CONCLUDING REMARKS

Akihiro Amano

School of Business Administration,
Kobe University

Before presenting concluding remarks, I should like to express our deep gratitude to the Center for Global Environmental Research for providing us with such a worthwhile opportunity for exchanging views among researchers interested in the economic effects of controlling global warming. This may probably be the first time that so many researchers involved in different modeling experiences in Japan have got together, but unfortunately we did not have enough time to prepare for a more ambitious objective of attempting comparative studies with common basic assumptions and simulation conditions. I simply hope that this conference will give an impetus to some kind of joint research among the participants in the near future.

Let me now make some comments by way of concluding remarks.

1. The most significant theme of this conference is the social costs of utilizing global atmosphere as a dumping place of greenhouse gases like CO2. Uzawa and Goto quantified these costs as imputed or shadow prices of CO2 emissions.

Most authors expect that CO2 emissions will continue to grow substantially unless something is done. Many authors also ascertained the effectiveness of economic measures such as carbon taxes to curve CO2 emissions. There are disagreements, however, concerning the accompanying costs in terms of GNP losses. One obvious problem is that estimates of economic losses vary so widely. A similar tendency has been observed in the OECD global-model comparison workshop. We will have to investigate further the reasons of these wide differences. Another problem is related to the availability of other policy measures that can offset undesirable impacts of carbon (or other environmental) taxes. Some authors maintain that economic costs of a carbon tax can be fully offset by using the revenues to remove severe distortions of pre-existing taxes (see Shackleton *et al.* (1991)). Simulation exercises dealing with carbon taxes usually keep other policies unchanged in order to isolate the effects of original changes. This does not mean, however, that "economic losses" are inevitable. We may conceive of various policy packages that can neutralize undesirable side-effects of the initial set of measures.

2. If a model does not incorporate responses of demand for fossil fuels to changes in relative energy prices, then policy responses can rely only on technological improvements or innovations, on the one hand, and on direct regulation through standard settings on outputs, inputs, or techniques of production, on the other hand. It seems quite unrealistic, however, to suppose that responses through price changes are actually negligible or very small, but some of the early models of the Japanese economy did draw gloomy pictures using such models with a tendency to overestimate necessary reductions of economic activities, or to place over-reliance on subsidies for energy-saving technologies to attain a certain target of emission abatement.

3. The effects of subsidies and of R&D investments upon the introduction of less carbon-intensive technologies have been analyzed by such authors as Ito and Onishi (see

also Nagata *et al.* (1991)). This is the area where model-based analysis has not been done so extensively, and further studies should be encouraged. In the OECD workshop on global-model comparison studies, the importance of assumptions concerning the "AEEI" (autonomous energy efficiency improvements) has been stressed, but they are simply set exogenously in each model and no attempt has so far been made, theoretically or empirically, to justify the numbers.

The same is probably true with the question of international technology transfers. The greater part of energy-saving and clean-energy technologies is proprietary of the private sectors, so that the areas and the extent of required public promotion, together with financial requirements, need further investigations.

4. The macroeconomic and sectoral impacts of controlling CO2 emissions in Japan have become much clearer than, say, two or three years ago. But, as mentioned above, there still remain gaps between the results of short-run, demand-determined models and those of long-run, supply-determined models. Since it is usually very difficult to evaluate a wide range of problems with one particular model, it is important to analyze not only the quantitative magnitudes of economic costs but also the exact channels through which these costs are incurred. Differences among models may be due to differences in parameter values in the same channel, but they may also be due to the existence or the lack of particular channels in different models. It appears that we had better have medium- and long-term models of a particular country with sufficient details of sectoral disaggregation, on the one hand, and a global, long-term model with less sectoral disaggregation but a wider regional coverage of the world economy, on the other hand. The latter model can play an important role of computing consistent values of world variables such as primary energy prices and providing them to country or regional models.

5. Some papers discuss the question of recycling tax revenues. Depending on the level of carbon tax rates, the size of tax revenues can become substantial so that their disposition may have important implications. In order to isolate the incentive effects of emission taxes as far as possible, it would be necessary, in analyzing their effects, to maintain revenue neutrality. However, the trouble is that there are various ways of attaining revenue neutrality. Tax revenue can be used to reduce direct taxes, indirect taxes, social security contributions, and so on. That is, attainment of tax neutrality may have different implications on income distribution, sectoral prices, sectoral employment, etc. In order not to get problems entangled, therefore, the incentive aspects of carbon taxes had better be analyzed by assuming, for example, tax neutrality through reduction of indirect taxes or social security contributions.

This does not, of course, mean that carbon taxes should actually be introduced in such a fashion. In countries where non-trivial carbon taxes have been introduced, they usually accompanied some sort of tax reform. A question such as the regressiveness of carbon taxes can be discussed in this context.

6. Another important problem to be handled in long-term models is the impacts of abatement policies upon capital accumulation. This can easily be analyzed in macroeconometric models or turnpike models, but in other long-term models time paths of capital accumulation are often set exogenously.

7. When one is using an optimization technique in a long-term model of a particular country, it may be necessary to re-examine whether the constraints of the model are not affected by policy alternatives. For example, in the Turnpike Model (a long-term, multi-sector planning model) of the Economic Planning Agency (see Economic Planning Agency (1991)), such constraints as upper limits to export growth, upper limits to import

dependencies, and minimum requirements of external surplus may probably be affected should Japan and other major countries adopt carbon taxes of a certain magnitude. Since policy responses to global warming are likely to become global in nature, this is the area in which heavy reliance on a single country model should be avoided.

8. When we look at the problem from the international perspective, the repercussion channels through international trade cannot be easily dismissed as Ito and Yamaji emphasized. Important routes are changes in world prices of primary fuels resulting from changes in energy demand caused by abatement policies in individual countries. Another important set of routes are changes in comparative cost structures and the terms of trade arising from variations in world energy and commodity prices.

It is difficult for a single country model to incorporate long-term changes in the world energy supplies. Usually, world energy prices are considered exogenous invoking the so-called "small-country assumption". This assumption, however, is not appropriate when other countries adopt similar policies at the same time. A global model like Edmonds-Reilly model incorporates a market-clearing mechanism to determine world primary energy prices, and hence can provide useful side information if it is run side-by-side under a particular set of simulation assumptions.

9. Another important problem of international dimension is to determine which set of countries join in a common abatement policy group. If only advanced or industrial countries adopt carbon taxes, for example, there is a possibility that production and exports of carbon-intensive products in other countries are encouraged to such an extent that the initial reduction of CO2 emissions might be more than offset. This problem can be examined properly only by a global model that incorporates international trade of some disaggregated industries.

This problem is also related to the possible scheme of international redistribution of income involved in any international policy agreement as pointed out by Uzawa. If, for example, an international market of emission permits is to be established with some sort of initial allocation of aggregate permits, benefits and costs can differ markedly depending on the way how the allocation rules are settled. It may be necessary to introduce multiple indicators to form the rules in order to invite a larger number of countries to participate. If significant countries opt out, however, measures are necessary to avoid inefficiencies resulting from "trade-diverting" effects of abatement policies actually taken.

10. The question of international competitiveness pointed out by Morita is certainly related to the above problem, but it seems to involve a larger set of questions that can be classified into the following three categories: (A) the question of "trade diversion effect" as mentioned above, (B) the question of short-run industrial adjustment that can arise whenever efficiency requires changes in the industrial structure, and (C) the pattern of efficient international division of labor. Question A is discussed above. Question B is often encountered and handled by various positive and negative adjustment policies. Question C may involve a new dimension in the sense that, unless internalization of externality involves some sort of diversion effects as mentioned above, the efficient international division of labor should be based on the cost structures that reflect true social costs rather than private costs.

11. Finally, let me briefly touch upon some points mentioned by Morita which have not been taken up yet.

(1) Distortions arising from existing taxes and subsidies. Most models presented here really neglect existing taxes and subsidies when considering carbon taxes. But this point should certainly be subject to careful attention when realistic simulation exercises

are to be performed, as the OECD GREEN model clarifies that existing taxes and subsidies can have significant effects upon the carbon tax structure, because many industrial countries impose substantial implicit carbon taxes already whereas in some other countries energy is heavily subsidized (Burniaux *et al.* (1991), OECD (1992); see also Hoeller and Wallin (1991)).

(2) Analyzing macroeconomic effects. It may not be a sensible way to construct a huge model to handle all aspects of macroeconomic effects in one shot. Each model-type has its own advantages and disadvantages, and the advantage can best be attained in a simpler and clearer form. A large model can easily become a black box, and the best practical way seems to lie in the choice of a few models of different type as modules to be combined as necessity arises.

(3) National preferences of tax systems. There are bases that business societies prefer direct regulations to indirect or economic measures. There may also be some rationality for each people to have different political preference. The greenhouse gas question, however, is of a global character to start with, and the necessity to harmonize domestic policies will soon arise. Any new arrangement, therefore, needs to incorporate high level of transparency and international comparability.

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