Proceedings of the 2023 International Conference on Management Research and Economic Development
DOI: 10.54254/2754-1169/26/20230552

A Game Analysis on International Emissions Trading under Climate Change

Shunsheng Wang[1,a,*]

[1]*Beijing National Day School, Beijing, 100000, China*
a.wss_060415@163.com
**corresponding author*

Abstract: Carbon emissions and climate are intricately related. People's activities are growing as a result of advances in science and technology, which raises carbon dioxide emissions. As a result of these greenhouse gases, the atmosphere's ability to dissipate heat will decline, raising global temperatures and making climate change a more serious issue. To achieve sustainable development, people must begin to pay attention to these challenges and strike a balance between the environment and economic progress. This paper introduces the mechanism of emissions trading and the benefits of its operation. In order to discuss the possibility of enabling countries to use emissions trading, this paper uses a non-cooperative game theory model to analyze the choices made by developing and developed countries under the background of the Kyoto Protocol. Combined with the equilibrium obtained by the hypothesized model, some methods and reasons for improving the results are proposed. This paper concludes that both developed and developing countries are more inclined to use emissions trading to achieve emission reduction targets or obtain certain benefits.

Keywords: climate change, emissions trading, game theory

1. Introduction

Climate change has been a controversial topic in recent years with more drastic industrial activities. Scientists indicated that the "greenhouse" effect caused by human actions, such as burning fossil fuels, farming, and deforestation, is the major driving force of temperature rise. Due to the total demand for resources increasing as the world population gradually grows, on the one side, manufacturers must produce more energy to fulfill people's needs, which results in more carbon emissions being released into the air, worsening the climate system. On the other side, human beings have to pay the penalty as global warming brings forward a series of economic threats. According to Swiss Re, one of the biggest insurers in the world, climatic effects may reduce the world economic output by 11-14% by 2050 – a $23 trillion decrease in annual global economic production [1].

With the goal of reducing greenhouse gas emissions that contribute to climate change, the United Nations promulgated the Kyoto Protocol in 1997. The industrialized nations that join the Kyoto Protocol will be expected to reduce emissions collectively by 2012 to a level roughly 5% below the emission level in 1990 [2]. Under this circumstance, the main goal of this research is to use the game theory model to conduct a more thorough analysis of the effects of carbon trading. Game theory can assist people in determining the behavior of all countries or corporations under optimal strategies. Carbon trading strategic decisions made by countries or companies have an impact on one another,

DOI: 10.54254/2754-1169/26/20230552

and government can forecast the cost of emission rights, the number of participating nations, the market response, and other variables using the game theory model, allowing people to create better policies to meet emission reduction targets.

2. The Advantages of Emissions Trading

The two main components of emissions trading schemes are a pollution cap and tradable allowances that are equivalent to the cap and allow holders of the allowances to emit a certain amount of the pollutant. This cap makes sure the environmental objective is achieved, and the tradable permits provide each emission source the freedom to choose its own course for compliance.

2.1. Providing Future Pathways for Pollution Reduction

Not only does emissions trading reduce carbon emissions but it also provides obvious pathways for pollution reduction. As long as emissions are at or below the designated emissions cap across all covered industries, the quantity-based strategy of emissions trading guarantees compliance. To provide a clear route for emissions reduction over the medium to long term, jurisdictions adopting emissions trading have sought to adopt gradually decreasing and credible caps in accordance with national climate goals.

2.2. Benefiting Countries from an Economic Perspective

Emissions trading also benefits countries around the world from an economic perspective. To begin with, emissions trading delivers cost-effective abatement. According to studies conducted in Organization for Economic Co-operation and Development (OECD) nations, emission swapping is a very affordable mitigation strategy. According to a recent OECD research, broad-based carbon taxes and emissions trading had the lowest expenses per ton of emissions reduced when compared to other instruments. Besides, flexibility is offered by carbon trading; businesses can choose where and when to cut emissions. The cheapest mitigation methods are chosen first. Participants can also reduce pollution when doing so will save them the most money. And the price signal generated by emissions trading automatically adjusts to altering economic circumstances, making emission reductions more affordable when the economy is slowing and more costly when it is expanding.

What is more, emissions are separated from economic growth through emissions trading, which promotes low-carbon development. Emissions trading supports nations in veering off a carbon-intensive development route and eases the transition to a low-carbon economy. Many countries that allow for the trading of emissions are already moving toward economies that use less carbon.

2.3. Furthering the Goals of Public Policy

Emissions trading also helps further the goals of public policy. First, revenue is generated by emissions trading. Emissions trading can produce additional government revenue through the auctioning of allowances, which can then be used to fund additional climate action, lower other taxes, or provide compensation for low-income households or other groups who have been negatively affected. Second, emissions trading generates statistics on emissions and makes information exchange easier. Data on emissions is produced by the monitoring, reporting, and verification (MRV) networks that support emissions trading. This data enables jurisdictions to assess economy-wide emissions, pinpoint the potential for covered industries to reduce emissions, and monitor the development of mitigation goals. Evidence from the EU emissions trading program indicates that taking part in emissions trading promotes information sharing among important stakeholders and aids

DOI: 10.54254/2754-1169/26/20230552

in increasing knowledge of climate change issues at the management level of businesses. Likewise, the emission reductions attained under Tokyo's emissions trading have been greatly aided by knowledge exchange between the regulator and covered organizations. Finally, there are significant co-benefits produced by emissions trading. The goals of public health, energy security, job growth, and land-use change can all benefit from positive synergies with emissions trading. In particular, by lowering local air pollution, it has the ability to produce long-term benefits for public health [3].

3. The Allocation of Emission Permits

Due to the fact that permits can be purchased and sold on an allowance market, how to allocate emission permits is an essential problem to be solved. One involves the government auctioning off permits, and the other involves "grandfathering," or distributing licenses randomly in accordance with some formula based on current emissions. Since the quantity of permits remains constant, both allocation strategies offer the same incentives for abatement at the margin and, naturally, result in the same environmental outcome. Their difference is a distributive one. Resources are transferred from emitters to the government through auctions, which bring in money for the government. According to the "ancestral" system of emission permits, polluters are given assets in the form of exchangeable property rights. Any plan allows for certain licenses to be sold at auction and the remaining ones to be given away for free; this flexibility offers the permit system an edge over the analogous carbon tax, since all proceeds, by convention, go to the government. The government should market emission permits rather than "grandfathering," Cramton and Kerr vehemently contend, for three reasons: the government can increase economic efficiency by lowering distortionary taxes by using these funds. With auctions, complex and unavoidable arguments over allocation decisions are eliminated, and small producers and new entrants have equitable access to emission permits. Auctions also spread the costs of carbon control and the benefits of permit distribution more fairly across the economy. The claim that retroactivity more accurately captures the implicit social agreement with incumbent producers that their use of the atmosphere as a carbon sink is free, on the basis of which they invest, is in opposition to these reasons [4].

4. Game Theory Model

4.1. Assumptions

-There are only a developed country and a developing country.

-Due to The Kyoto Protocol, while developing countries can choose whether to participate in carbon reduction (carbon emissions trading), developed countries must participate in carbon reduction but can choose whether to participate in carbon emissions trading. To make the game easier, assuming the cost for developed countries to use emissions trading to reduce carbon is the same as other methods.

-The cost of reducing carbon emissions varies. Globally, achieving a specific reduction at the lowest cost can be accomplished by equating marginal reduction costs across nations. However, developed nations should make greater efforts to reduce their emissions, given that they are responsible for past emissions accumulated in the atmosphere and given their present capabilities [5]. As a result, the cost for developed countries to implement the carbon emission is larger than developing countries.

-A non-cooperative game: each nation makes its own decisions on how much to invest in economic development and how much to minimize carbon emissions.

DOI: 10.54254/2754-1169/26/20230552

Table 1: Results of implementing carbon emissions in different countries.

		Developed country	
		Implement	Not implement
Developing country	Implement	B-C,-B	-C,-A
	Not implement	0,-A	0,-A

Assume that A>B>C

A: a developed country's cost to reduce carbon (same costs for other methods to reduce carbon).

B: profits earn by developing country selling permits to developed country / the cost for developed country to buy permits to meet the standard of carbon reduction.

C: a developing country's cost to reduce carbon.

Pure NE=(Implement, Implement) & (not Implement, not Implement)

4.2. Result and Analysis

When both countries implement emissions trading, the developing country is able to sell its extra permits to the developed country because the developing country can meet the standard easier. As a result, the developing country is able to earn profits so they have the incentive to engage in emissions trading. The profits earned by the developing country are calculated by the revenue of selling permits minus the cost of carbon reduction. Because B is greater than C, B-C is positive, so they earn positive profits. By involving developing nations in emissions trading, substantial capital inflows would be made available to them, promoting economic development. Additionally, it would enable the world to benefit from the fact that the majority of them are developing their infrastructure, which would decide the long-term trends of greenhouse gas pollution [6].

The cost for the developed country to implement emissions trading is A, which is the greatest and the same as other methods to reduce carbon emissions. Therefore, as long as the price of permits bought by the developed country is lower than the cost to implement other methods, they are willing to buy permits and engage in emissions trading. The cost for them to buy permits is opposite to the revenue gained by the developed country, which is -B.

When only the developing country chooses to implement emissions trading, there is no one for the developing country to sell its permits to, so it needs to afford all the costs. Besides, due to the developed country choosing another method, it needs to bear the cost -A. However, whether the developed country implements emissions trading or not, if a developing country chooses not to implement this policy, the developed country is not able to buy any permits from anyone, thus having an outcome of -A.

Observing Table 1, there are two Nash equilibria, which are (Implement, Implement) & (not Implement, not Implement). However, the first outcome is (B-C,-B) and the second one is (0,-A), so outcomes for both countries are better in the first one (Implement, Implement). As a result, both countries would choose to implement the policy.

5. Suggestions on a Smooth Implementation of Emissions Trading

To ensure that emissions trading is implemented more smoothly, there are several ways to promote the implementation. Many countries are reluctant to cut emissions because it would be too costly and slow economic growth. Therefore, the government can try to promote research on green energy innovation, which can reduce emissions while reducing costs and increasing participation. Reduce the financing threshold and cost of industrial companies' low-carbon technological innovation, and improve the credit policy for financing green and low-carbon technology. Although low-carbon technology innovation aids low-carbon technology progress and energy-saving efficiency

DOI: 10.54254/2754-1169/26/20230552

improvement, it is difficult to accomplish due to R&D financial constraints. In order to correctly invest in energy-saving technology projects, speed up the development of low-carbon technology, lower the cost of changing the energy structure, and increase the low-carbon technology's competitiveness in the market, financial institutions need to be guided [7].

Second, the introduction of the reputation system is also a good option to promote emissions trading. The reputation system is a powerful tool for ensuring players' ethical conduct and raising market quality. To accomplish this, a reputation system integration with a trading mechanism—in which participant success and commitment to emission reduction efforts are indicated by reputation—is used [8]. The commitment of a nation to tackling environmental concerns and reducing greenhouse gas emissions can be communicated to investors, international organizations, and other nations through a positive reputation. This can boost international cooperation, encourage economic progress, and stimulate foreign investment. A reputation-based trading system, however, is difficult to implement in the present ETS environment.

However, there are also some uncertainties and factors that may influence the outcome but not in the model. In the model, the carbon price B in the model is an unchanging number, but in reality, the carbon price will be affected by many factors and is not stable. Residents primarily influence the carbon price by altering consumer demand on the market for goods and thereby influencing the production choices made by businesses. Businesses modify their own demand for carbon quotas and have an impact on customer demand, which affects the price of carbon. Governments influence the price of carbon by acting directly in the carbon market and by influencing both consumer and business demand for carbon quotas [9].

It is assumed in the model that when developed countries implement emissions trading and developing countries do not, the benefits of developing countries are zero. In reality, however, developing countries can benefit from environmental improvements in the long run without having to implement such a policy. So the developing country needs to consider the benefits of selling permits and the benefits of not implementing them, so it may form a relative prisoner's dilemma. When nations have unlimited options, the Nash equilibrium results in significantly more carbon emissions than desirable. Because of this, climate change is occasionally referred to as a societal dilemma. This and other normal-form games help people comprehend the free-rider issue, but they do not reveal the sequential structure of strategic behavior [10]. This enables people to deal with the societal dilemma.

6. Conclusion

Emissions trading sets out a clear path for reducing carbon pollution. From the economic side, emissions trading delivers cost-effective abatement, promotes low-carbon development, and provides considerable flexibility. In terms of the policy, emissions trading provides revenue for the government and more comprehensive information and co-benefits for the country. In the model developed, it is the end result that both developed and developing countries implement policies. Developing countries can gain from it, and developed countries can meet their emission reduction targets more easily. In order to smooth the implementation of the policy, the government needs to promote green energy innovation in the country to reduce the cost. The introduction of a reputation system would also guarantee the effectiveness and efficiency of the market. However, some factors are not considered in the model. In real life, the carbon price is easily affected by various factors, such as the demand and supply of residents and enterprises. In addition, the free-rider is not considered, and developing countries may be able to enjoy the benefits of emission reduction brought by developed countries by not implementing this policy.

DOI: 10.54254/2754-1169/26/20230552

References

[1] *Flavelle, C. (2021). Climate Change Could Cut World Economy by $23 Trillion in 2050, Insurance Giant Warns. New York Times 22.*
[2] *Revkin, A. (2001). Global warming impasse is broken. New York Times, 1A, 8.*
[3] *Eden, A., et al. (2016). Benefits of emissions trading. Berlin: ICAP Policy Paper.*
[4] *Elkins, P. and Terry, B. (2001). Carbon taxes and carbon emissions trading. Journal of economic surveys 15(3), 325-376.*
[5] *Akimoto, K., et al. (2010). Estimates of GHG emission reduction potential by country, sector, and cost. Energy Policy 38(7), 3384-3393.*
[6] *Philibert, C. (2000). How could emissions trading benefit developing countries. Energy Policy 28(13), 947-956.*
[7] *Yu, Y. J. and Shi, J. W. (2022). Environmental regulation, low-carbon technology progress and energy efficiency. Frontiers in Environmental Science, 1725.*
[8] *Jøsang, A., Ismail, R. and Boyd, C. (2007). A survey of trust and reputation systems for online service provision. Decision support systems 43(2), 618-644.*
[9] *Ji, C. J., Hu, Y. J. and Tang, B. J. (2018). Research on carbon market price mechanism and influencing factors: a literature review. Natural Hazards 92, 761-782.*
[10] *Wood, P. J. (2011). Climate change and game theory. Annals of the New York Academy of Sciences 1219(1), 153-170.*