International Transportation and Environmental Regulation

DONG Weijia

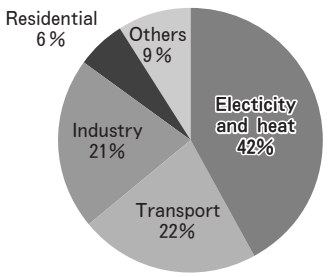
Greenhouse gases emissions from international shipping and aviation, which are the essential pillars of international trade, are important because the emissions are increasing sharply due to trade shifts from proximate partners to distant partners and the emissions are excluded from the present worldwide environmental framework. This paper overviews the current situation and challenges of environmental regulation in the international transport sector, then introduces the literature review of theoretical and empirical analysis, to establish the international transport and emission trade model, and to seek the practical environmental regulation policies.

Keywords: Environmental regulation, Emissions trading system, International trade, Transportation

Ⅰ. Introduction

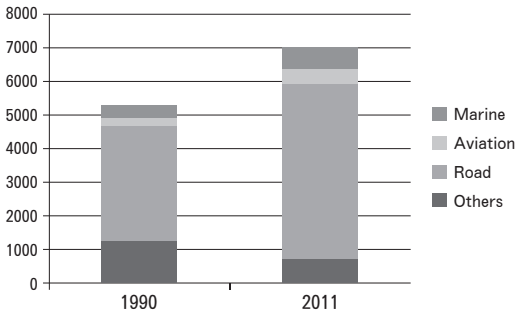
With the expansion of international trade and economic growth in emerging countries, demand for international transport has been increasing rapidly. The greenhouse gas emissions from international transport sector also continue to increase. According to the research report of International Energy Agency (IEA), CO_2 emissions from the transportation industry has increased by 33% since 1990, and account for approximately 22% of global emissions in 2011. As for the sub-section of the transportation sector, the fast emissions growth was driven by emissions from the road sector, which increased by 52% since 1990 and accounted for about three quarters of transport emissions in 2011, It is important to note that despite efforts to limit emissions from international transport, emissions from marine and aviation bunkers, both about 80% higher in 2011 than in 1990, grew even faster than those from road. Figure 1 shows the proportion of the CO_2 emissions in different sectors, and Figure 2 shows the percentage of CO_2 emissions of each sub-section of the transportation sector.

Figure 1. World CO_2 Emissions by Sector in 2011



Source: IEA(2013)

Figure 2. CO_2 Emissions from Transport Sector



Source: IEA(2013)

The present worldwide environmental framework (the United Nations Framework Convention on Climate Change (UNFCCC))

excludes greenhouse gas (GHG) emissions from international transport. The reason is that it is difficult to identify which countries should be responsible for GHG emissions arising from international transport, with regulations on international transport entrusted to specialized international organizations such as the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO). Moreover, there is also an important difference in the basic principles employed by the UNFCCC, the ICAO and the IMO in that it is common to use the principle of Common but Differentiated Responsibility (CBDR) in multilateral agreements on the environment under the UNFCCC. However, historically both the ICAO and the IMO have adopted the nondiscriminatory principle. This is one reason why it is difficult to take the interests of developing countries into account.

The purpose of this paper is to overview the current situation and challenges of environmental regulation in the international transport sector, then introduce the literature review of theoretical and empirical analysis, to establish the international transport and emission trade model, and to seek the practical environmental regulation policies.

Ⅱ. CO_2 Emission Reduction Potential from International Transportation

Global demand for transport appears unlikely to decrease in the foreseeable future; the World Energy Outlook 2013 projects that transport fuel demand will grow by nearly 40% by 2035. And the rising demand for aviation and shipping is expected to significantly increase CO_2 emissions from these sectors under a BAU (business-as-usual) scenario where no new policies are adopted to control CO_2 emissions. This will happen because growth rates for aviation and marine travel are higher than energy efficiency improvements. Furthermore, low-carbon fuels are not expected to achieve significant enough market penetration to lower CO_2 emissions, from the aviation and marine transportation sectors in a BAU scenario due to their relatively high costs.

A number of technological and operational options are available to limit the rapid growth in aviation CO_2 emissions expected in a business-as-usual future. These include improved navigation systems in the near to medium term and advanced propulsion systems, lightweight materials, improved aerodynamics, new airframe designs, and alternative fuels over the medium to long term. Combining the various abatement options, the potential exists to reduce annual CO_2 emissions from global aviation by more than 50% below BAU projections in 2050 (see Table 1).

On the other hand, CO_2 emissions also can be mitigated from shipping by increasing efficiency (i.e., decreasing fuel consumption/ton-mile) and using less CO_2-intensive fuels or power sources. Operational measures, such as speed reduction, offer a large and near-term mitigation option, while improving the energy efficiency of new ships and switching to alternative fuels provide longer-term potential. However, absent a technological breakthrough,

Table 1. GHG Reduction Potentials in 2050 by Abatement Option and Sector

	Reduction Potential in Aviation Sector	Reduction Potential in Marine Sector
Operations	5%	27%
Design and Propulsion	35%	17%
Alternative Fuels and Power	24%	38%
Total Reduction from BAU Emissions in 2050	53%	62%

Source: McCollum et al. (2009)

application of all available technological mitigation options could slow, but is not likely to be enough to stop, the rising emissions caused by increasing demand for shipping (IMO 2008).

The technological and operational potential for reducing international and domestic CO_2 emissions from aircraft and marine vessels is considerable; however, the rate of improvement under business-as-usual conditions is unlikely to be sufficient to eliminate the projected growth in emissions from steadily increasing demand. To slow and eventually reverse this growth, policy intervention is required in the form of regulations or incentives to accelerate the adoption of fuel-saving advanced technologies and operational measures. The next section outlines international policy options for reducing GHG emissions from aviation and marine transportation.

Ⅲ. Environmental Regulation of International Transportation

1. Environmental Regulation of International Shipping

Although international shipping is the most energy efficient mode of mass transport and only a modest contributor to overall CO_2 emissions, a global approach to further improve its energy efficiency and effective emission control is needed as sea transport will continue growing apace with world trade. As already acknowledged by the Kyoto Protocol, CO_2 emissions from international shipping cannot be attributed to any particular national economy due to its global activities and complex operation. Therefore, IMO has been energetically pursuing the limitation and reduction of GHG emissions from international shipping, in recognition of the magnitude of the climate change challenge and the intense focus on this topic.

IMO's Marine Environment Protection Committee (MEPC) has given extensive consideration to control of GHG emissions from ships and finalized in July 2009 a package of specific technical and operational reduction measures. In March 2010 MEPC started the consideration of making the technical and operational measures mandatory for all ships irrespective of flag and ownership. This work was completed in July 2011 with the breakthrough adoption of technical measures for new ships and operational reduction measures for all ships, which are, consequently, the first ever mandatory global GHG reduction regime for an entire industry sector. The adopted measures add to MARPOL Annex VI a new chapter entitled "Regulations on energy efficiency for ships", making mandatory the Energy Efficiency Design Index (EEDI) for new ships and the Ship Energy Efficiency Plan (SEEMP) for all ships. The regulations apply to all ships over 400 gross tonnage and above and are expected to enter into force through the tacit acceptance procedure on 1 January 2013.

However, the technical and operational measures will not be sufficient to satisfactorily reduce the amount of GHG emissions from international shipping in view of the growth projections of human population and world trade. Therefore, market-based mechanisms have also been considered and would serve two main purposes: providing a fiscal incentive for the maritime industry to invest in more energy efficient manner and off-setting of growing ship emissions.

In line with the work plan adopted at MEPC 55 (October 2006), potential Market-Based Measures (MBMs) have been considered in-depth by every single MEPC since MEPC 56 (July 2006). MEPC 55 work plan ceased at MEPC 59 (July 2009), where the Committee recognized that technical and operational measures would not be sufficient to satisfactorily reduce the amount of GHG emissions from international shipping in view of the growth projections of world trade. It was therefore agreed by overwhelming majority that an MBM was

Table 2. Market-Based Measures：Main Proposal

Countries, Organizations	System	Main proposal
Denmark, etc.	GHG FUND	Establishes a global reduction target for international shipping, set by either UNFCCC or IMO. Emissions above the target line would be offset largely by purchasing approved emission reduction credits. The offsetting activities would be financed by a contribution paid by ships on every tonne of bunker fuel purchased.
Norway, Germany, France, etc.	ETS：Emission Trading System	Sets a sector-wide cap on net emissions from international shipping. A number of allowances (Ship Emission Units) corresponding to the cap would be released into the market each year via a global auctioning process. The units could then be traded.
Japan, World Shipping Council (WSC)	EIS：Efficiency Incentive Scheme	GHG Fund contributions are collected on marine bunker. Part thereof is refunded to ships meeting or exceeding agreed efficiency benchmarks and labeled as "good performance ships".
USA	SETC：Ship Efficiency and Credit Trading	Subjects all ships to mandatory energy efficiency standards. As one means of complying with the standard, an efficiency-credit trading program would be established. These standards would become more stringent over time,
Jamaica	PSL：Port State Levy	Levies a uniform emissions charge on all vessels calling at their respective ports based on the amount of fuel consumed by the respective vessel on its voyage to that port (not bunker suppliers).

Source: IMO (2011)

needed as part of a comprehensive package of measure for the effective regulation of GHG emissions from international shipping. In this regard, the Committee agreed upon a new work plan for the further consideration of MBMs culminating in July 2011 at MEPC 62. MBMs place a price on GHG emissions and serve two main purposes: providing an economic incentive for the maritime industry to reduce its fuel consumption by investing in more fuel efficient ships and technologies and to operate ships in a more energy efficient-manner (in-sector reductions); and offsetting in other sectors of growing ship emissions (out-of-sector reductions). In addition, MBMs can generate funds that could be used for different purposes such as adaptation and transfer of technology. The proposed Market-Based Measures are summarized in Table 2.

2. Environmental Regulation of International Aviation

ICAO responded to the mandate from the Kyoto Protocol and incorporated activities related to measures to reduce GHG emissions in its work program soon after the Kyoto Protocol was adopted. ICAO staff and public and private sector experts participated in the development of the Intergovernmental Panel on Climate Change (IPCC)'s Special Report on Aviation (IPCC 1999) and have worked with other experts on methodological issues related to modeling and reporting of GHG emissions from aviation. ICAO has also explored a number of policy options including: encouraging voluntary programs; developing and evaluating designs for an emissions trading program for aviation emissions and issuing draft guidance for incorporating international aviation emissions into national emissions trading schemes; analyzing the possible use of a fuel tax or charge; examining the potential for

improved operational measures to reduce fuel burn, and exploring the possible design and use of emissions or efficiency standards.

At the 36th Session of the ICAO Assembly in 2007, the member countries discussed a range of policy options along with issues related to reconciling the concept of common but differentiated responsibilities contained in the UNFCCC with the concept of non-discrimination contained in the Chicago Convention under which ICAO operates. This issue specifically arose in the context of the European Union's emissions trading scheme, which is designed to apply to all airlines flying into or out of EU airports. The countries at the Assembly adopted guidelines for countries to use in developing their own national emissions trading schemes. A key element of these guidelines was that participation in any national emissions trading regimes should only be on the basis of the mutual consent of the countries involved. Because of the potential conflict with the European Union emission trading system, 42 European countries reserved their position regarding this element of the resolution.

Moreover, a number of nations have expressed concern that the EU decision was not based on the mutual consent of the countries involved and may seek to challenge the legality of including aviation emissions within the European Union's emissions trading regime under the terms of the Chicago Convention. In seeking to advance efforts to address GHG emissions from the aviation sector under ICAO, the 36th Session of the Assembly also established a Group on International Aviation and Climate Change (GIACC) with the task of developing a program of action to address this issue. This group was to establish a possible global aircraft fuel efficiency goal and a menu of options for achieving this goal from which countries can choose (ICAO 2010).

Following a series of meetings, GIACC issued a final report in June 2009 (ICAO 2009). This report recommends an approach where individual countries develop action plans to suit their circumstances guided by a global aspirational goal for GHG emissions. GIACC recommends an aspirational goal of 2% per year improvement in fuel efficiency. For context, average passenger growth is forecasted to be 5% per year, with emissions growth at 3%, under BAU conditions. Thus, GIACC's aspirational goal would slow but not offset the expected growth in emissions. The Group discussed options related to carbon-neutral growth or goals aimed at reducing total emissions over time, but the group did not achieve consensus in support of these proposals. In addition, GIACC recommended that countries select from the basket of measures developed by ICAO, which include aircraft-related technology development, improved air traffic management and infrastructure use, more efficient operations, economic/market-based measures, and regulatory measures. GIACC also recommended that ICAO continue to develop a CO standard for new aircraft types. While reaching agreement on the Programme of Action, no consensus emerged from the GIACC discussions on issues related to the extent of involvement of developing countries or the need for market-based strategies (ICAO 2009).

Furthermore, in October 2009, members of the airline industry trade group, the International Air Transport Association (IATA), also announced fuel efficiency improvement targets. IATA pledged that the industry would improve fuel efficiency by 1.5% a year through 2020. As a long-term goal, the industry would aim to reduce GHGs by 50% from 2005 levels by 2050. IATA also launched a Carbon Offset Program, which is simply a way for individuals or organizations, in this case airline passengers and corporate customers, to "neutralize" their proportion of an aircraft's carbon emissions on a particular journey by investing in carbon reduction projects. Over 30 IATA member airlines have introduced the

offset program either integrated into their web-sales engines or to a third party offset provider. IATA's program brings both standardization to the process and makes it possible for airlines of any size to easily introduce a credible and independently validated offset program. Offsets are carefully selected and accounted for, and the issue of carbon calculation has been resolved by committing to the ICAO methodology supplemented with actual airline carbon data.

Finally, since the start of 2012 emissions from all flights from, to and within the European Economic Area (EEA) - the 28 EU Member States, plus Iceland, Liechtenstein and Norway - are included in the EU Emissions Trading System (EU ETS). The legislation, adopted in 2008, applies to EU and non-EU airlines alike. To allow time for negotiations on a global market-based measure applying to aviation emissions, the EU ETS requirements were suspended for flights in 2012 to and from non-European countries. For the period 2013-2016 the legislation has also been amended so that only emissions from flights within the EEA fall under the EU ETS. Exemptions for operators with low emissions have also been introduced. For details see the Documentation and FAQ tabs above (which also include information on the European Commission's initial proposal for emissions coverage within the European regional airspace). The EU made this change following agreement by the International Civil Aviation Organization (ICAO) Assembly in October 2013 to develop a global market-based mechanism addressing international aviation emissions by 2016 and apply it by 2020. This agreement followed years of pressure from the EU for global action. The amended law provides for the Commission to report to the European Parliament and Council on the outcome of the 2016 ICAO Assembly and propose measures as appropriate to take international developments into account with effect from 2017.

Ⅳ. Literature Review of Theoretical and Empirical Analysis

Among the earliest attempts to analyze the topic of transportation by introducing transport into the framework of the simple general equilibrium model of international trade was Mundell's (1957) study based on an earlier work by Samuelson (1954). Samuelson was primarily interested in the question of the effects of transport costs on the terms of trade in the context of the transfer problem. Mundell, on the other hand, had a broader interest in the implications of transport costs and stressed the geometry of the problem.

Unlike Samuelson and Mundell, Herberg (1970) assumed that the transport service is distinct from the two traded goods and can be supplied by either country. The technology in the transport sector was assumed to be linearly homogenous in labor and capital, but rather than leaving market forces determine the supplier of transport services Herberg stipulated that each country transports its own imports. Cassing (1978) adopted a simplified version of the Herberg model in which only one traded commodity requires transportation services.

Moreover, Copeland and Taylor (2005) and Marschinski et al. (2012) examined international emissions trading between final goods sectors. They found that a country may be harmed by international emissions trading but did not obtain a clear condition for the welfare effects of international emissions trading. Most recently, Abe et al. (2012) analyzed the effects of trade liberalization and environmental regulation in a two-country strategic trade policy model when international transportation generates global pollution. However, they used a one-good partial equilibrium model to shed light on the strategic effects between countries, thereby omitting any interactions between industries through factor movements.

Efforts to empirically measure the

contribution of international transport to GHG emissions also have been limited in scope. Recently, Criatea at el. (2012) combined data on trade, transportation modes, transport emissions, and output emissions to calculate the contribution of transportation to trade-related greenhouse gas emissions in the aggregate and for all trade flows worldwide. It is shown that international transport is responsible for one-third of world-wide trade-related emissions, and over 75% of emissions for major manufacturing categories.

Ⅴ. Conclusions

In order to avoid future climate change, reduction of greenhouse gases in the long term is significantly urgent. Since the emissions from international transportation in the future are expected to increase more rapidly than other sources of emissions, it is important to reconsider the role of environmental regulations of international transport sector.

In this paper, we overviewed the current situation of environmental regulation of the international transport sector. Under the "national approach" which is promoted by the international organizations such as ICAO and IMO, conflicting interests between sovereign nations are irreconcilable, particularly the conflicts between the developed countries who advocate "the principle of nondiscrimination" in Chicago Convention, and the developing countries who insist "the principle of Common but Differentiated Responsibility". Thus, it is difficult to establish the international environmental regulation system, even to set the aggressive reduction targets of total amount of GHG emission. In contrast, the "global sector approach" which is promoted by IATA, is able to integrate the airlines companies of developing and developed countries and all segments of the aviation business, to take advantage of the aviation sector's proactive approach to addressing the issues of climate change.

For future research, it is certainly worthwhile to build theatrical models to more deeply understand the mechanism underlying environmental regulations on international transport. Marketable permit systems of final goods and international transport can be integrated into a single worldwide marketable permit system to reduce global pollution emissions more efficiently. It is also interesting to construct an oligopoly model of international trade to consider strategic interactions between firms with respect to international emissions trading in international transport.

References

Abe, K., K. Hattori, and Y. Kawagoshi (2014), "Trade liberalization and environmental regulation on international transportation," *Japanese Economic Review*, first published online: 22 May, 2014.

Cassing, James H. (1978), "Transport Costs in International Trade Theory: A Comparison with the Analysis of Nontraded Goods," *The Quarterly Journal of Economics*, Vol.92, No.4, pp.535-550.

Copeland, Brian and M. Scott, Taylor (2005), *Trade and the Environment: Theory and Evidence*, Princeton, the United States of America

Herberg, Horst (1970), "Economic Growth and International Trade with Transport Costs," *Zeitschrift fur die Gesamte Staatswissenschaft* (*Journal of Institutional and Theoretical Economics*), Vol.126, No.4, pp.577-600.

International Air Transport Association (IATA) (2009), *A global approach to reducing aviation emissions, First step: carbon-neutral growth by 2020*, Switzerland: IATA.

International Air Transport Association (IATA) (2010), *Industry Carbon Offset Program*: IATA.

International Civil Aviation Organization (ICAO) (2009), *Global Aviation CO_2 Emissions to 2050*: ICAO.
http://www.icao.int/environmental-protection/GIACC/Giacc-4/CENV_GIACC4_IP1_IP2%20IP3.pdf

International Civil Aviation Organization (ICAO) (2010), *Environmental Report*: *Aviation and Climate Change*, Canada: ICAO.
http://legacy.icao.int/icao/en/env2010/Pubs/ENV_Report_2010.pdf

International Maritime Organization (IMO) (2009), *Second International Maritime Organization*

Greenhouse Gas study 2009, United Kingdom: IMO.

International Maritime Organization (IMO) (2010), *MEPC61/INF.2, Reduction of GHG Emissions from Ships, Full Report of the Work Undertaken by the Expert Group on Feasibility Study and Impact Assessment of possible Market-based Measures* IMO.

International Maritime Organization (IMO) (2011), *Main Events in IMO's Work on Limitation and Reduction of Greenhouse Gas Emissions from International Shipping*: IMO.

McCollum, David, Gregory Gould, and David Greene (2009), *Greenhouse Gas Emissions from Aviation and Marine Transportation: Mitigation Potential and Policies*, Pew Center on Global Climate Change, Arlington

Marschinski, R., C. Flachsland, and M. Jakob (2012), "Sectoral linking of carbon markets: A trade-theory analysis," *Resource and Energy Economics*, Vol.34, No.4, pp.585-606.

Mundell, Robert A. (1957), "A Geometry of Transport Costs in International Trade Theory," *Canadian Journal of Economics and Political Science*, Vol.23, No.3, pp.331-348.

Samuelson, Paul A. (1954), "The Transfer Problem and Transport Costs; II: Analysis of Effects of Trade Impediments," *The Economic Journal*, Vol.64, No.254, pp.264-269.

United Nations Conference on Trade and Development (UNCTAD) (2011), Review of Maritime Transport.

（Graduate School of Economics, Nagoya University）