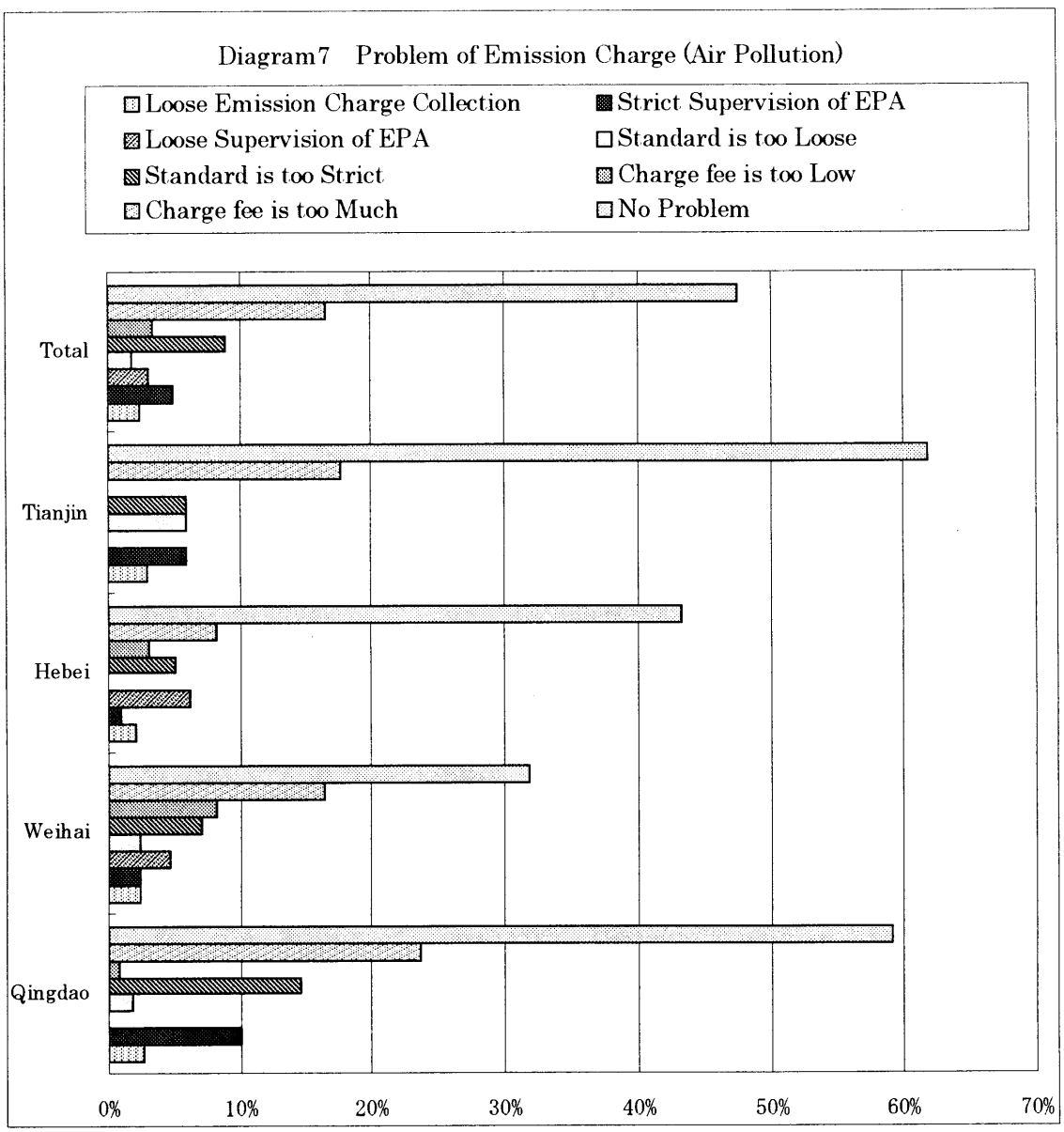


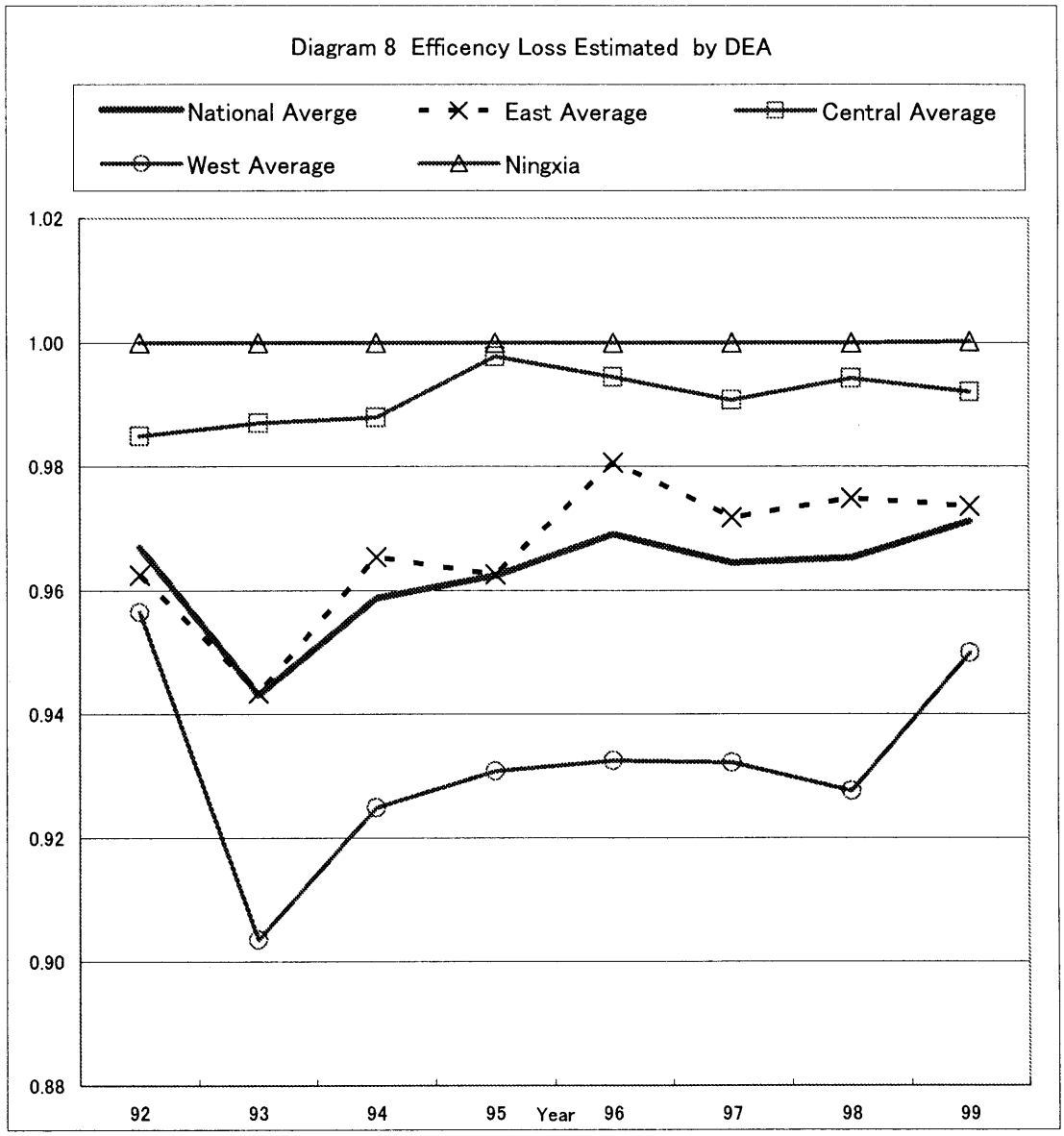
Source: Arayama et. al. 1997.

Diagram7 Problem of Emission Charge (Air Pollution)



Source: Arayama et. al. 1997.

Data Source: Estimated based on data from Chinese Environmental Year Book



	National Averge	East Average	Central Average	West Average	Ningxia
92	0.967	0.963	0.985	0.957	1.000
93	0.943	0.943	0.987	0.904	1.000
94	0.959	0.965	0.988	0.925	1.000
95	0.962	0.963	0.998	0.931	1.000
96	0.969	0.981	0.994	0.933	1.000
97	0.964	0.972	0.991	0.932	1.000
98	0.965	0.975	0.994	0.928	1.000
99	0.971	0.974	0.992	0.950	1.000

Table 1 Policies and Response of Firms (Loglinear Analysis)

		Three-synchronization				Emission Charge					
		Water		Air Emission		Industrial Wastes		Over-Standard Water		Air Emission	
		Effec-Tive	Not Eff.	Effec-tive	Not Eff.	Effec-tive	Not Eff.	Effec-tive	Not Eff.	Effec-tive	Not Eff.
Firm Type	SOEs	++	−−	++	−−						
	Urban Group Enterprises	++		++							
	TVEs										
	Foreign Enterprises										
	Private Enterprises										
	Others										
Strategy on the Rise of Coal's price	Saved Energy							++		++	
Environmental Protection Measures	Implemented: noise&vibration	++	−	++		+					
	Implemented: wastes	++					++				
	Implemented: water	++		++							
	Implemented: air emission	++		++						++	
	Planning: noise &vibration	++		++		++				++	
	Planning: wastes	++		++	−−	++		++		+	
	Planning: water	++		++		++		++			
	Planning: air emission	++		++		++		++		++	
Section for Environmental Control	Established	++		++				++			
	Not established & not planned	−−		−−		−−		−−			
The Requirement for Three-synchronization	Received: noise & vibration			++	−−						
	Received: wastes	++		++							
	Received: air emission	++		++	−						
Discharge Fee	Paid: water	++									
Redeem of Discharge Fee	Received: air emission			++		++			−−		
Technological Transfer for Environmental Protection Strategy from Overseas	Received: noise & vibration	−−		−−	++			−−		−−	
	Received: wastes	−−		−−		−−		−−		−−	
	Received: water	−−		−−				−−		−−	
	Received: air emission	−−		−−		−−		−−		−−	
Desirable Direction of China's Environmental Policies	Should give priority to economic growth	−−		−−						−	
	Should avoid to give priority to economic growth	++	−−	++	−−					++	
	Have to sacrifice some Environment for Economic growth									++	−
Environmental Policies' Influence on Current Chinese Economic Growth	Accelerate current Economic development					+					
Environmental Policies' Influence on Future Chinese Economic Growth	Decelerate future economic development			−						−	
	Accelerate future economic development			++						++	
Environmental Policies' Influence on Future Chinese International Competitiveness	Weaken future international competitiveness of Chinese firms	−		−		−−				−	
	Enhance future international competitiveness of Chinese firms	++	−−	++	−	++				++	

Note: " Eff." Indicates "effective"; "N & V" indicates noise & vibration.
"++" indicates positive and significant at 5% and "+" positive and significant at 10%. "−−" indicates negative and significant at 5% and "−" negative at 10%.

Source: Source: Arayama et. al. 1997.