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Effects of international sharing of pollution abatement burdens on income inequality among countries

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ABSTRACT

Improvements in environmental quality will boost output production and hence economic growth. However, although environmental abatement equally benefits all economies in the world, it is shown that, if the private productive resources are not yet accumulated sufficiently in low income economies, income inequality among economies can be widened in the short term not only under equal burden sharing of pollution abatement but even under income-proportional burden sharing. When the marginal productivity is diminishing, the negative effect of the burden is large relative to the positive effect of the improved environment in economies in which resources are not accumulated sufficiently.

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1. Introduction

It is well recognized that international coordination among countries is required to successfully deal with the global environmental problems. In fact, the issue of climate changes was a major topic at Heiligendamm in 2007 and the Bali and Hokkaido–Toyako Summits in 2008. As a step towards such international coordination, the Kyoto Protocol was formulated in 1997 and, after Russia ratified it, came into effect in 2005. While thirty-seven developing countries have ratified the protocol, including Brazil, China and India, they have no obligation beyond monitoring and reporting emissions, since they are considered developing countries with other serious problems to overcome. The Stern Review supports this view and stated that rich countries should bear the major responsibility for providing the resources for adjustment at least for the next few years. There seems to be wide agreement that if emissions continue unabated, the world will experience a radical transformation of its climate and that deep emission cuts will be required to stabilize greenhouse gas concentrations (see, for example, IPCC, 2007; Stern, 2007; Gore, 2006). Thus, the questions are (i) how much pollution emission should be reduced and/or abated and (ii) how the burdens should be shared among economies of various incomes.¹

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¹ Stern (2007) also suggested that while rich countries should bear in mind the differences in income and historical responsibility for the bulk of past emissions generated by consumption and growth, developing countries must also take significant actions.

In the present study, extending the two-economy model of Glomm and Ravikumar (2003) by incorporating environmental variables, and focusing mainly on question (ii) mentioned above, we examine the effects of different cost sharing schemes of pollution abatement among countries on their development paths thereafter. As to question (i), we assume here that the abatement conserves the environmental quality at least in the long term. Although the real problem is the international coordination required, it is well known that provision of public goods (i.e., the environmental quality in our context) involves the issue of incentive incompatibility of agents, and thereby the coordination may be difficult. In fact, the Hokkaido—Toyako Summit in 2008 did not seem to make any decisive step towards the coordination, although not only G8 members but also countries such as Brazil, Indonesia, Mexico, and South Africa declared their commitment to combat climate change. Developing countries refuse to be the only ones to shoulder the costs of the new environmental constraints, although industrialized countries are inclined to require them to be clean in their industrialization.² However, the consequences of the sharing schemes, when such coordination is possible, are worth examining, in particular, for ongoing coordination in the future.³

We show that income inequality may be widened in the short term not only under equal burden sharing of global pollution abatement but also even under income-proportional burden sharing if the productive resources (human capital in the present study) have not been accumulated sufficiently. When the income level is low, the burden of environmental abatement is relatively great because of its low resource accumulation, and the benefits from pollution abatement will be smaller relative to the burden under the diminishing marginal productivity. Thus, although the burden of abatement is smaller for a low income economy under the income-proportional sharing scheme, an increase in output brought about by the improvement of the global environment quality may be more than offset by a decrease due to the burden of the abatement when the productive resources are not sufficiently accumulated.

The next section builds up a model of income inequality between two economies, and then Section 3 examines the properties of the time path of the income ratio of the economies. However, it is difficult to derive clear-cut results qualitatively, since the dynamic system of the model is highly complex. Section 4 presents the results of some numerical calculations. The last section concludes the paper.

2. Model

We assume that the world consists of two economies, which are identical except that they have different mean incomes in the initial period. Focusing on the international sharing of pollution abatement costs, we neglect income inequality within a country and describe each economy as if each generation consists of a single individual in the economy. Individuals live for two periods: learning and accumulating human capital in the first period, and leaving home and working in the second.⁴ While an individual is affected by the human capital of his parental generation, he is also affected by the environmental quality in the output production process.⁵ The environmental quality of the earth is degraded by consumption activities in both economies but can be improved by abatement activities in them as well. For expositional simplicity, we assume away physical capital accumulation.

2.1. Private sector

The lifetime utility of an individual in economy j ($j=1,2$) is assumed to be written as

$$\frac{n_{jt}^{1-\sigma}}{1-\sigma} + \rho \frac{c_{jt+1}^{1-\sigma}}{1-\sigma} \quad (1)$$

where n_{jt} is leisure in period t , c_{jt+1} is his consumption in period $t+1$ and P_{t+1} denotes the quality of the global environment in period $t+1$. σ (> 0) is the absolute value of the elasticity of marginal utility of leisure and consumption and ρ (> 0) represents the subjective discount factor. Although the environmental quality could affect the utility of individuals, we omit the utility from the environment quality in the utility function, since we assume below that the environmental quality will be kept at the target level.

Assuming that the time endowment of individuals in each period is unity, $1 - n_{jt}$ represents their effort for human capital accumulation. Letting the human capital of his parental generation be h_{jt} , the stock of human capital in the second

² Among others, Economides and Miaouli (2006) solved an asymmetric non-cooperative (Nash) game among benevolent national governments in federal economies for pollution tax and cross-country transfer policies. Pallage (2000) investigated the self-enforcing mechanism for reaching Pareto optima, the implementation costs for players and the gains from international cooperation in replenishment of renewable resources shared by two countries with asymmetric wealth.

³ Recent development in behavioral economics showed that other-regarding motives are a better predictor of behavior than self-regarding ones in the game theoretic experiments, while cooperation and punishment keep step with each other (Henrich, 2006). See, for example, Gowdy (2008).

⁴ Assuming here that economies produce a single homogeneous good, there is no incentive for trade. The exclusion of trade is close to the approach of John and Pecchenino (1997) and Hoel (1991).

⁵ For example, Evans and Smith (2005) demonstrated that long-term exposure to high ozone levels significantly shortens life. Following Pautrel (2008), more frequent replacement of generations due to detrimental effects of pollution will lead to the loss of knowledge, reducing the growth rate. Pautrel (2009) also said that pollution stock induces chronic illness and disability, which forces agents to allocate more time to health-enhancing activities rather than to market production. See also Stern (2007). We abstract from the direct effects of environment on the learning process such as in Gradus and Smulders (1993) and Yoshida (1998).

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