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Analysis of road transportation energy consumption demand in China

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ABSTRACT

In this paper, we first analyze the historical trends in road transportation energy consumption and GDP in developed economies to find out the development characteristics of road energy consumption. The two indexes present obvious 'S' type patterns. Then, in order to explore the current status and future trend of road energy transportation in China, we employ path analysis to analyze the impact mechanism of the factors related to road transportation energy consumption. Next, we adopt the BMA model to select the core factors related to road transportation energy consumption in China, and on the basis of the model selection as well as univariate (ETS & ARIMA models) and multivariate (multiple regression) models, the road transportation energy consumption is analyzed and forecast. The results showed that the road transportation energy consumption rises by 0.33 percent for every percent increase in GDP and by 1.26 percentage points for every percent increase in urbanization. The road transportation energy consumption in China is expected to reach around 226181.1 ktoe by the end of 2015, and about 347,363 ktoe by 2020.

1. Introduction

Transportation plays an important support role for both social development and national economic development. With China's rapid economic development, industrialization and accelerated urbanization, transportation demand has also been increasing and its share of the total energy consumption in the economy has also been proportionally rising. At present, transportation energy consumption accounts for about 9% of China's total energy consumption and this proportion is increasing. In the 1990 s, China's transport energy consumption increased from 2180 ktoe to 58,028 ktoe (World Bank, 2010). Entering the twenty-first century, China's transportation energy consumption accelerated significantly with an average annual growth rate of 9.8% from 2000 to 2008 (China Statistical Yearbook, 2009). From the structure of the transport sector's energy consumption, road transport can be seen to be the major energy consumption sub-sector. The China Energy Research Association estimated that in 1990, 1995 and 2000, road transportation energy consumption accounted for 47.6%, 59% and 68.1% of total transportation energy consumption. The transportation industry is one of the primary contributors to

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greenhouse gases, with vehicle pollution progressively becoming the main source of pollution in big cities, so controlling these emissions constitutes a major challenge for carbon emission control efforts. According to the World Health Organization, atmospheric pollutants from motor vehicle emissions account for about 30% of the total emissions in some big cities at present; a large part of PM2.5 in the air is composed of automobile tail gas discharges.

As economic transformation and the development of the Chinese economy are set to continue, the transportation industry is expected to also change and acquire new characteristics. Following the mid/high speed economic growth, transportation production is also expected to grow at a mid/high speed of about 5–7%. In 2014, railways, highways, waterways and civil aviation passenger traffic growth were expected to be about 3.7% and freight volume growth about 7.2% (National Bureau of Statistics of the People's Republic of China, 2015). Due to the downward pressure on the economy, as well as the natural resource and environmental constraints, the sustainable development of the transportation industry is facing severe challenges. Therefore, an analysis of China's road transportation energy consumption demand is of great significance in this "new normal" period.

Transportation energy consumption has become a very important issue and is receiving increasing attention around the world. Considering the scarcity of natural resources and the increasing energy demand, an analysis of transportation energy consumption and an examination into consumption and the associated emissions reductions has practical significance.

1.1. Driving cores of transportation energy consumption

Hu et al. (2010) analyzed the main challenges encountered in sustainable road transportation development in China. They insisted economic development, rapid urbanization, improvement in living standards, technological and policy initiatives were the effect factors. Yan and Crookes (2010) summarized China's traffic energy consumption and energy saving potential from a life cycle perspective through an analysis of the Chinese road transport industry in terms of vehicle ownership, infrastructure, energy usage, carbon emissions and other related situations. Wang et al. (2014) discussed and analyzed the status of the Chinese transportation industry and the energy consumption growth trends for four different modes of transport: roads, railways, waterways and civil aviation. They also put forward several political suggestions by analyzing the main technical obstacles and addressing policy issues for energy savings in the Chinese transportation industry. Wang and Lu (2014) selected carriage of goods data from 31 provinces and cities in China to measure the rebound effect in the short-term and long-term using a double logarithmic regression equation and an error correction model. The results showed that in the long-term, the partial rebound effect for road freight transportation was 84%, 52%, 80% and 78% for the entire nation, and the eastern, central and western regions in China, respectively. In the short-term, a tiny super conservation effect was found in Chinese road freight transportation. Jia et al. (2010) analyzed the differences between transportation energy consumption in China and in the world and concluded that China's current statistics lacked energy consumption data for social and private cars, motorcycles, low speed automobiles and agricultural automobiles. They established an energy consumption transportation model and calculated the related parameters based on vehicle usage. They then compared China's transportation energy consumption level with other developed countries and found that China's per capita energy consumption and the transportation energy consumption proportion were relatively low, but had increased in recent years. Sun et al. (2013) analyzed China's urban traffic structure and maintained that vehicle numbers, fuel consumption per hundred kilometers and annual mileage were the main factors exerting influence on urban transportation energy consumption. They introduced a rate of change as parameters into the influencing factors and, using an LMDI model, established an urban transportation energy consumption dynamic scene combinational decomposition model. According to changes in the 3 factors, they established a 12 scenario model and analyzed urban traffic energy consumption trends under the different modes. Zhang et al. (2006) established a transportation energy consumption decomposition model to analyze the contribution of traffic service level, transportation mode shares and energy consumption intensity to transport energy consumption from 1980 to 2001. The results showed that transportation service turnover was the main driving force behind energy consumption, while changes in transportation structure exacerbated the growth. A reduction in energy intensity in the past was not enough to prevent an increase in energy consumption.

1.2. The choice of prediction method

Prediction method can be classified into univariate and multivariate (Chatfield, 1988). The univariate mainly include exponential smoothing method (ETS) model and ARIMA model, it focus on time series analysis based on historical data. The multivariate focus on scenario analysis regression models and structure time series models (Chai et al., 2014). Moreover, with continuous development of intelligent algorithm, the prediction methods improved from traditional methods to today's neural network algorithm, fizzy sets, rough sets, support vector machine (SVM), genetic algorithm, etc. intelligent methods have been widely used in energy forecast.

In summarizing the findings of previous studies, road transportation energy consumption demand has some apparent driving factors. Economic development boosts the growth of road transportation total turnover, which increases the road transportation energy consumption. However, an improvement in energy efficiency can reduce road transportation energy consumption and pollutant emissions. Gasoline prices and national fuel tax policy changes also affect road transportation energy consumption to a certain extent. With the promotion of an energy conservation and emissions reduction policy, the contradictions between employment, energy conservation and emissions reduction are sharpening. The government