



# The impact of natural gas price control in China: A computable general equilibrium approach



Yongda He<sup>a</sup>, Boqiang Lin<sup>b,\*</sup>

<sup>a</sup> School of Statistics, Shanxi University of Finance and Economics, Taiyuan, Shanxi 030006, PR China

<sup>b</sup> Collaborative Innovation Center for Energy Economics and Energy Policy, China Institute for Studies in Energy Policy, School of Management, Xiamen University, Fujian 361005, PR China

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## ABSTRACT

This paper depicts the natural gas price control behavior of the Chinese government in an imperfect competition market structure using a static CGE model. It simulates the effect of changes in natural gas price control policy on carbon emission, and the economic effects in view of demand side and supply side. Based on the above, we also analyze the carbon emission mechanism from economic and energy structure perspective. The results show that: an increase in natural gas price can reduce carbon emission, or tends to cause a long-term decline in the surplus profit rate of the natural gas industry. Moreover, the increase in natural gas price may raise the CPI, and reduce actual GDP and residents' welfare. On the contrary, a decrease in natural gas price may reduce CPI and enhance resident welfare. However, the long-term actual GDP will not increase, but carbon emission will increase and the surplus profit rate of the natural gas industry may reduce in the short term and increase in the long term. On the other hand, Both increase and decrease in natural gas prices may result in a decrease of the actual GDP level in the long term. The elimination of price control in natural gas supply may increase actual GDP and residents' welfare and reduce CPI. Meanwhile, it may increase carbon emissions and improve the profitability of the natural gas industry.

## 1. Introduction

While the growth of fossil fuel consumption has spurred economic growth, it has simultaneously brought about severe pollution problems (BP, 2016). In recent years, China's persistent smog problem has attracted a high level of interest in pollution issues. A large proportion of this smog can be traced back to China's energy consumption structure, of which coal is a primary component. For this reason, as the Chinese public makes increasingly strong environmental demands and responds to both the constraint of global climate change's severe trends and the related obligations, the key to adjusting and upgrading China energy structure is to shift from a coal-centered energy consumption structure to consumption of natural gas and other low-carbon clean energy sources.<sup>1</sup> However, because of the existence of price controls, China's natural gas market exists in a state of imperfect competition, in which the level of

marketization is relatively low, and the question of whether both the natural gas market and industry can progress toward rationalization through the driving forces of supply and demand still requires further study. On this basis, the analysis of the effects of natural gas price control on carbon emissions, their effect on the progress of marketization for natural gas prices, and on the transformation of China energy structure all carry important implications. The reform of natural gas pricing mechanism, prevention of irrational gas consumption and promotion of the development of the natural gas industry are practical problems in formulating energy and environment policies.

The natural gas industry has the obvious feature of a natural monopoly since the government controlled every segment of the industry. Therefore, the price of natural gas in China is not determined by market supply and demand.<sup>2</sup> Table 1 presents and compares the price of natural gas in China and other countries. This paper compares

\* Correspondence to: Collaborative Innovation Center for Energy Economics and Energy Policy, China Institute for Studies in Energy Policy, School of Management, Xiamen University, Fujian 361005, PR China.

E-mail addresses: [bqlin@xmu.edu.cn](mailto:bqlin@xmu.edu.cn), [bqlin2004@vip.sina.com](mailto:bqlin2004@vip.sina.com) (B. Lin).

<sup>1</sup> In November 4, 2014, China National Development and Reform Commission issued *China's National Plan on Climate Change (2014–2020)*. It pointed out that by 2020, natural gas will represent more than 10% of China's non-renewable energy consumption.

<sup>2</sup> Zhao (2011) showed that the average output price of natural gas in China from 2006 to 2010 is RMB 920/kilostere. After the Notice about Increasing Output Base Price of Onshore Natural Gas in China was issued by the National Development and Reform Commission (NDRC) in 2010, the output price of natural gas was required to be adjusted upwards by 230 Yuan, implying that the output base price of natural gas is RMB 1150/kilostere since 2010. In June 2013, NDRC issued the Notice about Adjusting Price of Natural Gas to increase the average terminal price all over the country by 260 Yuan all over the county. If the management and transportation fee remains the same doesn't change, the average output price of natural gas in China would be RMB 1410/kilostere after the price adjustment.

China's natural gas price with countries like Japan, England, USA, and Canada, which implement complete pricing mechanism.

Table 1 shows that the price of natural gas in China tends to rise, but is still lower than that in Japan and England. Before 2010, the price of gas in China was lower than that of the USA but higher afterward. A similar relationship also exists between the price of natural gas in China and Canada. It should be noted that for lack of domestic resources and special geological location in Japan, natural gas has to be imported by sea transport in the form of liquefied natural gas. Moreover, gas price in Japan is generally high because the pricing method is linked to the weighted average price of imported crude oil. However, in England, USA, and Canada, market mechanism reform has been relatively completed to realize the pattern of mutual competition between different natural gas sources. Relatively, the price of natural gas in these countries can largely reflect the real value and the relationship between supply and demand of natural gas.

The mechanisms for the formation of Chinese natural gas prices exhibit clear differences from those of the developed western countries. This is because, generally, at each stage (from production to sales), government regulation plays a role and the level of marketization is relatively low. Considering long-term objectives, the final target of price reform for natural gas in China is to release output pricing and promote market competition, meaning that the government will manage the natural monopoly linkages that have emerged around pipelines and transportation, completely enabling producer pricing, and allowing free competition. Thus, considering the goals of development and price reform in the Chinese natural gas market, we study the effect of government controls on prices and also analyze the economic and environmental effects of these controls. This study is of paramount importance as it relates to the establishments of urgent government controls.

In recent years, as a popular policy simulation tool, computable general equilibrium (CGE) model has been widely employed in the analysis of tax, public consumption, tariff and climate policy (André et al., 2005; Benavides et al., 2015; Turner et al., 2011; Branger and Quirion, 2013; Wu et al., 2014; He et al., 2014; Duarte et al., 2014). CGE models are deeply rooted in the standard microeconomic theory which builds a number of markets (product markets, factor markets and exchange market between domestic and foreign goods) and market players (residents, enterprises, government, and foreigners) (Dai et al., 2011; Thepkhun et al., 2013). Roson (2006) considers the technical aspects and the consequences, in terms of simulation results and policy assessment, of introducing imperfect competition in a CGE model. The study finds that technical choices made in designing the model structure may have a significant impact on the model behavior. This is especially evident when the output of the model, under an imperfect competition closure, is compared with that obtained under a standard closure, assuming perfect competition. From then on, many research papers employ revised CGE models with or without imperfect competition to do empirical research from different perspectives in demand of actual analyses. For example, Das and Chakraborti (2012) applied CGE model with imperfect competition to simulate various trade-related policies like import liberalization, foreign capital inflow and use of energy saving technologies under both perfect and monopolistic competition. Flaig et al. (2013) used a CGE model with imperfect competition to estimate the effects associated with particular alternative policies actually discussed to liberalize the Israeli dairy industry. The related research also includes Wang et al. (2009), He et al. (2010), Dai et al. (2011), Naranpanawa and Arora (2014), Zhang et al. (2016) etc.

Previous studies have made some important contributions to meet their needs of actual analyses, with modeling CGE of different types like, static models, which make up the most existing CGE models, or dynamic models, which are increasingly been used in numbers as faster computers and more efficient software have become available. However, when CGE models are employed to do energy analysis, they

**Table 1**

Comparison of Natural Price between China and Foreign Countries Unit: Yuan/m<sup>3</sup>. Source data: The data about natural gas price of all countries are from BP [1], and the exchange rate is from China Statistical Yearbook.

	China	Japan	America	England	Canada
2006	0.92	2.03	1.92	2.24	1.66
2007	0.92	2.10	1.89	1.63	1.67
2008	0.92	3.11	2.19	2.68	1.98
2009	0.92	2.21	0.95	1.18	0.82
2010	1.15	2.64	1.06	1.59	0.89
2011	1.15	3.40	0.92	2.08	0.80
2012	1.15	3.77	0.62	2.13	0.51
2013	1.41	3.58	0.82	2.35	0.65
2014	1.41	3.63	0.97	1.83	0.86
2015	1.22	3.72	0.87	1.94	0.81

mainly focus on coal, petroleum, electricity, etc. (Hamilton, 1983; Hooker, 2002; He and Wei, 2002; Blanchard and Gali, 2007; Sun, 2007; Lin and Mou, 2008; Wei et al., 2012; Yuan and Wu, 2011). There are fewer discussions about the natural gas sector in China with CGE model. With the increasing environmental demands and the promotion of energy structure reform in China, the pricing reform of natural gas and other clean energies have attracted attention in the academic setting. Wang et al. (2012) simulated the effect of a gas price increase on the macroeconomy using CGE model. Gao and Wang (2014) discussed the mechanisms by which natural gas price fluctuations affect other industries. Wang and Ye (2014) employed CGE model to evaluate the effects of reducing natural gas subsidy on the economy and industrial structures. Su et al. (2015) constructed a CGE model to simulate the impact of an increase in natural gas prices on the economy; they found that rising natural gas prices have negative impacts on GDP and household consumption but positive impacts on investments.

However, some weaknesses and limitations can be easily found in these previous studies. Firstly, the imperfect competition market structure of the natural gas industry is not taken into consideration. Secondly, they do not present and depict the characteristics of the scale economies within the natural gas industry. More importantly, with regard to government policy, the effects of Chinese government control on natural gas prices have not been captured. As a matter of fact, it is very important to study the price control behavior of the Chinese government in an imperfect competition market structure using the CGE model. In China, it is of practical significance to study the energy structure reform, whose purpose is to reduce carbon emission and relieve environmental pollution by cutting coal and oil consumption and improving natural gas usage. Therefore, fully considering the current conditions of the development in Chinese natural gas market, this paper develops a corresponding CGE model to analyze the price control behavior of the government and to simulate the effects of government price control behaviors on the economy and carbon emissions, from the perspectives of demand and supply. This simulation serves as the basis for analyzing CO<sub>2</sub> emissions mechanisms based on both economic and energy structure, providing an analytical perspective to help us fully comprehend China's energy market, as well as an effective reference for the reform of natural gas pricing mechanisms.

## 2. Model construction and data source

In order to simulate the effects of government control on changes in gas price with Chinese characteristics ( a market with imperfect competition), this paper constructs a corresponding static CGE model. By integrating and sub-dividing relevant industrial sectors, the model is mainly composed of 6 energy sectors: natural gas industry, oil exploitation industry, coal and mining industry, petroleum processing industry, production and supply industry of gas, and electricity and

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