



Exploring the transformation and upgrading of China's economy using electricity consumption data: A VAR–VEC based model

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HIGHLIGHTS

- The relationship between electricity consumption and economic growth is complex.
- A VAR–VEC model is used to captures the interdependencies.
- The Granger causality relationships in different industries show differences.
- Impulse response function and variance decomposition verify the dynamic behaviors.
- China's entry into WTO is the time node when transformation and upgrading appeared.

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ABSTRACT

Since the reforming and opening up in 1978, China has experienced a miraculous development. To investigate the transformation and upgrading of China's economy, this study focuses on the relationship between economic growth and electricity consumption of the secondary and tertiary industry in China. This paper captures the dynamic interdependencies among the related variables using a theoretical framework based on a Vector Autoregressive (VAR)–Vector Error Correction (VEC) model. Using the macroeconomic and electricity consumption data, the results show that, for secondary industry, there is only a unidirectional Granger causality from electricity consumption to Gross Domestic Product (GDP) from 1980 to 2000. However, for the tertiary industry, it only occurs that GDP Granger causes electricity consumption from 2001 to 2014. All these conclusions are verified by the impulse response function and variance decomposition. This study has a great significance to reveal the relationship between industrial electricity consumption and the pattern of economic development. Meanwhile, it further suggests that, since China joined the World Trade Organization (WTO) in 2001, the trend of the economic transformation and upgrading has gradually appeared.

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1. Introduction

There has been more than 35 years since the reform and opening up of China in 1978. During this period, China has achieved continued and rapid economic development and considerably improved its overall national strength, becoming

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one of the main engines of world economic growth [1,2]. Due to the fact that economic development cannot be separated from the support of energy, energy exploitation and utilization has been playing a fundamental role in China's economic growth [3]. Electricity is closely related to people's daily life, and it is also an important basic industry which related to national energy security, economic development and social stability. As always, the economic growth and electricity consumption have been considered to be closely related. For the countries in the process of industrialization and urbanization, electricity consumption and economic growth rate remain a relatively stable proportional relationship [4,5]. From 1980 to 2012, the proportion of China's GDP growth and electricity consumption growth remained nearly at 1:1. However, in the past several years, China's GDP and electricity consumption were not synchronized [4,6]. In 2014, China's GDP growth rate was 7.4%, but electricity consumption growth rate remained only 3.8% [7].

Actually, the process of China's economic integration can generally be divided into two stages according to join the WTO as a key point. The implementation of reform and opening up turned the long-term closed China into an exoteric economy. Later, the accession to the WTO urged China's integration into the economic globalization. But as a developing country which has not completed the economic transformation, there are still many serious problems. Faced with new global situation, the challenges of China are whether its economy can successfully adjust as soon as possible, and maintain their competitive advantage in the global competition.

In recent years, China's economic growth rate has gradually decreased. Especially in the third quarter of 2015, China's GDP only grew by 6.9%, which was less than 7% for the first time since the international financial crisis in 2008 [8]. Meanwhile, the tertiary industry in China accounted for more than secondary industry of GDP, and the tertiary industry has gradually become the main force of economic growth [8]. China's industrial structure is undergoing significant changes. Traditional industrial sales profit has declined, especially the heavy industry. Also, the fixed asset investment growth is slowing. At the same time, represented by advanced manufacturing and modern service industry, emerging industry has developed rapidly.

From the macroeconomic data perspective, China's economic transformation phenomenon has been realized by the government and the public over the past few years. But in fact, in order to adapt to the trend of economic globalization and further deepen reform and opening up, some corresponding countermeasures have been put forward from the perspective of organization, management and human resources to improve competitiveness since China accessed to WTO in 2001. Therefore, under the background of China's economic transformation and upgrading, the research on the relationship between energy consumption and economic growth has great theoretical and practical significance.

Different statistics methods were used in multifarious macro and economic issues. As studied by Bentes [9], he used cointegration and a dynamic VEC model to perform analysis and check economic relations examining the financial market integration among Portugal, Spain, Japan, United States and Brazil. He found a long-run market integration in the system. According to Senna and Souza [10], the VAR, VEC and variance decomposition were used to analyze the relationship between the main macroeconomic variables and the Brazil's Federal government spending on social welfare policy. His conclusion was that the social programs have a positive influence on domestic economy. Meanwhile, Ouedraogo [11] used theoretical framework cointegration tests and a panel error correction model to study the relationship between Energy consumption and economic growth of the economic community of West African States. Konstantakis et al. [12] used a relevant econometric framework based on VAR-VEC, which explore the dynamic interdependencies among the macroeconomic and financial factors and non-performing loans in Greece. The findings showed that both financial and macroeconomic factors have impact on non-performing loans. At the same time, Abosedra et al. [13] found that when considering the binary vector autoregressive framework with changes of exogenous variable temperature and relative humidity, there was a unidirectional causality from electricity consumption to economic growth in Lebanon.

The relationship between electricity consumption and economic growth has always been a hot research topic in the field of economical and sociological systems. Currently, there have been some relevant researches work with different methods. By using the minimum spanning tree (MST) approach, Kantar et al. [14] investigated the relationship between electricity consumption and GDP in 30 Asian countries. They found a strong relationship between energy consumption and economic growth for all income groups. Kemalbay and Korkmazoglu [15] focused on the impact of economic growth on annual electricity consumption using Partial least squares regression (PLSR). Shahbaz and Feridun [16] used the autoregressive distributed lag (ARDL) boundary test and confirmed the long-term equilibrium relationship between economic growth and electricity consumption in Pakistan. Based on industrial electricity-consumption data of five southern provinces of China, Yao et al. [17] studied the industrial correlation mechanism with minimal spanning tree (MST) and hierarchical tree (HT) models. They reflected that during the crisis time, the optimization of industrial structures strengthened the correlation mechanism.

This research hypothesis is to answer the following questions: Is the electricity consumption able to interfere GDP in the national and industrial economy? Are there differences for existence and direction of the relationship among different industry? And has the economic transformation trend appeared in China as early as 2001?

Paying attention to the transformation and upgrading, this study investigates the relationship between electricity consumption and industry output value of the secondary and tertiary industry before and after China's accession of WTO in 2001 based on the relevant data from 1980 to 2014. In this text, the existence of short- and long-term relationship between electricity consumption and macroeconomic variables is analyzed through the vector autoregression (VAR) and error correction vectors (VEC). Meanwhile, using impulse response function and variance decomposition, it can be verified how variables can impact the system of variables on the balance relationship. To the best of the authors' knowledge, this is the first study that reveals the trend of China's economic transformation and upgrading based on the relationship between

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