THE CONTRIBUTION OF TRANSPORT POLICIES TO THE MITIGATION POTENTIAL AND COST OF 2°C AND 1.5°C GOALS

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Overview

The transport sector represents a quarter of global CO_2 emissions and is recognized to be one of the main causes of global warming. Reduction of global transport-related CO_2 emissions to limit the magnitude or rate of long-term climate change will be challenging, because the continuing growth in passenger and freight activity will outweigh all mitigation measures unless transport emissions can be strongly decoupled from gross domestic product (GDP) growth. To reduce emissions from the transport sector, policy makers are primarily pushing for more efficient vehicles, alternative sources of energy such as electricity and biofuel, electric vehicles, speed regulation, reducing vehicle miles travelled (VMT), traffic signal coordination, public transit system improvement, and other traffic management measures. Existing studies have explored transport policies that can contribute to the achievement of decarbonization in the transport sector, however, there is limited information on whether and how transport policies affect the mitigation cost and whether these policies are conducive to achieving the stringent global temperature limits of below 2℃ and 1.5℃. To achieve a better understanding of the role of transport policies for climate change targets especially with respect to the context of Paris Agreement, the main purpose of this research is to investigate the interaction between transport policies, global dynamics of transport demand volume, energy consumption, mitigation potential, and cost for the goal of limiting warming to below 2℃ and 1.5℃.

Methods

A transport model, AIM/Transport, is developed to project the global passenger and freight transport demand for different modes and technologies and transport-related emissions, incorporating transport mode choice and technological details.The essence of AIM/Transport is a transport choice model that consists of different tiers. Passenger and freight transport flow can be divided between short and long distances. At the next level, transport modes compete with each other for short and long-distance travel.

AIM/Transport is coupled with a global computable general equilibrium model AIM/CGE to capture the interactive mechanism between the transport sector, energy, and the macroeconomy. AIM/CGE is also a one-year interval recursive-type, dynamic, general equilibrium model that covers all regions of the world and consists of 42 industrial classifications. AIM/CGE passes the macroeconomic variables to AIM/Transport for transport demand projection and estimation for modal split and technology shares. An iterative method was used to integrate AIM/CGE and AIM/Transport. The transport volume, transport-related energy consumption, and capital cost for transport device feedback from AIM/Transport is passed to AIM/CGE for parameter re-estimations of the transport sector in AIM/CGE. This loop continues until the energy consumptions computed in AIM/CGE and AIM/Transport are equal. The iterative procedure can help enrich the transport representation in AIM/CGE, based on detailed AIM/Transport information.

We structured the scenario framework in three dimensions. For the GDP and population, shared socioeconomic pathways 2 (SSP2) estimates were employed as default values for GDP and population in AIM/Transport. The second dimension is the climate policy dimension, denoted by “BaU”, “2D” and “1.5D”. In the “BaU” scenario, no climate mitigation efforts are assumed, while a carbon price is imposed in the “2D” and “1.5D” scenarios. The third dimension is the transport policy for simulating how different transport factors and policy interventions affect the mitigation potential and cost. We selected representative transport policies from technological and behavioral aspects. Here, energy efficiency improvement and vehicle technological innovation were applied as transport technological factors; mass transit-oriented transport development and vehicle occupancy were used for transport behavioral factors, and the low-carbon scenario was applied to combine technological and behavioral issues.

Results

The results show that deep decarbonization in the transport sector can be achieved by implementing transport policies such as energy efficiency improvements, vehicle technology innovations particularly the deployment of electric vehicles, public transport developments, and increasing the car occupancy rate. As 15.7% of cumulative emissions can be reduced during 2005 to 2100, energy efficiency improvements provide the most significant reduction potential; the lowest reduction is attributed to mass transit-oriented transport development. Technological innovations, social transformation, and human behavior are all needed for a reduction in transport-related emissions. Implementation of transport policies combining technological innovation and changes in transport behaviors is required to achieve both the 2°C and 1.5°C goals.

The key finding is that low-carbon transport policies can reduce the carbon price, gross domestic product loss rate, and welfare loss rate generated by climate mitigation policies to limit global warming to 2°C and 1.5°C, because the low-carbon transport policies are conducive to decreasing the CO_2 emissions in the transport sector, which helps alleviate the economic losses generated by stringent carbon tax imposition. This implies that technological innovation and behavioral changes in the transport sector do exert positive influences on mitigation costs for achieving climate change mitigation targets. The contribution of transport policies is more effective for stringent climate change targets in the 1.5°C scenario, which implies that the stronger the mitigation intensity, the more transport specific policy required. The transport sector requires attention to achieve the goal of stringent climate change mitigation.

Conclusions

This study investigated the impacts on mitigation potential and cost using a global transport model AIM/Transport coupled with a computable general equilibrium model AIM/CGE. The integration of the transport model and CGE model can enrich transport representation in an integrated assessment model and capture mode and technological factors. Because the feedback between the AIM/Transport and AIM/CGE models helps detect the effects of transport sector dynamics on the macroeconomy, we are convinced that transport policies provide an effective contribution to modifying the mitigation cost. Importantly, the GDP and welfare loss for meeting the 2°C and 1.5°C targets in the long term can be reduced via low-carbon transport policies, which can contribute to the deep global transformation needed to achieve climate change mitigation targets. Because this methodology of transport modeling overcomes the limitations of linking the CGE model and the transport model, it may be used by transport planners to analyze how mitigation options would affect the dynamics of the macroeconomy. Interestingly, the greater effectiveness of transport policies was well demonstrated in the 1.5°C scenario, indicating that the transport sector deserves more attention for achieving stringent climate change mitigation targets.