Technological Dynamics toward CO2 Stabilization
Extended Abstract

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Abstract

A long-term energy model analysis is conducted to understand the technological dynamics in long-term climate policy. Three groups of dynamics are incorporated. First , there is "environmental Kuznets curve effect" known by environmental economics. It represents the positive correlation between income level and willingness-to-pay Secondly, "policy convergence" dynamics is known by policy science. Environmental policies in pioneering countries are imitated by the rest of the world through international elite networking, negotiation in free trade regime, and so forth. Thirdly, there are technological learning and spillover effects known by technology economics. All of them describe the dynamics that pioneering policy taken by leading countries diffuse to the rest of the world in time.

With the model the author analyzes environmental effectiveness of two types of climate policy. They are "pricing carbon", such as carbon tax and emission trading and "creating niche market", such as Renewable Portfolio Standards and Feed-in Tariffs. Findings include (1) very high price will be necessary for "pricing carbon" policy alone to prevent climate change, but (2) creating niche markets for nascent technologies will reduce the carbon price level to meet the same goal and makes it politically easier for countries. However, (3) there is the risk that hand-picked new technologies may not be rewarding in the long run. The author argues that an international division of labor for creating niche markets for nascent climate technologies are the sensible strategy to share the burden of the risks, to increase the acceptance of carbon pricing policy, and to enable nations to agree upon ambitious concentration target in near future.

1. Dynamics of Environmental Technology Policy

Three groups of dynamics are diagrammatically expressed in the Figure 1. They are incorporated in the subsequent model runs.

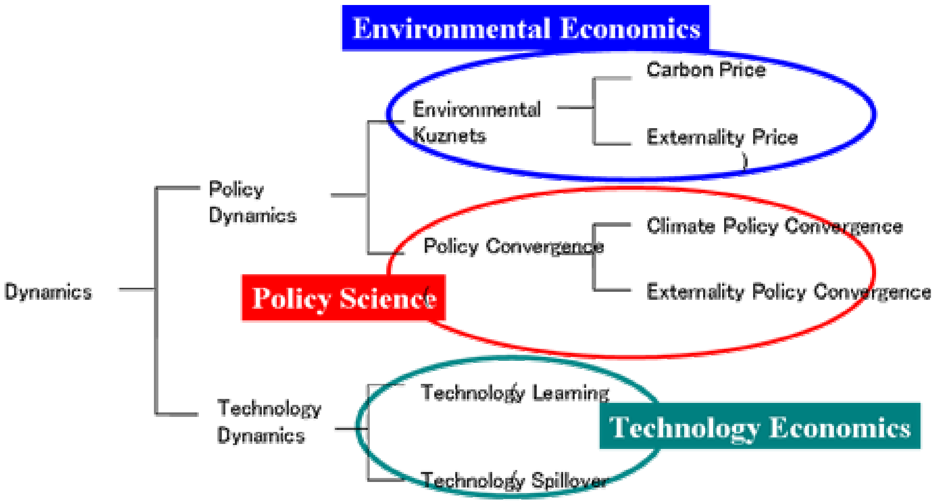

Figure 1. Three groups of dynamics.

2. Model Analysis

Twelve Cases are run to understand the environmental effectiveness of two types of climate policy. Emission targets are set for 550ppm (Figure 2 a and c) and 600ppm (Figure 2 b). In case (a) and (b), fast breeder reactor and CO2 recovery and storage technology are assumed to be available. In BAU of (a) through (c), no climate policy is taken. In H-TAX , 550 ppm goal is met by carbon pricing policy alone. In PAC of (a) through (c), 550 ppm is achived by the combination of carbon pricing and niche market policy. L-TAX represents emission path when the same tax as the PAC is imposed without niche market policy.

Niche market policy is modeled as the quota allocation of renewable energy, alternative fuel automobiles and hydrogen end use at regional level. Pricing policy is modeled as the carbon tax at regional level. For both, it is assumed that some developed countries take the lead and the rest of the world follow suits by the dynamics described in section 1. Carbon prices in developed countries are shown in Figure 3.

It is clearly shown that niche market policy drastically reduces the carbon price to meet the same concentration goal. To meet 600ppm, Fig. 2 (a) shows that tax rate is halved from $67 in H-TAX from $35 in PAC in 2050. The impact of niche market policy is more impressive when the competing technologies fail to prevail. If nuclear and carbon storage technologies fail, Figure 2(c) shows that the niche market policy can reduce the carbon price by 70% from $356 in H-TAX to $114 in PAC in 2050. In contrast, when competing technologies prevail, the technologies hand picked by the niche market policy does not prevail and the policy effectiveness is weak. Fig. 2 (b) shows that tax rate is still reduced, but the gain is only 30% from $92 in H-TAX from $60 in PAC in 2050. This margin is relatively small.

From the analysis, we learned that (1) very high price will be necessary for “pricing carbon” policy alone to prevent climate change, but (2) creating niche markets for nascent technologies will reduce the carbon price level to meet the same goal. However, (3) there is the risk that hand-picked new technologies may not be rewarding in the long run.

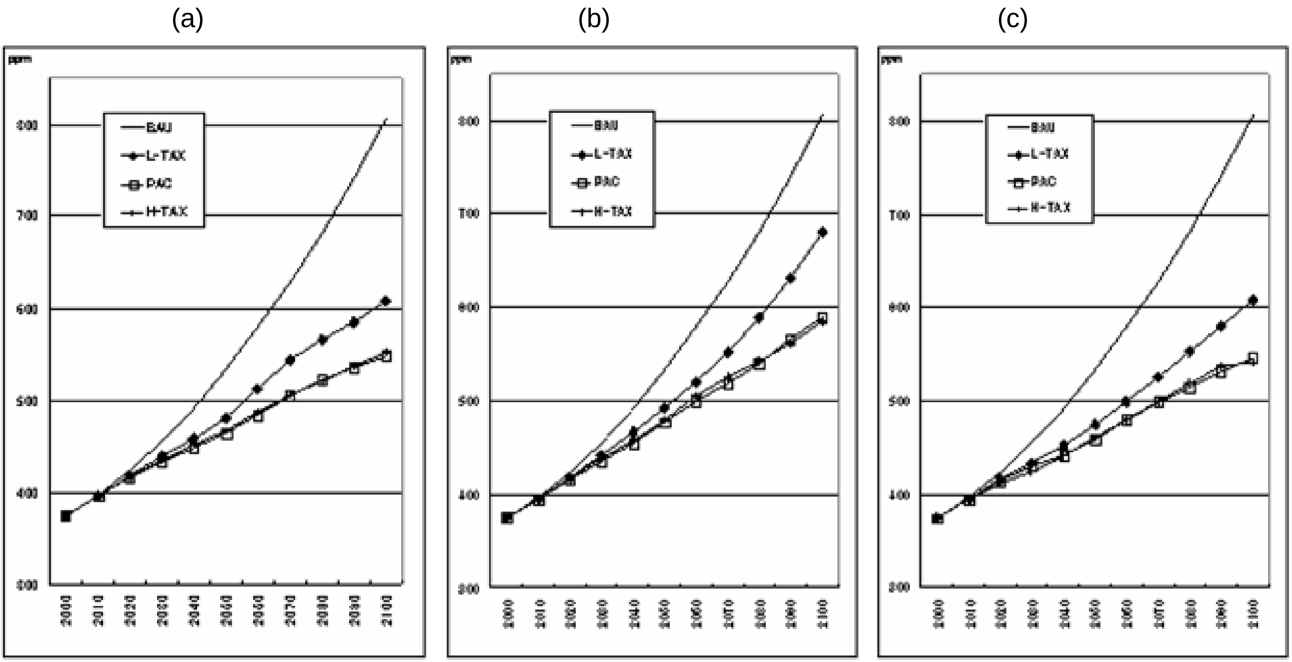

Figure 2 Calculated CO2 concentration. (a) 550ppm target, (b) 600ppm target, (c) 550 ppm target without FBR and CO2 R&S technology.

3. Policy Implication

There are political difficulties to immediately attach high carbon price to the emissions from all economic activities in most countries in the world. A necessary condition for appropriately pricing carbon is to develop technologies at affordable costs. Given the lifecycle of technologies from laboratory to the market as illustrated in the Figure 4, it makes sense for countries to flank the carbon pricing policy by R&D and
niche market policy to bring the costs down.

Choice of technology would be dependent upon the national circumstances, particularly resource endowment. Renewable rich regions, fossil fuel rich regions, or regions without both, would have comparative advantage to develop the niche markets for renewable, carbon recovery and storage, and energy conservation technologies, respectively. An illustration is given in Figure 5.

There are risks that the technology will not be prevailing in the end, but it would make sense for each country to identify the technologies that fit to their national interests, to create dedicated niche markets for them, and to contribute to climate change prevention.

An international division of labor for creating niche markets for nascent climate technologies are the sensible strategy to share the burden of the risks, to increase the acceptance of carbon pricing policy, and to enable nations to agree upon ambitious concentration target as soon as possible.

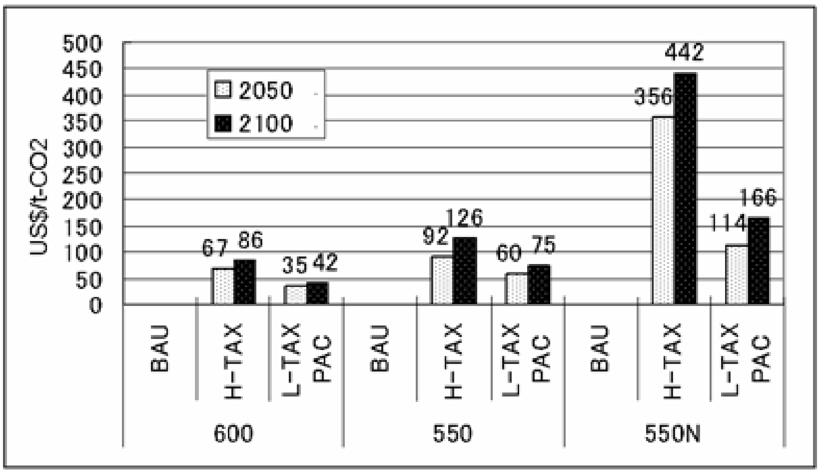

Figure 3 Carbon price (US$/t-CO2) in developed countries (Japan, the EU and the US) for three cases.

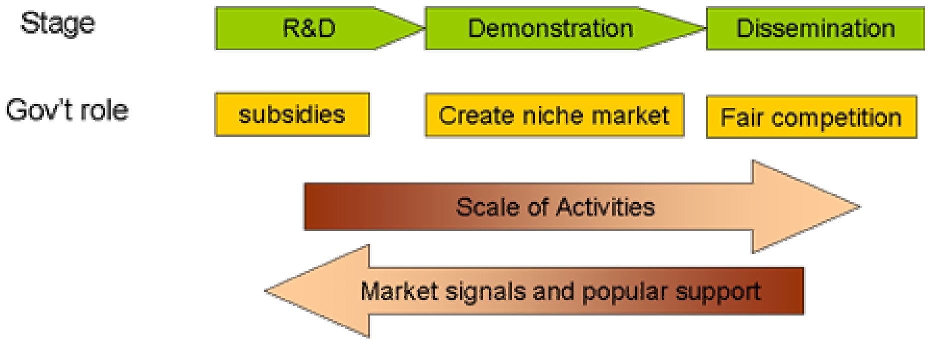

Figure 4 Lifecycle of technology.

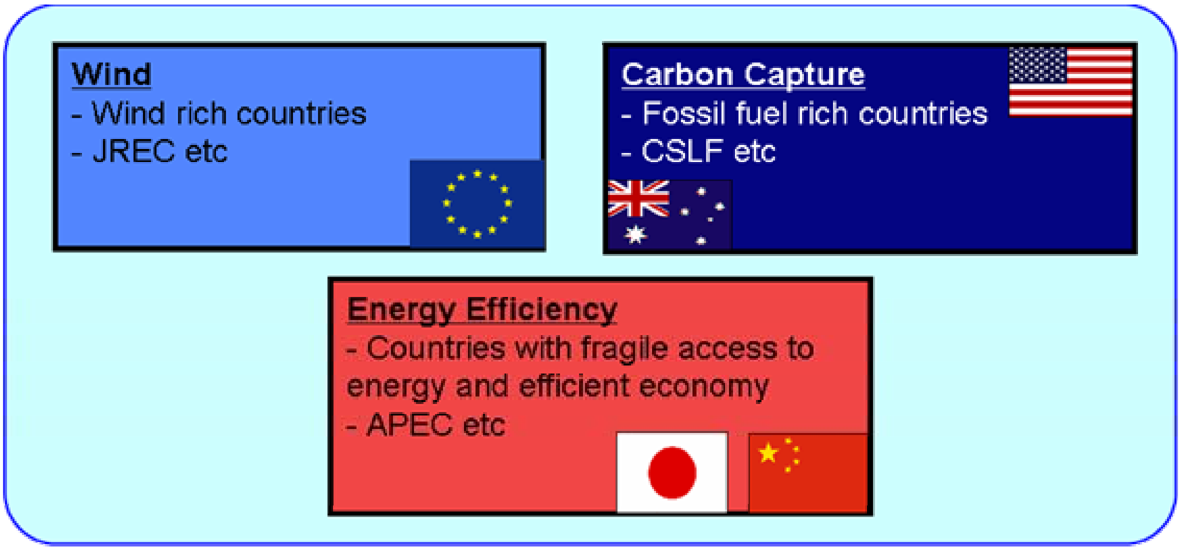

Figure 5 Illustrative example of international division of labor for nascent climate technologies

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