ABC Research Alert
Vol 11, Number 2
Published Online: 31 August 2023
https://abcresearchalert.com/

Carbon Emissions Trading Scheme's Disproportionate Abatement Costs on Developing Nations: Evidence from the Korea ETS

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Abstract

This research paper delves into the intricate dynamics of Carbon Emissions Trading Schemes (ETS), emphasizing the environmental injustices embedded in their implementation, particularly with respect to the disproportionate financial and economic impacts on developing countries. Centered on the case of South Korea's ETS, the paper employs a comprehensive case study to unveil nuanced insights into how these schemes influence the competitiveness of industries in nations undergoing economic development. Employing rigorous econometric analysis, the study scrutinizes the allocation of CO2 ETS permits across various sectors, revealing significant disparities in the distribution of abatement costs. The findings underscore the multifaceted challenges of formulating global climate policies that effectively reconcile the need for environmental sustainability with the economic constraints faced by developing nations. This paper advocates for a more nuanced and equitable approach to international climate action, suggesting modifications to ETS frameworks that better account for the distinct developmental stages and economic vulnerabilities of these countries. By urging a shift towards an approach that acknowledges and addresses these complexities, the research contributes significantly to the ongoing discourse surrounding the formulation of inclusive, efficacious, and just global environmental policies.

Keywords

Carbon, ETS, Developing Nations, Environmental Justice

INTRODUCTION

Global environmental initiative minimizing the implementation costs requires a global perspective. Through the Acid Rain Program (ARP) of the Clean Air Act Amendments of 1990, the United States Congress introduced the world's first cap-and-trade system to reduce acid rain deposition by limiting sulfur dioxide (SO2) emissions from central and midwestern power plants. By 2010, the ARP successfully decreased the total emissions of the six primary air pollutants (Carbon Monoxide, Lead, Nitrogen Oxides, Ozone, Particulate Matter, and Sulfur Dioxide) by more than 41 percent with costs considerably lower than that of the traditional command-and-control regulation (EPA, 2021). The cost-effective policy persuaded global leaders at "the Kyoto Protocol" of 1997 to apply the cap-and-

trade concept to the carbon emissions regulatory environment to sustainably enhance industry competitiveness. By setting a cap on the total amount of CO2 by industry, splitting the cap into permits for free market exchange, and lowering the allowance annually, the international community sought to create a steady market force against CO2 emissions.

Recent deglobalization of economies, ideas, and technologies has built pressure against global environmental cooperation. Rising geopolitical tensions in Europe, the Middle East, and the South China Sea along with signals of a global economic recession question policymakers worldwide whether to take on the abatement costs of the CO2 emissions trading scheme (ETS). In light of the Pollution Haven Hypothesis, increased environmental regulation could weaken industrial competitiveness. Furthermore, the Environmental Kuznets Curve (EKC) hypothesis states that nations with post-industrial, service-oriented economies may be more inclined to take on short-term financial and industrial competitiveness losses compared to nations in earlier stages of economic development. The varying perspectives on environmental policy between service-oriented economies and manufacturing-oriented economies highlight the importance of understanding global abatement costs of CO2 ETS to meet the United Nations 2030 Agenda for Sustainable Development.

Thus, this case study on the Korea ETS aims to help policymakers design international CO2 ETS policies that elicit global cooperation at minimal economic losses. With econometric evidence of CO2 ETS's impact on the six sectors (Manufacturing, Energy, Construction, Transportation, Waste Management, and Public) in a manufacturing-oriented economy, it is desired that policymakers will look beyond the service-oriented economies in crafting a global ETS initiative accounting national specificities such as history, context, and cost of living.

Background on EU ETS

Operational since 2005, the EU Emissions Trading System (ETS) has been a pioneer in the establishment and maintenance of an international ETS framework (European Commission, 2023). To meet the legally binding emissions reduction targets set in the 1973 Tokyo Protocol, the European Commission drafted the green paper (abstract ideas on the design of the EU ETS) as a policy instrument. With further adoption of measurements such as the EU ETS Directives and national allocation plans (NAPs), the EU ETS spread to comprise all the EU Member States, the European Free Trade Association countries (Norway, Iceland, and Liechtenstein) as well as Northern Ireland for electricity generation (European Commission, 2023). Following Switzerland's adoption of its independent CH ETS and Brexit (withdrawal of the United Kingdom from the European Union), the EU ETS has been linked to CH ETS since 2020 and decreased in membership to 30 nations since 2021.

The EU ETS has been a driving force in shaping global emissions trading policies, serving as a model for other jurisdictions seeking effective mechanisms to combat climate change. Its inception marked a significant milestone in international efforts to regulate greenhouse gas emissions, setting a precedent for collaborative and innovative solutions. The integration of EU ETS Directives and national allocation plans underscores the system's commitment to a comprehensive and adaptable approach. The inclusion of the European Free Trade Association countries and Northern Ireland reflects a commitment to inclusivity and broad participation in the pursuit of sustainable environmental practices. As the EU ETS strategically links with Switzerland's CH ETS, it not only demonstrates a commitment to cross-border cooperation but also facilitates a more unified and streamlined approach to emissions reduction across national boundaries.

EU ETS's Impact on Industry Competitiveness

The European Union Emission Trading Scheme (EU ETS), initiated in 2005, represents a cornerstone in the European Union's strategy to mitigate climate change by cost-effectively reducing industrial greenhouse gas emissions. Spanning four developmental phases — Phase 1 (2005-2007), Phase 2 (2008-2012), Phase 3 (2013-2020), and the ongoing Phase 4 (2021-2030) — the scheme aims to enhance its efficiency in emissions reduction and assess its influence on the competitiveness of

European industries. A comprehensive review of studies evaluating the EU ETS's impacts reveals a consensus that the scheme has had a minimal negative effect on industry competitiveness across Europe. This conclusion is supported by diverse research methodologies and analyses across sectors, highlighting the scheme's nuanced implications on European industries.

Research by Chan, Li, and Zhang (2013), employing regression analysis on counterfactual scenarios, suggests the EU ETS's impact is limited and predominantly influenced by external variables like material costs, indicating that regulatory burdens have not significantly compromised the competitive stance of industries on a global scale. Similarly, an analysis of German firms from the AMADEUS database by Anger and Oberndorfer (2008) found the EU ETS to have negligible effects on revenues, reinforcing the view that firms can effectively manage compliance costs. Conversely, Demailly and Quirion's (2008) study on the iron and steel sector, identified as energy-intensive and emissions-heavy, presents a contrasting perspective with evidence of minor competitive losses attributable to the EU ETS, underscoring sector-specific vulnerabilities within the broader European industrial landscape.

The varied outcomes of these studies underscore the complexity of gauging the EU ETS's impact on competitiveness, influenced by factors such as sectoral energy intensity, cost-passing abilities, and emissions reduction technologies. Additionally, the scheme's evolution across its phases, integrating new mechanisms and adjustments, complicates overarching assessments. Despite the minimal impact on competitiveness at a general level, the nuanced effects on specific sectors and the importance of external factors are critical considerations for future adjustments to the EU ETS. As Phase 4 progresses, its continued refinement will be pivotal in balancing emissions reductions with the global competitiveness of European industries.

THEORETICAL AND METHODOLOGICAL FRAMEWORK

To assess the presence of disproportionate abatement costs between service and manufacturing-oriented economies, the author examines the relationship between CO2 ETS permit allocation and firm competitiveness. The National GHGs Management System (NGMS) database maintained by the Greenhouse Gas Information Center of the Korean Ministry of Environment has released comprehensive annual data on firm-level CO2 emissions and allocation permit usage since 2011. The average CO2 emission metric three years prior to the accounting period determines the average annual CO2 emissions for a company. Companies emitting more than 125,000 tCO2-eq on average per year or businesses emitting more than 25,000 tCO2-eq and voluntary applicants are subject to participate in the emissions trading scheme. Therefore, except for a very small number of new companies or companies that voluntarily applied, most companies were subject to the target management system and are now designated as companies subject to the emissions trading system (Han, 2023).

Owing to the lack of emissions trading schemes in major global manufacturing economies and the lack of standardized variables that could indicate the development of competitiveness and employment from 2015 to 2020, econometric analysis was conducted only with the Korean database. Regardless, the ex-post analysis of the impact of the carbon emission trading scheme may offer insights into varying perspectives of nations with differing economies imperative in global cooperation for a unified effort to reduce carbon emissions. For this empirical investigation, sectoral variables were generated according to the four-digit Industrial Statistics Analysis System (ISTANS) industry codes that are contained in the NGMS database. The sector classification includes manufacturing, energy, construction, transport, waste management, and public · etc. For more detailed information on the economic, sectoral, and emissions data employed in this analysis, please refer to Table 1. As "competitiveness is a firm's long-run profit performance and its ability to compensate its employees and provide superior returns to its owners" (Buckley, 1988), regression analysis on the impact of allocation factor on industry competitiveness and employment utilizing the economic data on the 641 Korean firms covered by the K-ETS effectively reflects the relationship. The related correlations are shown in Table 2. Average revenue BSI of the manufacturing, energy, construction, transportation, waste management, and public etc sectors was used as the dependent variable to perform ordinary least

squares (OLS) regression analysis on the monthly average revenue BSI metric of the six sectors from 2018-2020 comprising a total of 36 observations.

RESULTS

Table 3 presents the results of the OLS regression analysis used to test the hypothesis. The average monthly revenue BSI of the aforementioned sectors was used as the dependent variable and the allocation factor as the explanatory variable. With R2 — a statistical measure that represents the proportion of the variance for a dependent variable that's explained by an independent variable (Fernando, 2023) — of 47.6%, standard error — the variation between the calculated mean of the population and one which is considered known, or accepted as accurate (Kenton, 2023) — of 3.479%, the result of the OLS regression analysis displays relatively strong reflection of the dataset.

Furthermore, the p-value — statistical measurement used to validate a hypothesis against observed data — of 3.29e-6 is notably lower than the general threshold for statistical significance of 0.05 (U.S. Census Bureau, 2021), meaning the result is statistically significant indicating that the observed relationship is unlikely to be due to chance (Investopedia Team, 2023).

The robust regression analysis result affords greater significance to the calculated slope of 19.31 BSI/% —the relationship between the allocation factor and the average revenue BSI. The OLS regression analysis indicates that the allocation factor has a statistically significant impact on the average revenue BSI. Since the slope of the linear regression is positive, the average revenue BSI is expected to decrease with a smaller allocation factor.

DISCUSSION

Contemporary economic, cultural, and political pressure for environmental initiatives such as the CO2 ETS by the post-industrial nations on industrializing foreign nations reflects an embodiment of neocolonialism and hegemony. Reaping the benefits of unqualified industrialization and colonial resource exploitation, the selective “developed nations” expanded in territory and power at the cost of the global environment. Granted, in modern society exist established global laws and organizations “based on the principle of sovereign equality of all its members to maintain international peace and security” (UN Charter).

Behind the facade, however, remains a clear divide between the beneficiaries and the marginalized. Combining the empirical analysis of this study and recent employment trends in the United States, global environmental initiatives such as CO2 ETS decrease industry profit and competitiveness in manufacturing economies while creating demand for financial, technological, and consulting services.

The power disparity then serves as the most likely explanation for the developing nations’ reluctant compliance with the inequitable global environmental policy. Such marginalization of perspectives on national specificity undermines genuine international collaboration for sustainability. Thus, to advance global environmental initiatives beyond a superficial marketing tool, it is imperative to recognize and account for nations’ diverse development histories in establishing a global CO2 ETS.

Acknowledgment and reparations on the long-term effects of colonialism by the post-industrial nations are also crucial for equitable global environmental collaboration. According to Robinson, although colonialism brought technological advancement to Africa, little attempt was made to endure the benefits and thus had an overall negative impact on Africa (24). Yet, in the contemporary world, people see only the immediate result of the long-lasting consequence: developing nations’ lack of participation in environmental efforts compared to the “developed” nations.

As expressed by Chimamanda Ngozi Adichie, getting blinded by a single story leads to a skewed perception of responsibility in the contemporary environmental narrative. Whereas the post-industrial nations that have already reaped the benefits of unqualified industrialization could now afford the minor

sacrifice for sustainability, developing nations still grappling with the after-effects of colonialism may find sustainability detrimental to their growth.

POLICY IMPLICATIONS

To strengthen collaboration for sustainable development, governments must acknowledge the difference in perspectives of nations' different economies and geographical locations. The finding holds great significance in that the observed positive relationship wherein the average revenue BSI decreases with the allocation factor contradicts prior studies conducted in service-oriented economies of Europe and the United States.

As leaders of industrialization — transformation away from an agricultural- or resource-based economy, toward an economy based on mechanized manufacturing (Investopedia Team, 2023) — Europe and the United States were the first to transition to a service-oriented economy and advocate for global cooperation in decarbonization.

Such post-industrialization economies base their argument on prior research on EU ETS, California's Cap-and-Trade Program, and Regional Greenhouse Gas Initiative (RGGI) reaching a common consensus that the decarbonization measurement has a minimal negative impact, if not beneficial, on the economy and industry competitiveness. Evinced by the result of the regression analysis, however, the carbon trading scheme inflicts disproportionate abatement costs in service and manufacturing economies. From the case study of Korea, the loss in industry competitiveness could dissuade international cooperation from manufacturing-oriented economies.

A viable solution accounting for the diversity is creating an international carbon market through bottom-up linking of emissions trading systems. Similar to the linkage of Switzerland's emissions trading system to that of the European Union, an international organization could compel nations to link their pre-existing ETS to the centralized ETS by providing flexibility on adding or removing criteria within the mandatory guideline. The Swiss Emissions Trading (EHR), for instance, integrated aviation and fossil-thermal power plants as a criterion. The international organization could also establish a standardized framework to distribute allocation considering how much the manufacturing and energy sectors — two industries with the most carbon emissions — comprise a nation's economy.

Additionally, this international carbon market could be bolstered by the inclusion of mechanisms that incentivize sustainable practices and penalize excessive emissions. One such mechanism could involve the allocation of tradable carbon credits based on a country's adherence to sustainable development goals and its success in reducing overall emissions. Nations that exceed their emission reduction targets could earn additional credits, which they could then trade with countries struggling to meet their goals.

Conversely, countries falling short of their commitments might face penalties, creating a financial disincentive for excessive carbon emissions. This dual approach of rewards and penalties would not only encourage global collaboration but also drive a more comprehensive and equitable effort toward mitigating climate change on a broader scale.

CONCLUSION

Ordinary Least Square regression analysis on 641 Korean firms validates carbon trading's disproportionate abatement costs on industry competitiveness in service and manufacturing- oriented economies. Following the definition "competitiveness is a firm's long-run profit performance and its ability to compensate its employees and provide superior returns to its owners" (Buckley, 1988), average revenue BSI is used as an empirical indicator for industry competitiveness.

The lack of public data on individual firms' allocation factors and examination into only the second phase (2018-2020) of the Korean emissions trading scheme along with external factors such as the COVID-19 pandemic of 2019 remains as a potential source of error for the regression analysis.

All in all, future empirical research into the differing perspectives of nations with service and manufacturing-oriented economies on carbon trading schemes is necessary to complement the ex-post insight and maintain global cooperation for the climate crisis at minimal economic losses.

	2015 allocation factor	2016 allocation factor	2017 allocation factor	2018 allocation factor	2019 allocation factor	2020 allocation factor
Manufacturing	0.479	0.479	0.393	0.466	0.484	0.546
Energy	0.436	0.436	0.436	0.446	0.393	0.361
Construction	0.012	0.012	0.012	0.068	0.078	0.007
Transportation	0.002	0.002	0.002	0.011	0.010	0.002
Waste Management	0.016	0.016	0.016	0.030	0.023	0.023
Public · etc	0.001	0.001	0.001	0.007	0.008	0.001
avg allocation factor	0.158	0.158	0.143	0.171	0.166	0.157

Table 1: 2015-2020 allocation factor by sector

*Note: Data obtained from the Korean Ministry of Environment

	Allocation Factor	Total Industry Profit % Δ	Total Industry employees % Δ	Manu-facturing Profit % Δ	Energy Profit % Δ	Construc-tion Profit % Δ	Trans-portation Profit % Δ	Waste Management Profit % Δ	Public · etc Profit % Δ
Allocation Factor	1.00								
Total Industry Profit % Δ	0.71	1.00							
Total Industry employees % Δ	-0.52	-0.81	1.00						
Manufacturing Profit % Δ	0.64	0.82	-0.33	1.00					
Energy Profit % Δ	0.74	0.84	-0.38	0.99	1.00				
Construction Profit % Δ	0.15	0.76	-0.85	0.39	0.37	1.00			
Transportation Profit % Δ	0.91	0.89	-0.82	0.63	0.71	0.53	1.00		
Waste Manage-ment Profit % Δ	0.85	0.84	-0.41	0.95	0.98	0.31	0.79	1.00	
Public · etc Profit % Δ	0.49	0.96	-0.87	0.69	0.69	0.92	0.77	0.66	1.00

Table 2: Correlation Analysis for Korean firm sample

*Note: 641 observations. Pearson's correlation coefficients for the respective variable pairs are given.

Regression Statistics	
Multiple R	0.689613111
R Square	0.475566243
Adjusted R Square	0.46014172
Standard Error	7.48655864
Observations	36

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1728.079661	1728.079661	30.83182962	3.28613E-06
Residual	34	1905.651049	56.04856027		
Total	35	3633.73071			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	28.22318446	8.936175798	3.158306763	0.0033215	10.06269026	46.38367866	10.06269026	46.38367866
allocation factor	19.31846541	3.479148579	5.552641679	3.28613E-06	12.24798481	26.388946	12.24798481	26.388946

Table 3: OLS Analysis for Allocation Factor

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