Paper ID APEN-MIT-2019_203
Applied Energy Symposium: MIT A+B
May 22-24, 2019 • Boston, USA

# Macroeconomic impacts under the trend of energy use transformation

# on China's auto industry based on CGE model —— Case study of Guangdong

Zhuoqun Gao,
School of management
Harbin Institute of Technology
Harbin, China
Department of Policy Analysis and Management
Cornell University
zg262@cornell.edu

R. Richard Geddes
Department of Policy Analysis and Management
Cornell University
Ithaca, United States
rrg24@cornell.edu

Tao Ma
School of management
Harbin Institute of Technology
Harbin, China
matao@hit.edu.cn

*Abstract*

In order to alleviate energy shortages and environmental pollution problems, new energy vehicles have become an important development direction of the automotive industry today, including electric vehicles, hybrid vehicles, hydrogen-powered vehicles and so on. At present, China has the advantage of becoming the world's largest electric vehicle market, accounting for about half of global sales. International automakers are also investing heavily in China. The energy consumption of Chinese cars is in the stage of upgrading from fossil fuels to clean energy. Energy conservation and emission reduction are also important issues for the Chinese government. In this research context, this study attempts to establish a CGE model based on the data of Guangdong social accounting matrix to simulate the change of energy prices under the policy promotion and the reduction of automobile fossil fuel consumption for the economic system. The impact of simulating the improvement of environmental pollution caused by structural changes in energy use provides a scientific basis for the government's macro decision-making. This study is mainly aimed at the economic impact of consumer preferences change caused by government's policies and publicity to promote the new energy vehicle development, we divided the energy use transformation into 2 ways: general and high level promotion. In each stage, we simulated the macroeconomic impacts and found significant changes caused by consumption structure change.

*Keywords: Energy use transformation, auto industry, CGE model*

## I. INTRODUCTION

With global warming, environmental degradation, and resource crises, problems such as protecting the ecological environment, conserving energy, and reducing emissions have gradually evolved into one of the major environmental problems facing humanity. China is the largest developing country in the world today, while its economy is growing rapidly, it has also become the world's largest emitter of carbon dioxide. China is facing increasing pressure to reduce emissions.

According to the International Energy Agency's "Energy Technology Perspectives 2015", the transportation industry accounts for nearly 27% of the world's final energy consumption and is the second largest carbon dioxide emission industry in the world. Promoting new energy vehicles is an important means of reducing energy consumption and carbon dioxide emissions in China.

Guangdong Province is implementing “Made in China 2025”. In 2018, the government has issued the “Opinions of the People’s Government of Guangdong

Province on Accelerating the Innovation and Development of New Energy Vehicle Industry".

It can be seen from the chart of energy consumption structure in Guangdong Province that the consumption of fossil fuels is declining, while the consumption of electric energy and other energy sources is increasing year by year. Specific to the automotive industry, according to statistics from the Traffic Management Bureau of the Ministry of Public Security, Guangdong's total vehicle ownership was over 20 million in 2018. Guangdong is also the sales base of new energy vehicles in China. More than 1/8 of new energy vehicles are sold in Guangdong. At present, the number of new energy vehicles in Guangdong has reached 250,000, with the percentage of 0.87% of total vehicles.

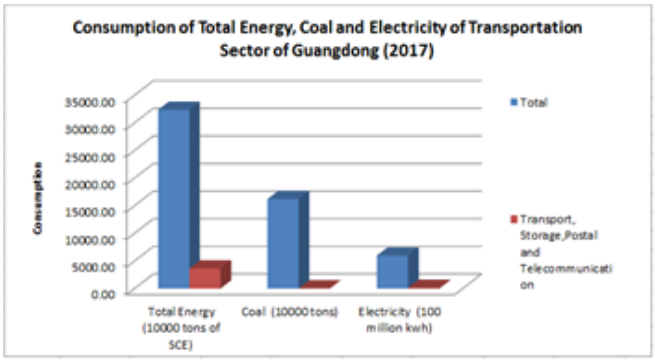


Fig.1 Consumption of total energy, coal and electricity of transportation sector of Guangdong

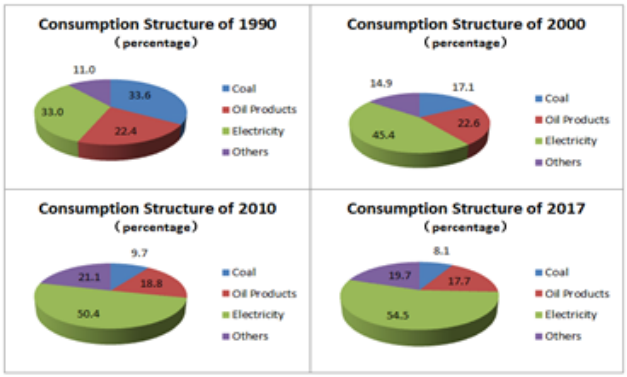


Fig.2. Guangdong Province's energy consumption structure

Data source: Guangdong Statistical Yearbook

The development of new energy vehicles is conducive to the realization of China's energy conservation and emission reduction targets. On the whole, new energy vehicles use energy more efficiently than traditional fuel vehicles and emit less harmful gases such as carbon dioxide. At the same time, the promotion of new energy vehicles will impact the traditional industrial chain of diesel locomotive production. The intervention of government subsidies will reduce the resistance of new energy vehicles, but it will also affect the government's investment in other infrastructure industries, thus affecting economic development. This study is mainly aimed at the economic impact of consumer preferences change caused by government's policies and publicity to promote the new energy vehicle development.

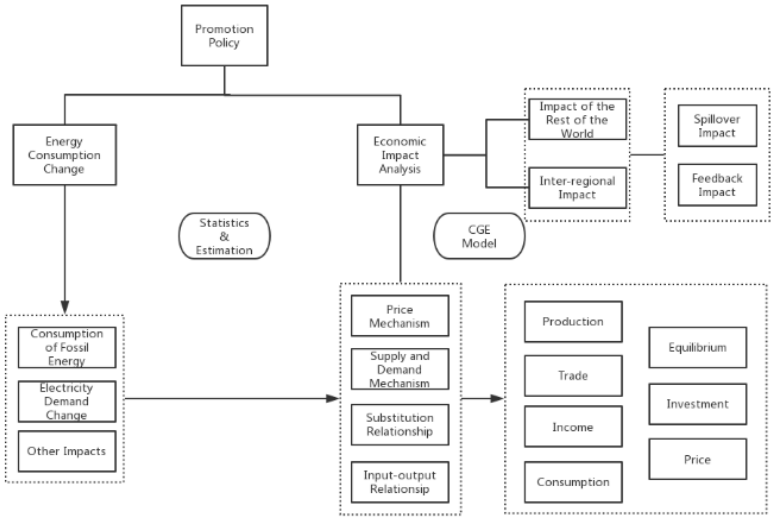


Fig.3. Impact mechanism

## II. METHODOLOGY

The Computable General Equilibrium Model (CGE) is widely used in policy analysis. CGE models are constructed based on the traditional Walras paradigm, the model can be described as a system of simultaneous equations deduced by all actors' maximizing behavior, simulates the activity of social subjects like households, firms, government, and foreigners.[1] This study analyzes the economic impact of new energy vehicle promotion policies through the regional CGE model. Considering the openness of economic activities in the research area, China is divided into two Guangdong Province, which is the province of study, and the other provinces. The model consists of 42 sectors, which are classified according to the input and output tables of Guangdong Province of 2012. The government is divided into local government and central government. Production factors are divided into labor and capital. Based on the regional CGE model, the

model adds a description of the association between the study area and the rest of the country. It analyzes the flow of commodities and factors between the regions, the quantitative analysis of the complex economic relations between regions is a good tool for the study of regional policies and regional development issues. Its basic structure includes: production module, trade module, income and expenditure module, investment savings module, macro closure module, commodity market equilibrium and factor market equilibrium module. Inter-regional economic linkages mainly include inter-regional commodity transactions, inter-regional investment flows, and inter-regional labor flows.

In the trade module, the imperfect substitution between commodity produced domestically and the imported commodity is described as CES (Constant Elasticity of Substitution) function. The CET (Constant Elasticity of Substitution) function is used to describe the substitution relationship between exports and domestic products. In the production module, intermediate input is compounded by the domestic product and the input imported from other region, which is described as Leontief function. The compound of value-added factors and intermediate inputs is assumed to follow the CES production function. The substitution of production factors of capital and labor is assumed to follow the C-D (Cobb-Douglas) function. Under the condition of market equilibrium, the total supply is equal to the total demand, and the region's commodity demand and commodity supply in other regions have formed regional flows of commodities. The Guangdong provincial Social Accounting Metrix(2012) is compiled by Centre for Economic Systems Simulation Research.

The structure of the model is shown as follows:

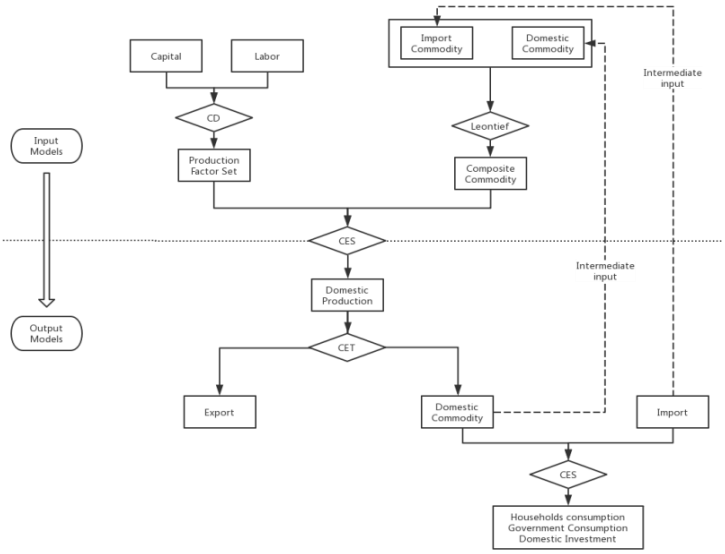


Fig.4. Model Structure

## III. SIMULATION

### A. *Scenarios*

We estimated the proportion of new energy vehicles from 2012 to 2052 based on the "Quantity in the development plan of energy-saving and new energy automobile industry in 2012-2020" of Guangdong Province, and designed the scenarios based on the estimation of Households consumption structure change between gasoline and electricity.

TABLE I. SIMULATION SCENARIO

| | **Year** | **Household consumption structure change (Electricity and gasoline)** |
|---|---|---|
| General level promotion | 2012 | 0.1% |
| | 2022 | 0.5% |
| | 2032 | 1% |
| | 2042 | 2% |
| | 2052 | 4% |
| High level promotion | 2012 | 0.2% |
| | 2022 | 1% |
| | 2032 | 2% |
| | 2042 | 4% |
| | 2052 | 8% |

### B. *Simulation results:*

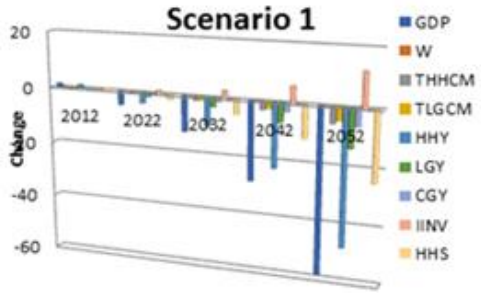


Fig.5. General level promotion policy

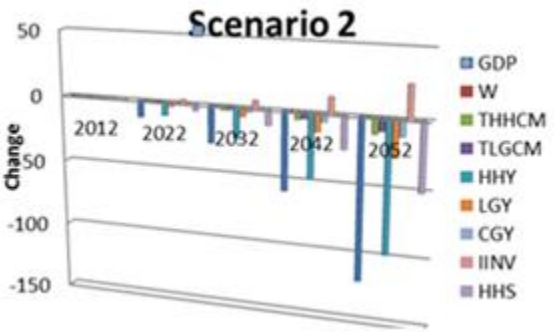


Fig.6. High level promotion

W: wage rate, THHCM: Total household consumption, TLGCM: Total local government consumption, HHY: household , LGY: Local Government Income, CGY: Central Government Income, IINV: International Investment, HHS: Household saving

## IV. Conclusion

Under the quite extreme scenarios, the policy of encouraging the use of new energy vehicles is implemented based on the estimation. Changes in the consumption structure have a significant impact on the macro economy. The results show that changing the energy consumption structure in this way will have negative impact on economic system. Only IINV's showed positive growth. High level of promotion policy will result in more serious GDP losses than a general promotion policy. Therefore, a more cautious approach should be taken in the relevant policy choices. While guiding the consumption trend, the government should support and promote technological innovation to reduce adverse economic impacts while reducing environmental pollution. In other words, an effective energy consumption guidance policy should take into account the impact on economic development while achieving environmental protection.

## REFERENCES

[1] Wang Y, Dong Z, Wang Y, Liu G, Yang H, Wang D. Impact of Electricity Production Tax on China's Economy, Energy, and Environment: A CGE-Based Study. Polish Journal of Environmental Studies. 2019 Jan 1;28(1).