A Computable General Equilibrium Analysis of Energy Tax Reform for Carbon Mitigation in Japan.

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Introduction

The increasing concerns regarding climate change have underscored the importance of implementing carbon pricing policies. A critical issue associated with the introduction of carbon pricing is the management of pre-existing energy-related taxes, such as the petroleum and coal tax. Although these taxes contribute to the reduction of CO_2 emissions by escalating the costs of energy, they were not originally designed with CO_2 reduction as a primary objective. This misalignment results in considerable discrepancies in tax rates per unit of CO_2 across different energy sources. For enhanced efficacy in CO_2 reduction, equalization of these tax rates is advisable. Consequently, substituting the current energy-related taxes with a uniform carbon tax could mitigate the economic burdens associated with reducing CO_2 emissions. Typically, the economic repercussions of climate policies are assessed using computable general equilibrium (CGE) models. However, most existing CGE analyses do not adequately account for energy-related taxes, and the potential benefits of replacing these taxes with a uniform carbon tax remain largely unexplored. This study develops a comprehensive CGE model that incorporates existing energy taxes in Japan to examine the economic advantages of such an energy tax reform.

Methodology

This study employs a computable general equilibrium (CGE) model in a simulation to analyze the reform of energy-related taxes. The model is static and configured for Japan, including 24 commodities and 14 sectors, with the 2015 Input-Output Table serving as the benchmark data and the 3EID providing CO_2 emissions data. It considers the seven existing energy-related taxes in Japan. Due to the lack of detailed tax information in the Input-Output Table, supplementary data from the National Tax Agency were utilized. Notably, taxes such as the petroleum and coal tax are subject to usage-based exemptions, yet in the Input-Output Table, these taxes are documented at the import or production stage. This misalignment impedes accurate exemption accounting. To address this limitation, the study recalibrates the tax data from the import or production stage to the usage stage. Under this framework, the study analyzes several scenarios:

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Scenario	Description
BME	This represents the benchmark equilibrium.
REM	A policy scenario where existing energy-related taxes are removed.
CES	After removing energy-related taxes, a carbon tax is introduced to keep CO_2 emissions constant at the BME level.
CTR	After removing energy-related taxes, a carbon tax is introduced to keep tax revenue constant at the BME level.
CESE	CES scenario + tax exemptions applied to “iron and steel” and “cement” sectors.
CTRE	CTR scenario + tax exemptions applied to “iron and steel” and “cement” sectors.

Results

The table below details the macroeconomic impacts. In the CES scenario, despite stable CO_2 emissions, both GDP and welfare exhibit increases, suggesting that employing a carbon tax to maintain current levels of CO_2 emissions is more efficient than utilizing existing energy-related taxes. Moreover, in the CTR scenario, substituting energy-related taxes with a carbon tax, while preserving the original tax revenue, results in a significant decrease in CO_2 emissions (15.7% reduction) alongside improvements in GDP and welfare. This underscores the efficiency of carbon taxes even when tax revenues are held constant. In both the CESE and CTRE scenarios, despite the allowance for tax exemptions, the macroeconomic impacts closely resemble those in scenarios without exemptions, indicating that targeted exemptions for sectors such as iron and steel and cement do not markedly compromise overall economic efficiency. These findings support the notion that replacing existing energy-related taxes with a carbon tax could provide substantial economic benefits in terms of CO_2 reduction.

Macroeconomic impacts

Variables	BME	REM	CES	CTR	CESE	CTRE
CO_2 ($MtCO_2$)	1,222	1,332	1,222	1,031	1,222	1,054
CO_2	0.00	8.97	0.00	-15.70	0.00	-13.81
Carbon price (yen/ton)	0	0	747	4,590	928	5,011
Energy tax revenue (billion yen)	4,731	0	0	0	0	0
Carbon tax revenue (billion yen)	0	0	913	4,731	1,134	4,731
GDP		0.28	0.26	0.10	0.26	0.10
Welfare		0.28	0.26	0.06	0.25	0.06

Values without specified units represent the percentage change from the BME.