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中国潜在分割碳减排机制的省级经济和空气质量健康影响

摘要

中国已启动全国碳排放交易体系（ETS），并计划形成一种新的省级碳排放控制机制。虽然先前研究分别探讨了 ETS 和省级减排目标，但整合两种机制的潜在分割碳减排机制对经济及空气质量相关健康的影响尚未得到充分研究。本研究采用综合建模框架，比较了 2035 年在相同全国碳排放总量目标下，三种省级控制机制对经济和 PM2.5 及臭氧相关健康结果的影响。研究发现，与传统省级控制机制（PRO_CAP）相比，ETS 使全国福利至少提高 0.12%。分割碳减排机制（PART_REG）将全国 ETS 应用于电力和高耗能行业，同时对其他行业设定省级减排目标，实现了全面 ETS 覆盖（FULL_ETS）下福利改善的 85%。ETS 使 CO2 及共同排放的空气污染物从中国北方转移至南方，改善了北方省份的空气质量，但恶化了中部和南方省份的空气质量。与 PRO_CAP 相比，PART_REG 下全国早逝人数增加 32,700 人（95% 置信区间：23,200—41,600 人）。综合考虑福利变化和货币化健康损害，ETS 在全国层面仍具成本效益，PART_REG 下的净效益中位数为 66 亿美元，比 FULL_ETS 高 20%。北方和东南沿海省份获得净正收益，而部分中部省份面临净负影响。

关键词

可计算一般均衡（CGE）；气候政策；空气质量；人群健康；成本效益分析

Abstract

China has launched the national emissions trading system (ETS) and intends to form a novel mechanism to control provincial carbon emissions. While previous studies have examined ETS and provincial reduction targets separately, the impacts of the potential integration of these approaches on welfare and air quality-related health remain underexplored. In this study, we employ an integrated modeling framework to compare the economic impacts and health outcomes associated with PM2.5 and ozone under three provincial control mechanisms with the same target for national total carbon emissions in 2035. Our findings indicate that ETS improves national welfare by at least 0.12% compared to the conventional provincial control mechanism (PRO_CAP). The partitioned carbon regulation mechanism (PART_REG), which applies the national ETS to power and energy-intensive industry sectors while assigning reduction targets to other sectors at the provincial level, achieves 85% of the welfare improvement observed under full ETS coverage (FULL_ETS). ETS redistributes CO2 and co-emitted air pollutant emissions from northern to southern China, improving air quality in northern provinces but worsening it in central and southern provinces. The national premature deaths increase by 32,700 (95% CI: 23,200—41,600) under PART_REG compared to PRO_CAP. When comparing the changes in welfare and monetized health damages, ETS remains cost-effective nationally, with a median net benefit of US$6.6 billion under PART_REG —20% higher than that under FULL_ETS. Northern and southeastern coastal provinces experience net positive benefits, while some central provinces face net negative impacts.

Keywords

computable general equilibrium (CGE), climate policy, air quality, human health, cost-benefit analysis

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