Burden Sharing and Self-enforcing Climate Agreements

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1. Introduction

A world's scientific consensus maintains that climate change is due primarily to the human use of fossil fuels and carbon dioxide released is the main greenhouse gas (GHG). Recent IPCC report (2018) requires the unprecedented change of society and the drastic reduction of GHG emissions asked to stop climate change over 1.5 degrees and to avoid the worst-case scenario of climate change. However, since climate change is a global public bad and there is no supranational enforcement authority, individual countries are tempted to free-ride and let others abate. For the settlement of this issue, the global community has struggled to make international environmental agreements over the past three decades, and it has considered the allocation of emissions among countries.

This paper aims to find a new scheme of burden sharing to make the agreements stable by deriving the optimal allocation of GHG emissions among countries. Equity that is the principle of `fairness' is the basis of burden sharing in climate agreements. All countries have widely accepted the principle in the agreements such as the Kyoto Protocol and the Paris Agreement. However, how equity considerations make the treaties self-enforcing in the long term is less clear. Hence, we address this question by using the dynamic framework. Further, to focus on the burden sharing rules, it is necessary to consider heterogeneity in the payoff structure between countries.

2. Basic setup

This paper presents the repeated-game framework in which heterogeneous countries emit GHG in every period. For simplicity, we assume that the two countries are members of the climate agreement, and all emission decisions are observable. We can interpret a country as a group. The agreement chooses the target level of total emissions that is less than the one-shot Nash equilibrium level, and then allocates the emission quotas for the countries. We describe the agreement as to the trigger strategy in which a deviation from the agreement results in the withdrawal of all countries from the agreement. Making the agreement self-enforcing, we construct the trigger strategy that describes the agreement as a subgame-perfect equilibrium.

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3. Results

One of the main results in this paper is about a scheme of allocating emission quotas to make the agreement the most stable. We find the optimal emission quotas that equalize the incentive to comply with the agreement between countries. Compliance incentive equalization means that the temptations to deviate from the agreement should be equalized between countries through finding the optimal emission quota. Suppose one country has a stronger temptation to deviate from the agreement. That is, the opponent country has a greater slack of incentive to comply with the agreement. In this situation, transferring the slack of the incentive across countries through reallocating emission quotas makes the agreement more stable. This is because permitting more emissions mitigates the temptation to deviate. The improvement of the stability continues until the two countries' compliance incentives become equal. We show that the more emitting country in the status quo (the one-shot Nash equilibrium) can emit more in the optimal emission quota. This type of emission allocation could be associated with the grandfathering rule, which means that future emission quotas should depend proportionally on existing and/or past emissions level of the country. We can justify the grandfathering rule from the viewpoint of compliance incentives. On the other hand, we also show that there are cases in which a country who emits less in the status quo should have a larger reduction rate of emission at the optimal emission quota.

Some comparative statics and an extension lead to several policy implications. First, we consider the effect of mitigating total target emission level. We show that avoiding an ambitious target total emission level is in the interest of countries with a larger burden. It might lead to the deviation of the countries permitting small emission reduction rate. Second, we consider the effects of technology investments on the stability of agreements. In particular, clean technology investment that decreases the marginal benefit of the own emission results in the decrease of the emission level in the status quo. This improves the compliance incentive for the investing country, while it worsens the other's incentive. The former effect comes from decreasing cost of emission reduction for the investing country. The latter arises from the smaller status quo emission level, which means weaker punishment. The result implies that the transfer of clean technology improves the compliance incentive of the recipient country. Finally, we apply the idea of allocating emission quota to improve the stability of climate agreements to the situation where countries have heterogeneous discount factors. The transfer of clean technology investment also works to improve the stability in such a situation. This is because the transfer of clean technology improves the compliance incentive of the recipient country at the sacrifice of the donor country.

References

IPCC, 2018. Global warming of 1.5, https://www.ipcc.ch/sr15/.