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EDITORIAL

Climate change mitigation and green transformation in China

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Introduction

Limiting global warming to below 2 °C or 1.5 °C (relative to pre-industrial levels) has been broadly accepted as the long-term target to avert unbearable climate damages (IPCC 2018). To fulfill this climate goal, the world must rapidly reduce GHG emissions (mainly carbon emissions) to or below zero, which relies on implementing concrete emissions control policies and a green transformation (Rogelj et al. 2015), thus imposing severe challenges for countries at all development stages.

As one of the fastest-growing economies, China emitted about 10 billion tons of CO_2 in 2019, over 28% of global emissions (BP. 2020). Despite a slight decline in 2020, China's carbon emissions are likely to increase again in the post-COVID-19 era (Le Quéré et al. 2021). In 2015, China pledged to peak its carbon emissions by 2030 in its Nationally Determined Contributions (NDC) for the Paris Agreement. In 2020, China updated its climate targets with greater ambitions—a commitment to neutralize its CO_2 emissions by 2060. Thus, it is crucial to investigate the design, implementation, and impacts of China's climate policies, also providing valuable insights for climate governance in other regions.

In the recent decades, several policies have helped China achieve its previous climate target, i.e., reducing its carbon intensity by 40–45% in 2020 relative to the 2005 level (Tang et al. 2019). These policies include the energy transition from fossil fuels to renewables (Duan et al. 2019), energy saving associated with efficiency enhancement (Huang et al. 2019), as well as economic transformation by total factor productivity (TFP) improvement (Yang et al. 2021). In the meantime, emerging climate policies such as carbon pricing and renewable energy incentives are expected to play an increasingly important role in reaching ambitious long-term goals (Yuan et al. 2020).

With the development of big-data processing and computing technologies, the impacts of these energy and climate policies can be simulated and analyzed using various methodologies, including top-down general equilibrium models (Wu et al. 2020; Yuan et al. 2020), bottom-up technology aggregated models (Wang et al. 2020), climate-economic integrated models (Newbold and Marten 2014; Duan et al. 2019), and state-of-the-art decomposition methods (Chen et al. 2020). These methodologies need to be refined to help assessing different policy goals, particularly given multiple uncertainties (Otto et al. 2015).

At the backdrop of these points, we initiated this Topical Collection, which includes six papers. The topics of the selected papers range from relationships between CO_2 emissions and economic growth, policy and technology options for green transformation, to spatial inequality of capital distribution towards sustainability all embedded within the context of addressing global climate change from the regional perspective of the world's largest emitter.

Decoupling of carbon emissions and economic growth

Two papers deal with the decoupling of emissions and growth from both national and industrial perspectives. Chen et al. (2020) applied the production-theoretical decomposition analysis (PDA) and Kaya identity (Kaya 1990; Zhou and Ang 2008) to study the determinants of decoupling between China's economic growth and carbon dioxide emissions. They developed a new decomposition method that combined Tapio decoupling elasticity index with PDA (Tapio 2005), by which they show that China achieved a strong economy-emission decoupling in 2012–2013 and 2015–2016.

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Wang et al. (2020) estimated the marginal abatement cost curve for the oil industry in China. Their results show that the per capita disposable income of China's oil industry will increase by 66% when the emissions reduction level rises from 1 to 50%. Consequently, the industry will spend 36.5–42.5 billion yuan per year to achieve the required carbon reductions consistent with China's NDC goal. This work also shows the benefits of applying the marginal abatement cost curve; it saved 34% of the abatement costs compared to the traditional emissions inertia method. This study provides evidence for economy-emission decoupling at industrial scale.

Green transformation: Policy and technology

Economic decarbonization heavily relies on substantial green transformation, which in turn depends on large-scale deployment of non-carbon technologies (e.g., renewables) and flexible policies (e.g., carbon pricing). Lin and Chen (2020) conducted an empirical study on China's rapidly growing solar photovoltaic (PV) industry using a fixed-effect panel model. A cost estimation model was also proposed to evaluate the average CO_2 abatement cost of power substitution. The study identified key factors that affect solar PV deployment, ranging from carbon reduction constraints, government subsidies, technological progress, energy substitution, economic growth, to solar radiation resources. The results show substantial regional differences in the carbon reduction costs of PV solar. Driven by region-specific electricity tariffs for PV, the mitigation cost in Eastern China is significantly higher than in other regions.

Inspired by Kumar and Managi (2009), Yang et al. (2021) constructed a meta-frontier Malmquist-Luenberger Productivity Indicator (MMLPI) to evaluate the change in the Green Total Factor of Productivity (GTFP) based on parametric hyperbolic distance function. They show that the annual growth rate of China's GTFP is 3.37%, and the GTFP follows a gradual upward trend. Exogenous technological change plays a leading role in the increase of green productivity, followed by environmental regulations on technological innovation.

Carbon pricing and renewable energy policy are two critical elements in the climate policy package, but their impacts are often entangled. The objective of Wu et al. (2020) was to understand the economic implications of the interaction between carbon pricing and renewable incentives. Using a multi-regional computational general equilibrium (CGE) model, they compared the economic impacts of an emissions trading system (ETS) with and without a national renewable energy policy in China. The results show that although ETS performs better in the cost-effective reduction of carbon emissions across the country, renewable energy incentives could accelerate the low-carbon energy transition in resource-intensive regions.

Sustainable development and spatial inequality

Inclusive wealth (IW) measures all forms of assets, including productive capital, human capital, and natural capital. IW indicates a region's ability to create and maintain human well-being over time and demonstrates how human, manufacturing, natural, and environmental factors interact and contribute to sustainability. Zhang and Nozawa (2020) developed a hybrid geospatial method to measure the distribution and interaction of the productive capital, human capital, and natural capital in China and Japan, based on multi-source high-resolution data. They show that Japan's IW density is about six times higher than China's, showing that Japan is currently more sustainable. Furthermore, the study shows that IW's spatial inequality is much higher in Japan than in China.

Conclusion

The papers included in this Topical Collection contribute to a better understanding of climate mitigation and green transformation at the regional level. The studies characterize accelerating decarbonization efforts and outcomes for China using a range of quantitative methods, including econometrics, macroeconomics, CGE models, and geospatial analysis. Notably, several studies quantified the regional variations in carbon abatement costs and the inclusive wealth measurements. Spatial equity patterns should be considered in the policy design for a green transformation and sustainable development. Looking ahead, more attentions should be paid to the pathways and implications of reaching long-term carbon neutrality and develop advanced methods to characterize uncertainties that originate from the Earth's climate systems, economic development, energy and climate policies, and technology research, development, and deployment.

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