

Abstract of Doctoral Thesis:

“An Economic Analysis of Environmental Regulations”.

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The Organization of The Thesis.

The purpose of this thesis is to provide some economic analyses on environmental regulations.

The thesis is organized in the following way.

Chap. 1: Economics Analyses of Environmental Problems: An Overview.

Chap. 2: The Analysis of Differentiated Emission Tax.

Chap. 3: Economic Growth and Carbon Emissions.

Chap. 4: The Double Dividend from Carbon Regulation
in Japan.

Chap. 5: Concluding Remarks.

In Chapter 1, I describe environmental problems in general and present a brief overview of previous economic studies on environmental problems. Chapter 2 to Chapter 4 provide my own researches. In Chapter 2, I conduct a theoretical analysis on the effects of differentiated emission taxes. In Chapter 3, I conduct an empirical analysis of the relationship between economic growth and carbon dioxide emissions. In Chapter 4, I empirically examine the so-called double dividend hypothesis in the context of Japanese carbon regulations. In the last chapter, concluding remarks are provided.

Chapter 1: Economics Analyses of Environmental Problems: An Overview.

The environmental problems that have been emerging rapidly all over the world since the middle of the 20th century are widely believed to constitute major problems to be faced in the

21st century. These problems include global environmental problems such as global climate change and ozone layer depletion; pollution; waste problems; deforestation; desertification; depletion of exhaustible resources; destruction of ecosystems; and loss of biodiversity. This brief list illustrates the diversity of environmental problems in the world. Many scientists point out that these environmental problems, especially global climate change, are likely to have substantial adverse effects on both human and ecological systems

Faced with these risks of environmental destruction, most governments and international organizations have recognized that environmental problems are among the main issues to be addressed in the 21st century. In the field of economics, these environmental problems have also been recognized as major economic problems, and a number of studies (both theoretical and empirical) have analyzed the possible effects of these environmental problems on human society and have attempted to provide effective solutions to them.

Chapter 1 presents the previous economic studies on environmental problems. There I focus on the following four issues which are closely related to the research of this thesis: (i) economic analyses on environmental emissions, (ii) economic analyses on global climate change, (iii) the environmental Kuznets curve argument, and (iv) the double dividend hypothesis.

Chapter 2: The Analysis of Differentiated Emission Taxes.

Background Chapter 2 presents one of my own researches. Regulation of emissions such as pollutants and greenhouse gases (GHGs) is becoming a major issue in environmental regulation disputes. As a policy instrument for regulating emissions, emission taxes have attracted much attention and have been introduced in many countries. For example, Scandinavian countries and Germany have introduced carbon taxes in 90's. One characteristic of such emission taxes is that they are often differentiated across industries. That is, some industries are allowed lower taxes than other industries or some industries are exempted

from taxes. However, most of previous theoretical analyses have typically considered uniform emission regulations and differentiated emission taxes have not been investigated adequately. To fill this gap, I have conducted a theoretical analysis on the effects of such differentiated emission taxes.

Model As a model, I adopt the standard 2×2 Heckscher–Ohlin–Samuelson model, and as in the literature, incorporate emissions as a third production factor. Since I assume that goods prices are constant, my model represents a small open economy or the production side of an economy. Under this setting, I examine the effects of differentiated emission taxes on good outputs and emissions. By the term “differentiated emission tax”, I mean a policy that changes the level of emission taxes for one industry.

Main Results My findings are summarized as follows. First, increasing the emission taxes imposed on an industry may increase the output of that industry. Second, while strengthening emission taxes uniformly across industries always reduces emissions, strengthening emission taxes unevenly may increase them. The first result is counterintuitive because higher emission taxes should have a cost-push effect and thus lead to downward pressure on the output of that industry. I showed that the reason for this paradoxical result is that emission tax has not only the cost-push effect but also the substitution effect which affects factor markets.

The second result is analogous to so-called ‘carbon leakage’. Carbon leakage relates to the situation in which, when some countries unilaterally reinforce emission regulations, the activities generating emissions shift to unregulated or less regulated countries through, for example, changes in production patterns, the relocation of firms, or a fall in the prices of emission-generating products. Consequently, the effectiveness of the regulations is weakened or even completely eliminated. My second result means that phenomena such as interna-

tional carbon leakage may occur among industries within a single country.

As a policy instrument for regulating emissions, emission taxes have attracted much attention and have been introduced in many countries. However, my analysis indicates that according to the way in which emission taxes are introduced, they may have unintended and detrimental effects on an economy.

Chapter 3: Economic Growth and Carbon Emissions.

Background In Chapter 3, I empirically investigate the relationship between economic growth and carbon dioxide emissions. As has been mentioned above, global climate change is considered to be one of the most serious environmental problems for the near future. To assess the future trend of global climate change, we need to project the future trend of GHG emissions because they are a major cause of global climate change. These GHG emissions are closely related to human economic activity because their rapid growth in recent decades is almost completely attributable to the increase in GHG emissions from fossil-fuel combustion and changes in land use. This means that to project future GHG emissions, it is necessary to project the future trend of economic activity.

Many papers have already studied the relationship between economic growth and GHG emissions. Most studies project that world GHG emissions will increase rapidly in the near future, mainly because of higher economic growth in the developing countries. This projection assumes that there is no policy intervention. However, the well-known environmental Kuznets curve (EKC) arguments suggest that the strength of environmental regulations are often closely related to income levels and that a country with higher income tends to impose more stringent environmental regulations. This argument provides an important perspective for designing policies for environmental protection because it suggests that policies that improve the environment in the short run may be detrimental in the long run. In other words, the desirable policy is not to restrain economic growth but to maximize it and

then introduce environmental regulations when popular concern for environmental quality is sufficiently high. In Chapter 3, I take account of this view and investigate the effects of economic growth on the amount of carbon emissions.

Approach My approach has the following two features. First, although the ordinary studies on the environmental Kuznets curve use econometric approach, I employ a simulation method based on a CGE analysis. The model is a multi-sector, multi-region static model based on GTAP-EG which allows for six Annex I regions and seven non-Annex I regions, and eight goods including five different energy goods. This approach enables evaluation of the details of the changes accompanied with economic growth, for example, changes in energy compositions and energy intensity. This advantage is noteworthy in comparison with econometric methods in which reduced-form equations are estimated.

The second feature is that I explicitly consider the dependence of carbon regulations on income levels. In previous studies of the environmental Kuznets curve, regulations on emissions have not been considered explicitly. By contrast, I explicitly consider the dependence of regulations on income levels and incorporate it into the model. The key aspect of my analysis is the method of incorporating the endogeneity of emission regulations into the model — that is, how regulations depend on income levels. For this, I presume that Kyoto Protocol-type emission regulations are imposed on economies and then derive the relationship between income and the regulations from the consequences of such a policy intervention.

Main Results My numerical analyses yield the following results. Although economic growth raises per capita income and, therefore, emission regulations are strengthened in all regions, emissions increase significantly in all regions. This is because the responsiveness of regulations to income changes, which is inferred from the Kyoto Protocol-type regulations,

is too weak to restrain emissions. I test this finding by doing some sensitivity analysis on the responsiveness of the regulations, and found that the above results are unchanged. Thus, my conclusion is that carbon emissions are likely to increase throughout the world with further increases in economic growth even if I take account of the dependence of carbon regulation on income level. Although the EKC argument suggests that economic growth does not necessarily damage the environment, my results show that this argument is unlikely to apply to carbon emissions.

Chapter 4: The “Double Dividend” from Carbon Regulation in Japan.

Background In Chapter 4, I evaluate empirically the double dividend hypothesis for Japanese carbon regulation. Although carbon regulation itself has attracted much attention, it is thought that carbon regulation could be implemented more effectively and smoothly by combining it with reform of the existing tax system. The argument is as follows. Carbon regulations, such as emission taxes and permit trading, often yield additional revenues to the government. With these additional revenues, the government can reduce existing tax levels without reducing revenue. Since most existing taxes, such as corporate income tax and labor income tax, are considered to be distortionary, reducing these taxes will probably correct distortions in the economy and thereby improve the efficiency of the tax system. If the government can improve efficiency by swapping existing distortionary taxes for emission regulations, introduction of emission regulations improves not only the environment (“the first dividend”) but also the efficiency of tax system (“the second dividend”). The double dividend refers to the situation in which emission regulations yield the second dividend as well as the first dividend.

Although it is widely recognized that emission regulations can have desirable effects on the environment, they usually encounter strong opposition because they are likely to introduce further burdens on the economy. However, policymakers who can achieve the “double

dividend” can introduce emission regulations costlessly. If emission regulations are costless, policymakers and environmental protectionists can promote environmental protection without friction. Owing to its attractiveness in the policy area, many researchers have investigated the double dividend hypothesis both theoretically and empirically. Although several researchers have already conducted empirical studies on the double dividend hypothesis, most of them focuses on the US and European economies. In Chapter 4, I try to evaluate the double dividend hypothesis from Japanese carbon regulations.

Approach I employ a CGE approach using a multisector dynamic general equilibrium model. The model has 27 sectors and goods (nine goods produce carbon emissions) and covers 100 years (1995 to 2095). In the business-as-usual scenario, where no emission regulations are introduced, we incorporate various taxes that apply in Japan, such as labor taxes (labor income tax and social security contributions by employers), capital taxes (asset income tax and corporate income tax), and consumption taxes. I assume that these taxes are reduced when emission regulations (carbon taxes) are introduced.

Main Results Based on the model and assumptions above, I examine the double dividend hypothesis and obtained the following results. First, in almost all scenarios, the lifetime utility decreases as a result of emission regulations. This means that the possibility of the double dividend is fairly low. The previous empirical studies focusing on Europe and U.S. showed that the double dividend is not likely to occur in most situations. My result suggests that the same argument is applicable to carbon regulations in Japan. Of course, the fact that the possibility of the double dividend is low does not mean at all that carbon regulations are meaningless. However, if the double dividend will not be realized, in order to justify carbon regulations in efficiency ground we need to evaluate gross benefit from the abatement as well as its gross cost, which is regarded as a burdensome task.