Theoretical Analysis of International Environmental Agreements: Repeated Game Models

高島, 伸幸

https://doi.org/10.15017/1806802

出版情報: 九州大学, 2016, 博士(経済学), 課程博士
バージョン:
権利関係: 全文ファイル公表済
Today, the emissions of various transboundary pollutants are causing global environmental damage. Since one country’s reduction of such pollutants will benefit all other countries in a non-exclusive and non-rival manner, each country has an incentive to free ride on the abatement efforts of others, and consequently, the abatement efforts of individual countries do not reach an effective level. Therefore, coordinated action by countries is essential in reducing transboundary pollutants. As no supranational authority exists that can dictate environmental policy to nations, each country has to enter into international environmental agreements (IEAs).

This doctoral thesis provides a new theoretical framework for IEAs, using a repeated game model in which the game is repeated infinitely. In repeated game models, agreements need to specify a strategy that can enforce signatories’ cooperation. It must be in the best interest of each country to individually act in accordance with the strategy (i.e., the subgame perfection requirement). Additionally, renegotiation must be prevented in such an equilibrium agreement (i.e., the renegotiation-proofness requirement). In particular, it must be in the best interest of the punishing countries to collectively punish a non-complying country before restarting the cooperative relationship. As a result, signatories are forced to cooperate through credible threats for deviation. If these requirements are satisfied, the IEA can be sustained as a weakly renegotiation-proof (WRP) equilibrium. The thesis contains six chapters.

Chapter 1 presents the research background, motivations, and contributions of the thesis. We also explain the thesis structure.

Chapter 2 provides a literature review of IEAs in repeated game models and introduces the basic IEA models and strategies that prescribe the abatement behaviors of countries in IEAs in a repeated game.

Chapter 3 investigates an IEA where all countries participate in case that each country has impartial altruism, that is, cares about the net benefits to other countries from pollution abatement. A high degree of impartial altruism is needed for full participation in the one shot game model. Under the assumption of high altruism, however, each country tends to abate irrespective of existence of IEAs. We show the possibility of an IEA with full participation in which each country has a low degree of impartial altruism by employing the Penance-$m$ strategy, which limits the number of countries that are permitted to punish a non-compliance in
order to sustain all countries’ participation. Our conclusions are as follows. A full participation IEA with low impartial altruism is feasible if considered in a repeated game framework. Additionally, the impartial altruism decreases the lower bound of discount factor where a full participation state is sustained as WRP equilibrium. In other words, the impartial altruism facilitates the sustainability of IEA. Our results show that setting a credible threat for a deviation is the key factor in explaining the effect of impartial altruism and feasibility of IEA where all countries cooperate.

Chapter 4 shows the effect of ancillary benefits on the condition of full participation in an IEA by employing the Penance-m strategy in two cases of payoff function: linear benefit and cost functions and linear benefit and quadratic cost functions. We assume an IEA where all countries participate, as in Chapter 3, but no country has altruism. In this chapter, a new concept of additional benefit by emission abatement is considered. Environmental protection not only generates benefits that all countries equally receive by reduction of transboundary pollutants (primary benefits), but also private benefits that only abating countries receive through the improvement of local environment (ancillary benefits). Our main results show that full participation IEA is sustained as WRP equilibrium even though ancillary benefits are taken into consideration. Additionally, the introduction of ancillary benefits is shown to decrease the number of punishing countries with linear costs, while this number remains unchanged with convex costs.

Chapter 5 provides a new framework for IEAs, which include punishment exceptions for accidental deviation. Unlike Chapters 3 and 4, which consider that IEAs are formed globally and that the deviation is intentional, this chapter considers regional agreements in which neighboring countries participate and that deviation from an agreement can occur accidentally because of phenomena such as natural disasters. If an IEA signatory deviates accidentally, it fails to achieve its pollution abatement target. This chapter theoretically demonstrates the rationality of integrating an exception clause into IEAs for accidental deviation by presenting a new strategy, called Regional Cooperative, which integrates punishment deductibility for accidental deviation into an IEA. Under a Regional Cooperative strategy, the neighboring countries’ punishment levels change depending on the types of deviation: intentional deviation and accidental deviation. That is, neighboring countries behave more cooperatively when an accidental deviation occurs, while the signatories from the other region completely abandon their abatement as punishment.

Our main contributions are as follows. First, no country deviates intentionally on a WRP equilibrium. Second, for accidental deviation, punishing countries tend to revoke the punishment and return to cooperation if an accidental deviator increases its abatement volume. In other words, the abatement efforts of the accidental deviator can lead to renegotiation. We conclude that our new strategy motivates the accidental deviator to engage in abatement and the punishing countries to restart cooperation by renegotiation. Consequently, prevention of social welfare loss due to punishment is possible through renegotiation in cases of accidental deviation.

Chapter 6 concludes the thesis. We summarize the main findings in Chapters 2-5 and present the future scope for research.