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Research On The Us Electricity Market Based On Price Fluctuations

Mei Sun*, Juan Li, Cuixia Gao, Dun Han

Center for Energy Development and Environmental Protection, Jiangsu University, Zhenjiang, Jiangsu 212013, PR China

Abstract

Electricity power is the basic industry and it plays an important role in the national economy. Based on the random matrix theory (RMT), we study the average correlations evolution of electricity price among 51 states, and identify their four regime shifts during the period of January 1990 to August 2014 in the U.S. residential, commercial and industrial electricity markets. Then, the genetic algorithm is applied to the analysis of clusters evolution. The results show that, the correlations of electricity price increased continually in the three departments. However, it decreased in 2012 which verifying the sensitivity to fuel market further. Besides, four regime shifts exist in the three departments even though the different time of occurrence caused by price level. Finally, the research results are analysed and summarized.

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Keywords: U.S. electricity market, Electricity price, Regime Shifts, Cluster evolution ;

1. Introduction

Electricity industry[1-4] is the foundation of the national economy, and electricity price affects operating cost in other industries and the living standard of residents directly. In the 1980s, the reform of electricity industry has swept the world[5,6]. Western countries began to loosen the regulations, restructured and established a competitive electricity market, which have promoted the progress of the global electricity market. In the U.S., most of the electricity industries belong to privatization. Electricity industry reform mainly means reducing regulation as well as increasing competition. The programs of reform were different by regions. But, the only purpose is to fuse market mechanism into the electricity industry, to optimize and improve the allocation and efficiency of resources using competition and privatization.

In recent years, as one of the most important commodities for national development and people's life, electricity market is concerned by researchers and policy makers increasingly. It should be mentioned that

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related surveys on electricity market have been previously conducted by a few researchers and organizations. Peter Cappers et al. [7] summarize the existing contribution of Demand Response resources in U.S. electricity markets. They concluded that competition is critical to the development of electricity markets. A more recent update was accomplished by G. Castagneto-Gissey [8] in 2014 on European electricity market. They analyzed the interactions of a representative sample of 13 European electricity spot prices during the period 2007-2012 based on complex network theory. Their model is able to create a time-varying network describing the evolving influences among the European electricity prices, is able to detect important changes in market integration and can be considered a suitable and promising approach for this task.

The existing literatures has provided a solid empirical investigation and a good reference to understand the evolution of a certain electricity market around the world, but some research of U.S. electricity market still need to be further implement. The U.S. electricity market is one of the largest electricity markets in the world, and it is also the first country to reform. There are two reasons for us to study the U.S. electricity market. One is for its more mature operation mechanism and supervision systems. Another is the higher market competition. The main objectives of our survey efforts are to explore the principle of the U.S. electricity market from the angle of electricity price, and to provide a reference for research in future electricity market. It is also our hope that this research could be used to facilitate reform scheme for China electricity market, as well as to help energy investors assess the overall potential risk of electricity market.

Nomenclature

RMT	Random Matrix Theory
M	Month
S	Size of moving window

2. Data and Methods

2.1. Data

In this paper, the data of electricity prices are divided into three kinds: residential, commercial and industrial both for 51 states and the U.S. Each kind of data is recorded monthly from 1990M1 to 2014M8, given a total of 296 values (http://www.eia.gov/).

2.2. Methods

(1) Moving windows and Correlation coefficient matrix. P_i (t) presents the t-month electricity price of *i*-state (*i*=1, 2, 3…51). Then, the logarithmic return at time t is defined as

$$r_i(t) = \ln P_i(t) - \ln P_i(t-1) \quad (1)$$

For each window, we compute the correlation matrix C(t), whose element C_{ij} is the Pearson correlation coefficient[9] between the return time series of states i and j.