Energy Policy 95 (2016) 126–134

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

The driving factors behind coal demand in China from 1997 to 2012: An empirical study of input-output structural decomposition analysis

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HIGHLIGHTS

- The driving factors behind coal demand in China from 1997 to 2012 are studied.
- An input-output structural decomposition analysis is developed.
- A fresh perspective of domestic demand, foreign trade, and industrial upgrading is employed.
- The influences of these affecting factors on China's coal demand from six high energy-consuming industries are investigated.
- Targeted policy suggestions for energy conservation and emissions reduction are suggested.

ARTICLE INFO

Article history:
Received 11 September 2015
Received in revised form
27 April 2016
Accepted 2 May 2016

Keywords:
Coal demand
I-O SDA
Driving factors
High energy-consuming industries

ABSTRACT

With the rapid development of economy, especially the constant progress in industrialisation and urbanisation, China's energy consumption has increased annually. Coal consumption, which accounts for about 70% of total energy consumption, is of particular concern. Hence, it is crucial to study the driving factors behind coal demand in China. This work uses an input-output structural decomposition analysis (I-O SDA) model to decompose the increments of coal demand in China from 1997 to 2012 into the sum of the weighted average for eight driving factors from three aspects, including: domestic demand, foreign trade and industrial upgrading. Results show that: during the research period, the demand for coal increases by 153.3%, which is increased by 185.4% and 76.4% respectively due to the driving forces of domestic demand and foreign trade; in addition, industrial upgrading can effectively restrain the growth in coal demand with a contribution rate of −108.6%. On this basis, we mainly studied the driving factors of coal demand in six high energy-consuming industries, namely the electrical power, energy processing, metals, mining, building materials and chemical industries. Finally, we proposed targeted policy suggestions for the realisation of energy conservation and emissions reduction in China.

1. Introduction

With further reform, and opening up, the Chinese economy has developed rapidly. Energy consumption has increased annually. Owing to China's energy resource endowment being characterised by rich coal, meagre oil, and lean gas reserves, it is difficult to change the coal-based energy structure in the short-term. Thus, coal consumption, which accounts for about 70% of total energy consumption, is of particular concern (National Bureau of Statistics (NBS), 2015). As shown in Fig. 1(a), coal demand in China was about 3.53 billion tons in 2012, which increased by 153.3% compared with that in 1997 (NBS, 2015). China now is the largest producer and consumer of coal in the world, where the coal production and coal consumption account for about 46.9% and 50.6% respectively of the global total in 2014 (BP, 2015). Although the reserves of coal in China are relatively abundant compared with the reserves of petroleum and natural gas, they only account for 12.8% of the total reserves in the world; the reserve-production ratio (RPR) is only 30 in 2014, far below the global average of 110 (BP, 2015). Considering the huge amount of coal demand and the limited resource reserves, the coal resources in China are scarce in the long run (Cao and Bluth, 2013).

China's net coal imports were 103 million tons in 2009 (NBS, 2015) so that it became a net importer of coal for the first time (National Development and Reform Commission (NDRC), 2010), and the average growth rate per year was as high as 65.7% in the period from 2009 to 2013. Furthermore, the ratio of dependence

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http://dx.doi.org/10.1016/j.enpol.2016.05.007
0301-4215/

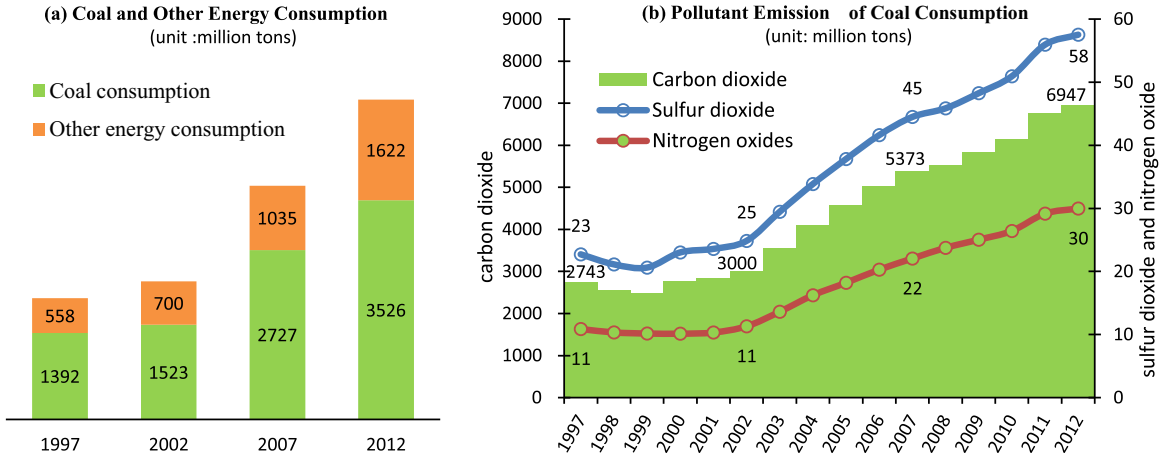

Fig. 1. Coal consumption and the emissions produced by coal consumption in China.

on coal imports has been rising from 4.3% in 2009 to 7.7% in 2013, and is on trend to continue to increase. However, China's coal exports have declined by 66.5% by 2013 compared with those in 2009 (NBS, 2015). The imbalance between supply and demand in China's domestic coal market has raised concerns about its energy security (Hao et al., 2015a). Thereby, the future energy security situation in China is hardly optimistic.

In recent years, owing to the immoderate use of fossil fuels, global warming and sea level rise have occurred, at the same time, some extreme weather event, for example, haze, sandstorms, have happened more frequently. The greenhouse gas emissions and air pollutants caused by energy consumption have been a focus of attention for society (Li and Wei, 2015; Hao et al., 2015b; Hao and Wei, 2015). Here, CO_2 is selected as representative of greenhouse gas emissions, while SO_2 and NO_X are chosen to represent pollutant gases respectively: we estimated the emissions produced by coal consumption in China from 1997 to 2012, as shown in Fig. 1 (b) and the method of calculation is provided in Appendix A.

To solve increasingly severe environmental problems, the international community is making positive efforts and negotiated agreements on emissions reductions. For example, as the Kyoto Protocol (United Nations Framework Convention on Climate Change, 1997) stipulated, greenhouse gas emissions from all developed countries should have been reduced by 5.2% by 2010 compared with the emissions in 1990. Due to the objective facts, including the huge total energy demand, the coal-based energy structure and the maximum pollutant load *per* unit coal emissions, China's energy conservation and emissions reduction strategy has attracted worldwide attention. Although China, as a developing country, temporarily does not need to undertake the task of emissions reduction, nevertheless, as a responsible power, China will make contributions to global carbon dioxide (CO_2) emissions and, therefore, the reduction thereof. At the Climate Change Conference held in Paris in December 2015, Chinese Government proposed that the CO_2 emissions per unit GDP should be decreased by 60–65% by 2030 compared with the emissions in 2005 (Xinhuanet, 2015). Thus, it is an urgent problem for the Chinese Government to achieve the goal of energy conservation and emissions reduction while ensuring steady economic development.

In general, facing increasingly serious energy security worries and the gradually emerging pressure of environmental management, it is imperative to control the excessive growth in coal consumption and reduce the unreasonable coal demand to enable the Chinese Government to cope with energy and environmental problems Hence, this study of the driving factors behind coal demand in China can improve energy utilisation efficiency and restrain unreasonable coal consumption. In this way, the relevant government departments can preferably grasp the characteristics of coal demand and reasonably formulate regulatory policy.

The paper is organised as follows: Section 2 reviews relevant studies on the factors influencing coal demand and classifies them. Section 3 introduces the I-O SDA and provides data sources, while Section 4 presents empirical analysis. In Section 5, the conclusions and policy suggestions are presented.

2. Literature review

There are large amounts of analyses on the influencing factors of energy consumption growth among the international academia, and the methods varied greatly. Kraft and Kraft (1978) first examined the causal relationship between energy consumption and economic growth in USA. Masih and Masih (1996) employed the dynamic ordinary least squares (OLS) procedure to derive robust elasticity estimate as well as cointegration and error correction methods (ECM) to derive short-run price and income elasticities of coal demand in China. Li and Leung (2012) examined the relationship between coal consumption and real GDP of China with the use of panel data. Michieka and Fletcher (2012) investigated the causal relationship between urban population, real GDP, electricity production and coal consumption in China for the period between 1971 and 2009. What's more, Lei et al. (2014) found that there is only a unidirectional causality from economic growth to coal consumption exists in China from 2000 to 2010. Wang (2014) investigated the effects of China's urbanisation on residential energy consumption and production energy consumption through a time-series analysis. Based on the fully modified OLS cointegration approach, Saboori et al. (2014) explored the bidirectional long-run relationship between road sector energy consumption, CO_2 emissions, and economic growth in Organization for Economic Co-operation and Development (OECD) countries. Saidi and Hammami (2015) investigated the impact of economic growth and CO_2 emissions on energy consumption for a global panel of 58 countries using dynamic panel data model estimated by means of the generalised method of moments (GMM). Furthermore, Caraiani et al. (2015) used a three-step analysis: stationarity, cointegration and causality tests to investigate the causality relationship between energy consumption and GDP in the context of emerging European countries.

It can be found that the existing studies on the factors driving energy consumption increase are mostly from the perspective of causal relationship. They focus on either testing the roles of economic growth, population, price, and income in stimulating coal