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The Impact of Regional Economic Growth Patterns on Carbon Emissions: A Study From China

Strengthening local capacity in the economic analysis of environmental issues

The Economy and Environment Program for Southeast Asia (EEPSEA) was established in May 1993 to support training and research in environmental and resource economics across its 10 member countries (i.e., Cambodia, China, Indonesia, Lao PDR, Malaysia, Myanmar, Papua New Guinea, the Philippines, Thailand, and Vietnam.) It aims to strengthen local capacity for the economic analysis of environmental issues so that researchers can provide sound advice to policy makers.

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Policymakers in China face the challenge of controlling greenhouse gas (GHG) emissions whilst trying to achieve economic growth. One of the complications they face is that levels of economic growth in the country's numerous provinces or regions vary considerably. This issue has a significant effect on GHG emissions, but it has not been looked at properly by researchers. To help fill this information gap, an EEPSEA study looked at the relationships between regional economic development, energy consumption and total carbon emissions in China's provinces.

The study is the work of Dr. Chunhua Wang from the University of International Business and Economics in Beijing. It found that uneven regional economic activity has had a significant impact on China's carbon dioxide (CO_2) emissions. In particular, uneven growth across regions significantly lowered CO_2 emissions in China (by about 580.34 million tonnes of CO_2) from 1996-2010. The study therefore concludes that, to achieve national CO_2 emissions targets, policymakers must take into account the effects of uneven growth. It also makes some policy recommendations on how this can be done.

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A summary of EEPSEA Research Report No. 2014-RR8: 'Regional Economic Development, Energy Consumption and Carbon Emissions in China' by Chunhua Wang,
School of International Trade and Economics, University of International Business and Economics, 10 Huixin Dong Jie, Chaoyang District, Beijing 100029, China.
Email: chunhua.wang@rocketmail.com; wangc@uibe.edu.cn

The carbon challenge

Since 1978, when China's economic reform was initiated, the country has had a rapidly growing economy and has enjoyed an average annual growth rate of 9.5%. As a result, both energy consumption and CO_2 emissions have increased at tremendous speed. In November 2009, the Chinese government announced a target of lowering carbon emissions per unit of gross domestic product (GDP) by 40-45% by 2020 (compared with 2005 levels).

The country's climate change and GHG policies mainly target the intensity of CO_2 emissions (i.e., the CO_2 emissions per unit of GDP). The carbon intensity of China's economy is a product of its energy intensity (energy-GDP ratio) and the carbon coefficient of energy (carbon-energy ratio). Thus, changes in energy intensity and the carbon coefficient contribute to changes in the carbon intensity of the economy. This is why policymakers in China have proposed and implemented different measures to lower energy intensity and the carbon coefficient of energy in the country.

The importance of the regional picture

The main objective of this study was to investigate the links between regional economic growth in China and trends in energy consumption and CO_2 emissions from the burning of fossil fuels. The study looked at the situation between the years 1995 and 2010. This work is important because CO_2 emissions and energy consumption targets in China are normally set by the central government, which then informs each province of their targets – it is therefore vital for central policymakers to understand what is happening at the regional level.

The study collected data on China's provinces for its assessment. Information on fuel types and consumption were obtained directly from various editions of the *China Energy Statistical Yearbook* (2000-2011), which is prepared by the National Bureau of Statistics' Department of Industry and Transport Statistics and the National Development and Reform Commission's Energy Bureau. Energy consumption was converted to CO_2 emissions using fuel-specific emission factors. The study also looked at statistical publications from specific provinces for more information about related variables. This information was used to construct province-level CO_2 emission estimates based on fossil fuel combustion data for 1995-2010.

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Factories in Datong, China

Changes in China's energy profile

The study found that from 1995 to 2002 the intensity of China's CO_2 emissions steadily declined. It then experienced a short period of increase from 2002 to 2005. The intensity of emissions reached its highest level in 2005. Since 2006, emissions intensity has again been decreasing (Figure 1).

Burning coal was found to be the most significant source of CO_2 emissions in China although its importance as a source of emissions has declined slightly over the years. Coal accounted for 75.15% of total emissions in 1995, but only for 69.51% of total emissions in 2010.

Decreasing energy intensity was found to be the most important source of the decline in CO_2 emissions intensity in China over

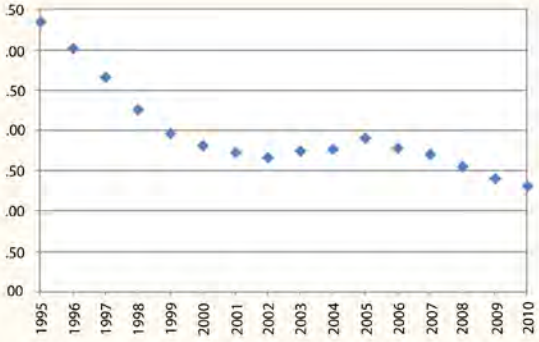

Figure 1. CO_2 intensity of China's economy (in t/CNY 10,000 1995 rates), 1995-2010

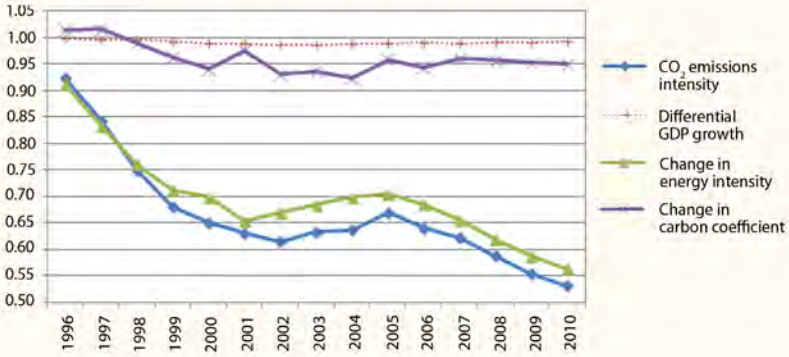

Figure 2. China's CO_2 intensity indexes, 1995-2010

the years studied. In contrast, the CO_2 coefficient of energy improved in the years before 2000, however its level remained largely steady in the years that followed (Figure 2).

It was found that changes in the capital-energy ratio and in the output structure of the economy, along with technological changes, have contributed to the declines in energy intensity of China's economy. Capital played the most important role in the process of energy intensity decline. It not only drove the decline in the provinces, but also contributed to a convergence of the level of energy intensity between provinces.

The differences between provinces

Growth rates in gross regional product (GRP), energy consumption, and CO_2 emissions were found to vary substantially across provinces in China. Between 2005 and 2010 the annual growth rate for the fastest-growing province was 17.59%, while the lowest annual growth rate amongst the provinces was 10.57%.

Disparities in carbon intensity and energy intensity across provinces were found to be striking. For example, carbon intensity in the province with the highest annual growth rate was more than nine times higher than in the province with the lowest annual growth rate. The CO_2 coefficient of energy also differed significantly across provinces.

On average, provinces experienced declines in the energy intensity and carbon intensity of their economies over the period studied. However, the carbon coefficient of energy in the provinces did not change much during these time periods.

Assessing the regional picture

To quantify the effects of differential growth, the study used a framework that broke down changes in CO_2 emissions into its sources. The year 1995 was used as the starting point. The framework incorporated four key factors: a) the national growth rate of GDP; b) the differential growth rates of GRP across regions; c) changes in the energy intensity across regional economies; and d) changes in the CO_2 emissions coefficient of energy consumption.

This approach allowed the impact of these factors to be isolated and analyzed over defined periods of time. The study also performed a non-parametric statistical analysis to understand the roles played by changes in energy intensity and carbon coefficient in the distributional dynamics of CO_2 intensity.

Uneven growth reduces CO_2 emissions

The study calculated the changes in CO_2 emissions between 1995 and for each year from 1996 to 2010. The sum of the changes during these years was 25,048.36 million tonnes. Results from the framework assessment suggest that differential growth saved about 580.34 million tonnes of CO_2 from 1996 to 2010. This is about 2.32% of the total changes.

The impact of differential growth on CO_2 emissions was found to be more important than the impact of changes in the carbon coefficient of energy in the years 1996, 1997, 2001 and 2003.

The assessment also found that output growth was a major source of the increase in CO_2 emissions, while a decline in energy intensity was the main contributor to the reduction of emissions.

The study shows that differential growth can increase or decrease CO_2 emissions. Its net effect depends on the distribution of carbon intensity and economic growth rates across regions.

Can China meet its emissions targets?

China has set itself the goal of reducing the CO_2 intensity of its economy by 40-45% by 2020, based from the level of 2005. This requires an annual reduction rate of 3.35-3.91% between 2005 and 2020. In addition, in September 2011, China's central government announced (in its national 12th Five-Year Plan, 2011-2015) that energy consumption per unit of GDP should be reduced by 16% in

the five years to the end of 2015 and that CO_2 emissions per unit of GDP should reduce by 17% over the same time period. Specific targets for energy intensity and CO_2 emissions intensity have also been set for individual provinces.

In light of these challenging goals, the study conducted simulations to analyze the chance that China would meet the targets of its 12th Five-Year Plan, as well as the goal of lowering carbon emissions intensity by 2020. The study was particularly interested in whether differential growth across regions would contribute to the chances of success.

To do this assessment, the study used forecasted values of GRP, energy consumption, and CO_2 emissions. It found that the energy intensity of the national economy will decrease by 15.12% between 2010 and 2015 and that CO_2 emissions intensity will reduce by 15.81%. This suggests that the national goals for lowering energy intensity and reducing CO_2 emissions intensity cannot be achieved.

However, the study finds that if economic growth patterns across provinces do not have as high a variation as the study's simulations predict, then the planned 17% decrease in emissions intensity during this period will have a better chance of being achieved.

Assuming that the targets for decreasing emissions intensity for 2015 could be achieved, the study finds that the 2020 goal of a 40% reduction in the CO_2 intensity of its economy could be met if China's energy intensity reduces by 10.17% in the next five-year period (2015-2020). This would be the case even if carbon coefficients do not change.

How to promote more sustainable growth

The findings of this study have significant policy implications. Overall, it found that differential growth across provinces plays an important role in determining emissions intensity at a national level. The study therefore recommends that, when policymakers set targets for reducing the energy intensity of each province, regional growth patterns should be taken into account. Indeed, it states that China's carbon emission reduction policies will only be optimal if they fully consider regional variations in economic growth rate, energy intensity, and carbon intensity.

The study suggests that regions with more efficient energy use or lower CO_2 emissions intensity should be able to receive more energy resources. Because of this, it recommends that both central and provincial governments need to improve the country's transportation systems to make it easier and more efficient to transport energy resources between regions. It suggests that, in the transport industry, coordination between policies to reduce GHG emissions could be achieved by promoting low-carbon and green transport, which is energy-efficient and produces less pollution and lower emissions. The aim of such an approach should be improving energy efficiency and optimizing the development of transportation.

Making improvements more sustainable

The study also finds that capital accumulation, changes in output structure, and technological change have all helped to lower energy intensity at both the national and provincial levels. However, the observed growth in energy productivity has been largely driven by capital accumulation, which put its long-term sustainability into question.

The study therefore recommends that relevant policies should place emphasis on decreasing energy intensity by promoting technological growth, improving the technical efficiency of poor areas, and upgrading the economic structure of the Chinese economy.

These are key suggestions as, in the years to come, China's macroeconomic policies will continue to focus on economic growth in the foreseeable future. The country will also be focused on cutting energy consumption per unit of GDP as part of a national plan for energy conservation. Because of this, capital accumulation will still play an important role in increasing energy productivity.

MALAYSIA: WorldFish headquarters, Jalan Batu Maung, Batu Maung, 11960 Bayan Lepas, Penang
Tel: +60 4 626 1606
Fax: +60 4 620 2263

PHILIPPINES: WorldFish Philippine Country Office, SEARCA Building, College, Los Baños, Laguna 4031
Tel: +63 49 536 2290 loc. 196

Email: admin@eepsea.net

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