A Regional Decomposition Analysis of CO_2 Emissions and Their Evolutions in China

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Introduction

CHINA IS CURRENTLY the world largest emitter of energy-related carbon dioxide (CO_2). Understanding the driving forces governing CO_2 emission levels and their evolutions in China can provide useful information for policy makers who aim to reduce green house gas emissions. Because of policy and historical reasons, considerable regional growth and income disparities exist in China. The regional disparities may influence energy use and CO_2 emissions. Therefore, this study is to investigate the driving forces governing CO_2 emission levels and their evolutions at regional level in China. We include the North, North-East, East, Central-South, South-West, and North-West region of China.

Regions of China

Methodology and Data

A STRUCTURAL DECOMPOSITION analysis method is used. The total CO_2 emission in the *i*th sector of the region *j* at the time *t*, CE^t_{ij}, is estimated based on energy consumption based on fuel type *k* at time *t*, $E^t_{ij,k}$, carbon emission factors of the *k*th fuel, EF_k, and the fraction of oxidized carbon by fuel as:

$$CE^t_{ij} = \sum_k CE^t_{ij,k} = \sum_k E^t_{ij,k} EF_k (1 - CS^t_k) O_k M$$

where CS^t_k is the fraction of the *k*th fuel that is not oxidized as raw materials in year *t*, O_k is the fraction of carbon oxidized based on fuel type *k*, and *M* is the molecular weight ratio of carbon dioxide to carbon.

The estimated CO_2 emission is further decomposed in order to analyze its driving forces using the following formula:

$$CE^t_j = \sum_i CI^t_{ij} EI^t_{ij} ES^t_{ij} GDP^t_j$$

where $CI^t_{ij} = CE^t_{ij}/E^t_{ij}$ is the CO_2 emission coefficient, $EI^t_{ij} = E^t_{ij}/GDP^t_{ij}$ is the energy intensity, $ES^t_{ij} = GDP^t_{ij}/GDP^t_j$ is the economic structure share, and GDP^t_j is the value of the *j*th sector. Thus the change of CO_2 emission between a base year and a target year (ΔCE) can be decomposed into four effects:

1. change in the CO_2 emission coefficient (*CI* effect),
2. changes in the energy intensity effect (*EI* effect),
3. changes in the economic structure effect (*ES* effect), and
4. changes in the economic activity effect (*GDP* effect).

Data from 1991-2007 are collected from various issues of China Statistical Yearbook and China Energy Statistical Yearbook.

Results

ENERGY CONSUMPTION IN each region in China has been increasing along with the rapid economic growth. Parallel to the growth of energy consumption, energy-related CO_2 emission in each region increased rapidly, especially during 2002-2007 (Figure 1). CO_2 emission intensity in each region showed downward trend from 1990 to 2001 (Figure 2). However, a slight increase in CO_2 emission intensity was seen during 2002-2006, especially in North-West and North.

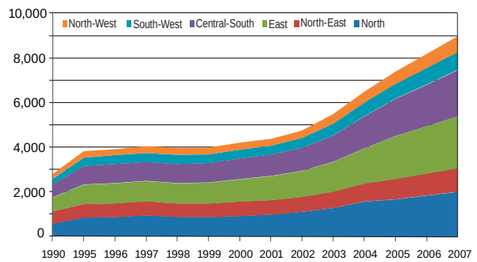

Figure 1. Regional CO_2 emission in China (MT)

The changes between year 2000 and 2007 in CO_2 emissions in Table 1 shows that GDP growth was the main driving force of total CO_2 emission growth in each region. In addition, the increase of energy intensity and economic structure change in Central-South and North-West increased CO_2 emissions in these two regions. All other regions had favorable changes for reducing CO_2 emissions in CO_2 emission coefficient, energy intensity, and economic structure. The changes in CO_2 emission intensity in Table 2 show that CO_2 emission intensity (ΔA) increased only in Central-South. In North-West, as the reduction in CO_2 emission coefficient was more than the increase in energy intensity and economic structure effect, the CO_2 emission intensity decreased.

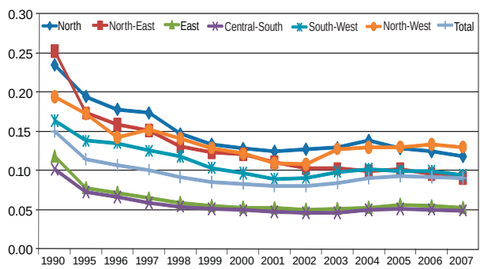

Figure 2. Regional CO_2 emission intensity in China (MT/100 million yuan)

Table 1. Regional decomposition of CO_2 emission changes between 2000 and 2007

	CI effect	EI effect	ES effect	GDP effect	ΔCE
North	-170.501	-8021.140	-350.623	55047.287	46505.024
North-East	-57.728	-9431.574	-1.788	26781.602	17290.512
East	-539.528	-2778.594	-38.527	65419.039	62062.390
Central-South	-917.760	1260.596	312.350	67251.257	67906.443
South-West	-68.041	-6942.405	-9.120	27674.983	20655.417
North-West	-537.829	378.979	43.301	16028.643	15913.093

Table 2. Regional decomposition of CO_2 emission intensity changes between 2000 and 2007

	CI effect	EI effect	ES effect	ΔA
North	-0.014	-0.666	-0.029	-0.709
North-East	-0.007	-1.110	0.000	-1.117
East	-0.017	-0.088	-0.001	-0.107
Central-South	-0.030	0.041	0.010	0.021
South-West	-0.011	-1.099	-0.001	-1.112
North-West	-0.135	0.092	0.011	-0.032

Conclusions

EMPLOYING QUANTITATIVE ECONOMIC tool, this study quantifies the contributions of several predefined factors to changes in energy-related CO_2 emissions and how the effects have evolved in six regions of China. The results reveal that the growth in economic activity accounts for most of the growth of CO_2 emissions. There are potentials for regions to reduce CO_2 emissions through the improvement of CO_2 emission coefficient, energy intensity, and economic structure, especially in Central-South and North-West.