Discussion Paper No.280

How GHG Control Policy Effect China and the World Economy

Zhengning Pu, Yasuhisa Hayashiyama

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Abstract
Two decade after the United Nations Framework Convention on Climate Change (UFCCC) had been settled, more and more evidence had proofed that extremely climate change had became a huge threaten for human being’s survive. For nowadays international community, a consensus was that Greenhouse Gas (GHG) emitted by human activities was one of the culprits which caused the extremely climate change. Thus, reduce GHG emissions caused by human activities had became a common global goal. However, the irreconcilable conflict between GHG emission reduction targets and development of human society made the GHG emission reduction goal remain like a mirage. In this study, we created a MRCGE model interlocked with GTAP. Moreover we used this model to evaluate the effect of carbon tax under different scenarios to the global GHG control target and to the macro economy, household utility in different regions of China and different areas of the world, with the result we hope to find out that whether carbon tax was effective or not for Global GHG emission control.

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1. Introduction

Two decades after the United Nations Framework Convention on Climate Change (UNFCCC) had been settled, the proposition on reducing global Greenhouse gas (GHG) was still in a long game. Although the international community already reached a consensus named as Kyoto Protocol in 1997, but because there is a conflict between the reduction target of energy use based on emission control requirements with the current human social development path which was fossil energy-based, the early national emission reduction commitments become more of a piece of paper talk. But in the past ten years, with the intensified emergence of extreme climate, the world society had realize that the time left for human beings to solve this critical issue is running out. Therefore, on COP17 conference held at Copenhagen in 2009, after a seesaw negotiation, major emitters of GHG such as USA, China, European Union and Japan finally made some concessions, announced emission reduction targets for the near future in their presentation at the conference.

Facing the pressure brought by emission reduction targets, besides using the three market mechanism Clean Development Mechanism (CDM), Emission Trading and Joint Implementation to meet emission reduction requirements, each major emitter also selected policy options such as development clean energy, increase investment in new technology, changing country's industrial structure to the face nation’s emission reduction - development conflict problem.

Besides all these policies, major emission countries also chose tax policies such as pigovian tax which economics believes to be effect for environmental control as their environmental pollution control measures to help achieve their goal of reducing GHG emissions. As for GHG emission reduction problem, the pigovian tax was usually been treated as energy resource tax for energy resource using or as carbon tax which levied directly from CO2 emission. In industrialized countries, pigovian tax had been used as environmental regulation means for a long time. For example, Denmark, the world's first national started its carbon tax imposed had its carbon tax started back in 1991. Followed with Denmark, Finland, Netherlands, Norway and Sweden these four countries also started their own carbon tax in an early period. Recently, Australia, also adopted its Carbon Tax Act at October 2011 made itself another carbon tax levying country in industrialized countries.

China was now known as the largest developing country and the largest carbon dioxide country in the world. Although it does not take emission reduction obligations in the Kyoto Protocol, but for its own sustainable development needs as well as huge emission reduction pressures outside the country, it had also announced its own pigovian tax to reach its COP17 commitment – compared to the year 2005, reduce 45% carbon dioxide per GDP unit in the year 2020. As to do so, China’s pigovian tax policy was as follow: in the year 2011, China will launch a 5% ad valorem energy resource tax trialed in its western provinces. One year after, this trial policy will extend nationwide. Furthermore, China announced it will start its carbon tax in 13 different provinces and cities in the year 2013 and make this tax become a national policy at the year 2015. With this background, predict environmental protection.

benefit and economic losses caused by carbon tax levying had became a practical significance study.

In current researches, examine the benefits and losses from environmental tax to a national or regional by Computable General Equilibrium (CGE) model is a common study paradigm which had been used worldwide. As researches in mainland China, He, et.al (2002) studied the relation between the carbon tax and carbon emissions reduction, concluding that reduction of China’s carbon emissions by five different levels would alter its respective marginal abatement costs (MAC) by 88.4 CNY/ton to 418.2 CNY/ton. Wang (2005) established a one-country static CGE model to simulate the effect of *ad valorem* energy tax in China. Results show that China would lose about 3.9% of its GDP if the nation’s carbon emission reduction rate were 40%. Moreover, the MAC for the nation in this study were about 100 CNY/ton with reduction of 10% and 470 CNY/ton with reduction of 30%.

Based on the Xie and Saltzman model, Wei (2009) constructed a CGE model with environmental feedback. They chose five levels of *ad valorem* taxation on energy resources (10–50%) to investigate the effects on China’s economy. According to their results, aside from the carbon emission reduction effect, an *ad valorem* tax on fossil fuels led to worsening of several of the nation’s microeconomic indexes such as GDP, household utility usage, and unemployment rate. However, their results also show that only when the *ad valorem* tax rate is over 20% will it cause all microeconomic indexes of the country to be reduced by more than 1%. As in 2009, Yang et al. (2009) constructed a model demonstrating that an energy tax had only a slight impact on China’s economy (all effects were under about 1%). Nevertheless, energy taxes would change China’s energy structure effectively, reducing coal use as a share of energy use.

All the studies described above share a commonality: all regarded the nation as the study object to elucidate the effects that are expected to occur in response to the exogenous shock. But when a global problem came for a giant nation such as China, two features of the problem is should be noted. These two features were a) since the country will have huge economic development difference between different regions, the region division within the country should be considered while the policy effect been evaluated. b) Carbon dioxide emission reduction is a global problem, one country could never reach successful in CO$_2$ emission reduction by its own, therefore, interactive between policy country and other country or region in the world should been considered.

Some CGE models, however, such as the GTAP model (Hertel (1997)) from Purdue University and the LINKAGE model from the World Bank, have incorporated data of multiple regions, as described by Van der Mensbrugghe (2005). These models divide the entire world into different regions and use international trade as their mutual linkage. In addition to these models, Monash University created a Multi-Regional CGE model (MMRF) that divided Australia into several states and territories. It has been used for widely various applications, such as the analysis of greenhouse gas problems by Adams, Parmenter and Horridge (2000). But these CGE models or concerned only with the regional division of one country, or only concerned the regional division of the world. In this study, we created a one country Multi Regional CGE (MRCGE) linkage GTAP model, which considered both the inner country regional division and world region division to evaluate the carbon tax effectiveness in China and worldwide.
2. Model structure

The MRCGE-GTAP linkage model used for this study is a static CGE model incorporating the assumption of a perfectly competitive market and zero profit. International trade follows a small-country assumption and the Armington assumption. Substitution between capital and energy during the production process was considered. This model is based on the one-country static CGE model presented by Hosoe, Gasawa, and Hashimoto (2004) and the static MRCGE model for China by Pu (2011). The model structure could be divided into two parts: structure which describe activities of different regions of China (MRCGE) and structure described activities all over the world (GTAP). In the following part, Fig1 – Fig 5 described the MRCGE part of the model, eq(1) – eq(7) was the market cleaning condition for MRCGE in this model. Also, Fig 6 – Fig 10 described the GTAP part of the model, eq(8) – eq(12) was the market cleaning condition for GTAP part of model. Besides, eq(13) – eq(18) were necessary conditions for the establishment of the linkage model. Explanation of the total equations and variables could be checked in the appendix and the explanation for each nest was as follows.

![Figure 1. Production Structure](image)

Production structure was showed in Figure 1, $VA$ stands for the value-added composite, which takes the labor and capital for the CES function into account. The composite intermediate input is a composite of the same intermediate inputs of different regions. The output of industry $j$ of region $r$ is regarded as the composite of $VA_{s,j}$ goods and all composite intermediate inputs under the CES function.

![Figure 2. Household Activities](image)
Figure 2 portrays the structure of household consumption. In this structure, composite household consumption comprises household consumption of the same industries of different regions. This composite was also finished under a CES function.

![Figure 2. Composite Household Consumption Structure](image)

Figure 3 portrays government activities for China in the model. All government activities are assumed to be executed by the regional local government. No central government exists. As the structure shows, the government’s income is based on taxation of three kinds: a production tax, energy tax, and direct tax. Direct taxes include labor income tax and capital tax. The government collects these taxes as government income and spends them on consumption and investment.

![Figure 3. Government Activities](image)

Figure 4. Export Structure

In the export structure, the local total output is divided into export supply and domestic supply. This division procedure is based on a CET function.

![Figure 4. Export Structure](image)

Figure 5. Import Structure

Figure 5 presents the import structure of the MRCGE part of the model. It might be said that the imported goods from the world market are combined with the local
supply in a CES function under the Armington assumption. Those composite
commodities are used to satisfy different demands, such as production input or
household consumption in the local region.

$$Q_{r,d} = \sum_{s \in S} XH_{r,d,s} + \sum_{s \in S} XG_{r,d,s} + \sum_{s \in S} \sum_{j \in J} XX_{r,d,s,j} + \sum_{s \in S} INV_{r,d,s}$$ (1)

$$\sum_{j \in J} L_{r,j} = FL_{s}$$ (2)

$$\sum_{j \in J} K_{r,j} = FK_{s}$$ (3)

$$EX_{r} = \sum_{i \in I} \sum_{s \in S} XX_{r,d,j,s} + \sum_{i \in I} \sum_{s \in S} XH_{r,d,j,s} + \sum_{i \in I} \sum_{s \in S} XG_{r,d,j,s} + \sum_{i \in I} \sum_{s \in S} INV_{r,d,j,s}$$ (4)

$$IM_{s} = \sum_{i \in R \times I} \sum_{s \in S} XX_{r,d,j,s} + \sum_{i \in R \times I} \sum_{s \in S} XH_{r,d,j,s} + \sum_{i \in R \times I} \sum_{s \in S} XG_{r,d,j,s} + \sum_{i \in R \times I} \sum_{s \in S} INV_{r,d,j,s}$$ (5)

$$TR_{s} = IM_{s} - EX_{r}$$ (6)

$$\sum TR_{s} = 0$$ (7)

Equations (1)–(8) represent the market-clearing condition of the model. Equation (1)
portrays the commodity market clearing condition. Equations (2) and (3) represent the
balance of the labor market and capital market. In the capital market, the model is
based on the assumption that all capital in the country can be transferred freely among
regions and industries. Equations (4)–(7) represent the domestic trade situation in the
model. In these equations, $EX_{r}$ in eq. (4) portrays one region’s net export to other
local regions, whereas $IM_{s}$ in eq. (5) represents one region’s total import from other
local regions. In eq.(7), $TR_{s}$ represents the net import from other local regions.

Hereinafter, the world model produced for this research has an even more simplified
structure of fundamental GTAP. It might be appropriate to be treating as a simple
version of original GTAP model. For example, GTAP had setup a World Bank sector
in the model to charge for the capital flow around all over the world. But in the model
described in this paper,

![Figure 6. Production Structure](image)

In Figure 6, showing the production structure, $WVA$ stands for the value-added
composite, which takes the labor, capital, land and nature for the CES function into
account. The composite intermediate input is a composite of the same intermediate inputs of different regions. The output of industry $j$ of region $rr$ is regarded as the composite of $WVA_{r,j}$ goods and all intermediate inputs under the CES function.

![Figure 7. Private Sector Activities](image)

**Figure 7. Private Sector Activities**

Figure 7 portrays the structure of household consumption for world’s $rr$ region. In this structure, composite household consumption comprises household consumption of the same industries of different regions.

![Figure 8. Government Activities](image)

**Figure 8. Government Activities.**

Figure 8 portrays government activities. All government activities are assumed to be executed by the region’s government. Each area only had one central government distinguished in the model. As the structure shows, the government’s income is based on several of taxation incomes: production tax, direct tax, consumption tax from private sectors, tax from each value added input, tax from intermediate input, tax earned from export and tax earned from tariff. The government collects these taxes as government income and spends them on consumption and investment (in this model, we assume that one region’s government use all savings for investment).

![Figure 9. Export Structure](image)

**Figure 9. Export Structure**
In the export structure as Figure 9 portrayed, local total output from one world region was divided into export supply and domestic supply. This division procedure is based on a CET function. For all the export good from one world region, a CET function would be used again for the division of export goods to China and export goods to other region division of the world.

Figure 10 presents the import structure of GTAP part of the model. As the figure shows, import goods from China and import goods come from other part of world out of China first composed as the composite import for the local region under CES function.

\[
WQ_{rr,i} = \sum_{j \in J} WX_{rr,i,j} + WXH_{rr,i} + WXG_{rr,i} + WXI_{rr,i}
\]  
\[
\sum_{i \in I} WLAB_{rr,i} = FWLAB_{rr}
\]  
\[
\sum_{i \in I} WK_{rr,i} = FWK_{rr}
\]  
\[
\sum_{i \in I} WLAN_{rr,i} = FWLAN_{rr}
\]  
\[
\sum_{i \in I} WENE_{rr,i} = FWENE_{rr}
\]  
\[
MM_{rr,i,oc} = EE_{oc,rr}
\]  
\[
PWE_{rr,i} = PWM_{oc,rr}
\]

Equations (8)–(14) represent the market-clearing condition of the GTAP part of the model. Equation (8) was the commodity market clearing condition. Equations (9)-(12) were the balance of labor market, capital market, land market and nature resource market.

\[
\sum_{r \in R} E_{r,j} = \sum_{r \in RR} MC_{r,j}
\]  
\[
\sum_{r \in R} M_{r,j} = \sum_{r \in RR} EC_{r,j}
\]  
\[
PWE_{i} = PWM_{rr,i}
\]  
\[
PWM_{i} = PWE_{rr,i}
\]

From equation (15) to equation (18), these 4 equations were the linkage condition.
which made it possible the link the MRCGE with the GTAP. In eq(15), \( \sum_{r \in R} E_{r,j} \) was the total export from China to the rest part of the world from MRCGE and \( \sum_{r \in RR} MC_{r,j} \) was the total import from China to the rest part of the world from GTAP, thus eq(15) was the balance equation for the export from model’s MRCGE part and import from China of model’s GTAP part. Just like equation (15), equation (16) was the balance equation for the import from model’s MRCGE part and export from China of model’s GTAP part. Equation (17) and equation (18) were the world market price balance between export prices from MRCGE with import price from GTAP and import prices from MRCGE with export price from GTAP. In these two equations, \( PWE_{i} \) was the world market export price for export commodities from MRCGE and \( PWM_{r,i} \) was the world market import price for import commodities from GTAP. Also, \( PWM_{i} \) was the world market import price for import commodities from MRCGE and \( PWE_{r,i} \) was the world market export price for export commodities from GTAP.

3. Data and Scenario

3.1 Regional Division

3.1.1 Region Division of inner China

For this research, 31 mainland China provinces and municipalities were divided into eight regions based on geography and economic facts. The regional division codes used is as shown in Table 1.

<table>
<thead>
<tr>
<th>Region</th>
<th>Included Provinces and Cities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>Heilongjiang, Jilin, Liaoning</td>
</tr>
<tr>
<td>North Municipalities</td>
<td>Beijing, Tianjin</td>
</tr>
<tr>
<td>Northern Coast</td>
<td>Hebei, Shandong</td>
</tr>
<tr>
<td>Eastern Coast</td>
<td>Jiangsu, Shanghai, Zhejiang</td>
</tr>
<tr>
<td>Southern Coast</td>
<td>Fujian, Guangdong, Hainan</td>
</tr>
<tr>
<td>Central</td>
<td>Shanxi, Henan, Anhui, Hubei, Hunan, Jiangxi</td>
</tr>
<tr>
<td>Northwest</td>
<td>Inner Mongolia, Shanxi, Ningxia, Gansu, Qinghai, Xinjiang</td>
</tr>
<tr>
<td>Southwest</td>
<td>Sichuan, Chongqing, Yunnan, Guizhou, Guangxi, Tibet</td>
</tr>
</tbody>
</table>

This manner of regional division is based not only on geography, but also on economics. Under this regional division, the eight divided regions have distinct economic characteristics. The Northeast region has long been an area of heavy industrial concentration. Its abundant mineral resources support and underpin heavy industry. The nation’s largest oil field—Daqing—is located in the region, which also has a highly developed oil industry. In addition to its industrial advantages, the area is well known as a crop production base.

The North Municipalities region is special among the regional divisions. The region includes only two cities: Beijing and Tianjin. Although they might appear similar in area or in economic scale, the political significance of the two cities and the high-technology equipment manufacturing and financial services based there give sufficient reason for them to be regarded as independent area divisions.

The Northern Coast area has rich natural resources and various industries, such as manufacturing, energy, steel, petrochemicals, and high-technology industries. At the
same time, the region has a rich output of agricultural products, such as cotton, edible oils, aquatic products, and vegetables. Its balanced economic structure gives this region strong competitive ability among regional economies.

The Eastern Coast and Southern Coast share certain similarities in their economic structures. Both areas have an export-oriented structure, with textile products and toys being the Eastern Coast’s main export products and textiles and light chemical products being the Southern Coast’s main export products. Benefiting from globalization, the two regions in such an export-oriented economic model have rapidly accumulated large amounts of wealth and have become the most economically developed areas in China.

The Central area includes six provinces that even ancient Chinese generals designated as the Central Plains area. This is a less well-off area: the major supplier of labor in China. Every year, millions of workers move from this area to coastal parts of the nation to find job opportunities. They are the major population of migrant workers nationwide. Aside from the labor supply, Shanxi province in this area is also the major supplier of coal for the nation.

The Northwest area includes several of the least-developed provinces in China, such as Ningxia, Gansu, and Qinghai. Although it might be the least developed region in the country, this region has many untapped mineral resources. These resource reserves endow this area with great economic development potential for the future.

The Southwest area is the last region in this division. The region in old China’s strategic planning was called ‘the third line’. This area has a complete industrial system and could achieve self-sufficiency. However, the industrial structure of this region has emphasized military–industrial production; this condition at some level has limited the economic development of the whole area. In addition to its industrial system, this area is known for its reserves of natural gas and rare earth minerals.

### 3.1.2 Region Division of the world

For the rest of world without mainland China, we divided it into 9 different regions. This division was referred to the international trade relationship between each region with China and the ranking of carbon dioxide emissions. World region division was showed in Table 2.

<table>
<thead>
<tr>
<th>NO.</th>
<th>Region</th>
<th>Country and Region Include</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OCN</td>
<td>Australia, New Zealand, Rest of Oceania</td>
</tr>
<tr>
<td>2</td>
<td>JPN</td>
<td>Japan</td>
</tr>
<tr>
<td>3</td>
<td>GCA</td>
<td>Hong Kong, Taiwan</td>
</tr>
<tr>
<td>4</td>
<td>ROA</td>
<td>Rest of Asia</td>
</tr>
<tr>
<td>5</td>
<td>USA</td>
<td>United States of America</td>
</tr>
<tr>
<td>6</td>
<td>EU27</td>
<td>European Union 27 (Belgium, Bulgaria, Czechoslovakia, Denmark, Germany, Estonia, Greece, Spain, France, Ireland, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Malta, Hungary, Netherlands, Austria, Poland, Portugal, Romania, Slovakia, Slovenia, Finland, Sweden, U.K)</td>
</tr>
<tr>
<td>7</td>
<td>RUS</td>
<td>Russian Federation</td>
</tr>
<tr>
<td>8</td>
<td>IND</td>
<td>India</td>
</tr>
<tr>
<td>9</td>
<td>ROW</td>
<td>Rest of the world</td>
</tr>
</tbody>
</table>
In this regional division, region *OCN, JPN, USA, EU27 and RUS* was been treated as the regions which include most of the industrialized nations of the world. Thus these regions could be seen as the developed part of the global. Region *GCA* was the short for “Greater Chinese Area”, which includes two regions of the world – Hong Kong and Taiwan. Since these two areas had a strong correlation in international trade with China, therefore, they were independently treated as a region from this research.

### 3.2 Industry Classification

Data used for the MRCGE-GTAP model were based on China’s 2000 multi-regional input–output matrix (2002) and GTAP7 database (2002). The input–output matrix includes 8 regions and 30 commodity sectors. However, the present study was undertaken not only to investigate the effect of energy tax policy but also to observe whether the country’s policy will affect the world in the future.

For the commodities, we referred to both database and reclassified the industry data sources. As Table 3 shows, the commodities were reclassified into 24 sectors.

<table>
<thead>
<tr>
<th>Reclassified Commodity Sectors</th>
<th>Commodity Include</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Agriculture</td>
<td>Agriculture</td>
</tr>
<tr>
<td>2 Coal Mining</td>
<td>Coal Mining</td>
</tr>
<tr>
<td>3 Oil and Gas Mining</td>
<td>Oil and Gas Mining</td>
</tr>
<tr>
<td>4 Other Mining</td>
<td>Metal ore Mining, Non-Metal ore Mining</td>
</tr>
<tr>
<td>5 Food Manufacturing</td>
<td>Food Manufacturing and Tobacco processing</td>
</tr>
<tr>
<td>6 Textile</td>
<td>Textile</td>
</tr>
<tr>
<td>7 Wearing Apparels</td>
<td>Wearing apparel, leather, furs, down and related products</td>
</tr>
<tr>
<td>8 Sawmills and Wood Products</td>
<td>Sawmills and furniture</td>
</tr>
<tr>
<td>9 Paper Products</td>
<td>Paper and products, printing and recording medium reproduction</td>
</tr>
<tr>
<td>10 Petroleum Processing and Coking</td>
<td>Petroleum Processing and Coking</td>
</tr>
<tr>
<td>11 Chemical Industry</td>
<td>Chemical Industry</td>
</tr>
<tr>
<td>12 Non-metallic Mineral Products</td>
<td>Non-metallic mineral products</td>
</tr>
<tr>
<td>13 Metal Smelting and Pressing</td>
<td>Metal smelting and pressing</td>
</tr>
<tr>
<td>14 Metal Products</td>
<td>Metal products</td>
</tr>
<tr>
<td>15 Machinery Industry</td>
<td>Machinery Industry</td>
</tr>
<tr>
<td>16 Transport Equipment</td>
<td>Transport Equipment</td>
</tr>
<tr>
<td>17 Electrical Machinery and Equipment</td>
<td>Electrical, Machinery and Equipment</td>
</tr>
<tr>
<td>18 Electronic and Communication Equipment</td>
<td>Electronic and communication equipment manufacturing</td>
</tr>
<tr>
<td>19 Other Manufacturing Industries</td>
<td>Measuring Instruments and Office Machinery, Machinery and equipment repair, Other manufacturing industries, Waste disposal</td>
</tr>
<tr>
<td>20 Electricity, Water and Gas Supply</td>
<td>Electricity, Steam, and Hot Water Production and Supply, Gas Production and Supply, Tap Water Production and Supply</td>
</tr>
<tr>
<td>21 Construction</td>
<td>Construction</td>
</tr>
<tr>
<td>22 Transportation and Warehousing</td>
<td>Transportation and warehousing</td>
</tr>
<tr>
<td>23 Commercial</td>
<td>Wholesale and retail trade</td>
</tr>
<tr>
<td>24 Services</td>
<td>Services</td>
</tr>
</tbody>
</table>

### 3.3 Scenarios

With the MRCGE-GTAP linkage model described above, we decide to setup five different scenarios to evaluate the effects by execution carbon tax in industrialized countries, China and the entire world. Goals for scenarios to achieve were referred to the Global carbon dioxide emission reduction target mentioned in Kyoto Protocol and the major emitter’s commitment on COP15 United Nations Climate Change
Conference held in Copenhagen. Although the first period target of Kyoto Protocol had been failed, but since it was still the only exist international common goal for CO2 reduction, we still considered to use this compared to year 1990 levels by 5.2% (equal compared to world 2005 levels by 4.4%) as the global CO2 reduction target in scenarios.

Table 4. Scenario Setup

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Industrialized countries execute same level carbon tax to reach the Kyoto Protocol Aim</td>
</tr>
<tr>
<td>S2</td>
<td>Industrialized countries execute same level carbon tax to main Industrialized countries Copenhagen commitment</td>
</tr>
<tr>
<td>S3</td>
<td>Industrialized countries and China execute same level carbon tax to reach the Kyoto Protocol Aim</td>
</tr>
<tr>
<td>S4</td>
<td>Industrialized countries and China execute same level carbon tax to main Industrialized countries Copenhagen commitment</td>
</tr>
<tr>
<td>S5</td>
<td>All nation's and the world execute same level carbon tax to reach the Kyoto Protocol Aim</td>
</tr>
</tbody>
</table>

Beside the global emission reduction target mentioned in Kyoto Protocol, since the total carbon dioxide emission from European Union and the USA was nearly one third of world’s total carbon dioxide emission for recent years\(^1\), also these two areas’ CO2 emission could represent the majority emission quantity of all industrialized countries, thus we took the COP15 commitment for these two areas (Compared with 2005, reduce 17% of CO2 emission for USA and 14% reduction for European Union) as the total Industrialized countries’ reduction target. This total industrialized countries’ carbon dioxide target as the Kyoto Protocol world total reduction target was settled as one main goal for scenario simulation.

In addition to the different objectives, the main difference between each scenario is the implementation of a carbon tax in different countries. As for scenario1 and scenario2, industrialized countries were the only carbon tax executive regions. In scenario 3 and scenario 4, China had joined with the industrialized countries to execute carbon tax. For scenario 5, the total world had executed as same level carbon tax to reach the Kyoto Protocol carbon dioxide emission reduction target.

4. Simulation Result

In this research, we attend to analyze economic and environment effect for different regions of China and for different regions of the world, hence we choose the EV (Equivalent Variation) change in different region of China, regional CO2 emission reduction rate of change and China’s industry output rate of Change as analysis index for internal China region. Indexes selected for world region analysis was CO2 emission reduction rate and EV changes for different division regions of the world.

\(^1\) The world total carbon dioxide emission was 30313.248 million ton in the year 2009, USA’s emission was 5424.53 million ton and European Union was 4307.285 million ton. More specific data could been seen from U.S Energy Information Administration’s web page: http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=90&pid=44&aid=8
Since in scenario 1 and scenario 2 China had not join the carbon tax with industrialized countries, as Figure 11 shown, the EV of each regions of China remains almost no change. But when China had joined the levying of carbon tax in scenario 3 to scenario 5, each region of China shows decrease in regional EV change.

![Figure 11. China’s Regional EV Change (Million USD)](chart)

As for EV decrease, every region had largest decrease in scenario 4 which China had execute carbon tax with industrialized countries to reach the total industrialized countries’ reduction target. The decrease was followed by scenario 3, when China had followed industrialized countries to use carbon tax achieve world CO₂ emission reduction target. In Scenario 5, which all countries on this planet had executed same level carbon tax to comply the Kyoto Protocol target, China’s regional EV losses was smaller than other two scenarios when China’s regional EV appear to reduce.

For inter-regional differences, in three EV reduce scenarios, central area of China where coal was most produced had the largest EV decline, followed by east coast area and northeast area of China, two areas which one had the most outsourced economy structure, another got China’s largest petroleum filed located in. For all eight regions, the EV decline in north municipalities were relatively low, this may mainly because of this region only have city Beijing and Tianjin include. Thus, the population differences between the region with other regions brings its relatively small change in regional EV.

![Figure 12. China regional CO₂ emission reduction rate of change (%)](chart)

Since the EV change in first two scenarios for China was positive, it was not...
surprised it lead to a CO$_2$ emission growth in China. Thus, when it comes to the regional CO$_2$ reduction rate of change analysis as Figure12 present, scenarios which China’s regional CO$_2$ emission reduced had been selected for analysis. As figure showed, the strengthen tendency remain same as it for China’s regional EV Change. But for inter-regional differences, south coast of China had the largest carbon dioxide emission reduction in each scenario. In scenario 3 which China execute carbon tax with industrialized countries to reach the Kyoto Protocol first term target, south coast of China had its CO$_2$ emission reduced for 9%. In scenario 4, this index even increased 2% more.

Compared with south coast, the CO$_2$ emission reduction rate for other region of China seems not very strong. Especially for the central region, where China’s main coal production base were and where suffer the most for its household utility showed by EV decrease. This situation may be explained as follows: although the carbon tax levied in central area may lead to a negative effect on regional economy which direct affect local’s household utility. But since China’s energy consumption was high based on coal using (coal using had take over more than 70% of China’s primary energy consumption for decade) and Since China’s coal using was highly self supplied, as the major coal base for China, the central area couldn’t stop to continuing put it investment into industry such as coal mining, this means the levied carbon tax was again re-invest in region’s coal production. This re-invest flow weakens the effect of carbon tax and caused the above result.

![Figure13. China’s industry output rate of Change (%)](image)

Figure13. China’s industry output rate of Change (%)
Besides using regional indexes, Figure 13 was a sample for the economic effect for the carbon tax policy to the total China nation. For nation’s industry output changes, it could be clearly see that for every scenario which China had executed carbon tax, its energy intensive industries such as petroleum processing and coking, chemical industry and energy supply industry as coal mining, oil and gas mining and electricity, water and gas supply had significant decrease for their industry output, only energy extensive industry such as service remain increase in such scenario. But in scenarios which China didn’t executed carbon tax but industrialized countries did, the energy intensive and energy supply industries had a positive growth in China.

It should also been notice that the textile industry and wearing apparels industry had showed decrease in every scenario even when China didn’t executed carbon tax. Since these two industries was two of China’s most export oriented industry, it could be understood that when the world economy had been affected by the carbon tax policy, China’s main industry will also be affected even the carbon tax was not executed in the country.

Like it been showed in Figure 14, for most scenarios which the carbon tax as mainly executed by industrialized countries, the region division in this research included industrialized countries all had significant EV decrease caused by carbon tax policy. In those industrialized regions, USA and European Union had the strongest EV decline especially in scenario 2 and scenario 4. Other regions which were taken as the developing and least develop regions only had its EV reduced in scenario which the total world ran same level carbon tax. The EV change for all regions in the world was just perfect explanation for China’s textile industry and wearing apparels industry output decrease: since industrialized regions had their household utility decreased a lot and since the industrialized countries were the most important importer for China’s textile products. Thus the decrease of household utility in these regions while naturally leads to the decrease of China’s textile and wearing apparels industry.

Figure 14. World Region EV Change (Billion USD)
When the carbon tax had brought EV decrease for different world regions while it had been execute, it had also lead different regions to reduce region’s carbon dioxide emission to reach the goals which scenarios were setup for. The result in Figure 15 shows that, when a country (region) had the carbon tax been execute, its regional CO2 emission would be reduced, while the opposite behavior may lead to an increase of one region’s CO2 emission.

Moreover, Figure 15 also proved that when industrialized countries achieved their Copenhagen COP15 commitment, the overall emission reduction levels of the world will be far more than the Kyoto Protocol emission reduction targets. Thus, the industrialized countries should take more serious with their CO2 emission reduction obligation.

5. Conclusion

In this study, we used the MRCGE-GTAP model to analyze the effect caused by the execution of carbon tax in different region of the world to China and global economy. As from the simulation result, four conclusions could be reached.

First, as the result from each scenario shows, execution of carbon tax could effectively reduce carbon dioxide worldwide. Furthermore, if main industrialized countries could execute same carbon tax, the Kyoto Protocol global target was achievable. If these countries could achieve their commitment on COP15, the target could achieve even more. But it should be aware that, in the MRCGE-GTAP model, the total carbon dioxide was endogenous by energy and energy intensive department, thus this reduction could be mainly considered as the reduction from industry activities.

Second, Carbon tax may have negative effects on major developed countries, especially for Japan, USA and European Union. Like the simulation result shows, Japan, European Union and USA will suffer for the most lost for their household utility while they were contribute the most for the CO2 emission reduction. With the first two conclusions two things had been proofed. On the one hand, the industrialized countries were the main reduction sources for global GHG reduction achievement; on
the other hand, more successful the reduction was the greater damage it will caused to the citizens of industrialized countries. Thus, an appropriate reduction policy should be arranged to balance the pros and cons for GHG reduction in industrialized countries.

Third, Worldwide execution of carbon tax without China may benefit China’s household utility. But it may have negative effect to China’s main export industry. As it could been seen from scenario1 and scenario2, China will benefit from other country’s carbon tax execution but since this kind of tax will effect global economy, country that had benefit from globalization such as China will had a decrease in its main world trade industries which as should in Figure 5.13 for scenario1 and scenario2. For this result we can see that for current global economy, no country could be spared while facing a global issue as climate change, even when it won’t join the global arrangement, its economy would still be affected.

Finally, this simulation show that carbon tax will also cause decrease in household utility in different regions of China, when the nation had execute carbon tax policy. China’s household utility in which energy resource production areas and outsourcing areas will suffer the most. Thus, when the carbon tax arranged nationwide in China, regional differences should be considered as it was for the whole world.

References


