## **CEEP-BIT WORKING PAPER SERIES**



# Impact of China's stock market development on energy

## consumption: An empirical analysis

Yue-Jun Zhang Jing-Li Fan Hao-Ran Chang

Working Paper 10 <u>http://ceep.bit.edu.cn/english/publications/wp/index.htm</u>

Center for Energy and Environmental Policy Research Beijing Institute of Technology No.5 Zhongguancun South Street, Haidian District Beijing 100081 August 2010

This paper can be cited as: Zhang Y-J, Fan J-L, Chang H-R. 2010. Impact of China's stock market development on energy consumption: An empirical analysis. CEEP-BIT Working Paper.

This study is supported by the NSFC (71001008, 70733005), Humanities and Social Science Research Foundation of Ministry of Education of China (09YJC630011), SRFDP (20101101120041) and Excellent Young Scholars Research Fund of BIT (2010Y1317). The views expressed herein are those of the authors and do not necessarily reflect the views of the Center for Energy and Environmental Policy Research.

© 2010 by Yue-Jun Zhang, Jing-Li Fan and Hao-Ran Chang. All rights reserved.

The Center for Energy and Environmental Policy Research, Beijing Institute of Technology (CEEP-BIT), was established in 2009. CEEP-BIT conducts researches on energy economics, climate policy and environmental management to provide scientific basis for public and private decisions in strategy planning and management. CEEP-BIT serves as the platform for the international exchange in the area of energy and environmental policy.

Currently, CEEP-BIT Ranks 121, top10% institutions in the field of Energy Economics at IDEAS (http://ideas.repec.org/top/top.ene.htm), and Ranks 157, top10% institutions in the field of Environmental Economics at IDEAS (http://ideas.repec.org/ top/top.env.html).

Yi-Ming Wei Director of Center for Energy and Environmental Policy Research, Beijing Institute of Technology

For more information, please contact the office:

### Address:

Director of Center for Energy and Environmental Policy Research Beijing Institute of Technology No.5 Zhongguancun South Street Haidian District, Beijing 100081, P.R. China

## Access:

Tel: +86-10-6891-8551 Fax: +86-10-6891-8651 Email: ceeper@vip.163.com Website: http://ceep.bit.edu.cn/english/index.htm

# Impact of China's stock market development on energy consumption: An empirical analysis

Yue-jun Zhang<sup>a,b\*</sup>, Jing-li Fan<sup>a,b</sup>, Hao-ran Chang<sup>a,b</sup>

<sup>a</sup>School of Management and Economics, Beijing Institute of Technology, Beijing 100081, China; <sup>b</sup>Center for Energy & Environmental Policy Research, Beijing Institute of Technology, Beijing 100081, China

#### Abstract

To investigate the influence of China's stock market development on energy consumption, the Grey Relational Analysis and Granger causality test approaches are used. Empirical results indicate that, first, the grey relational grade appears relatively high for both stock market scale and efficiency and energy consumption during 1992-2009, with 0.84 and 0.73, respectively. Second, China's stock market scale enlargement becomes an evident driver for energy consumption increase, while the influence of stock market efficiency is insignificant. Finally, energy consumption upsurge caused by stock market scale expansion of Farming, Forestry, Animal Husbandry, Fishery and Construction industries, and stock market efficiency promotion of Electric Power, Gas and Water Production and Supply and Manufacturing industries should be paid close attention.

Keywords: stock market; energy consumption; energy saving; grey relational analysis; causality

#### Introduction

Energy consumption issue is of great significance in China and energy saving is closely related to its socio-economic sustainable development. As the acceleration of industrialization and urbanization, China's energy consumption will continue to increase in the future. In fact, energy consumption increase is not only attributed to economic growth. The influence of financial development, especially stock market development, on energy consumption should not be ignored or underestimated as well.

First, the healthy stock market helps enhance listed enterprises' economic strength and efficiency, thus affecting energy consumption. However, some authors argue that although economic growth results in financial development, the influence of financial development on economic growth proves weaker; therefore, the influence of financial development on energy consumption appears insignificant <sup>[1]</sup>.

As for China, the relationship between financial development (particularly stock market development) and energy consumption also does not appear clear; nor have we figured out whether such relationship varies from industry to industry. Therefore, empirical research on the impact of stock market development on energy consumption is essential for the China's energy demand prediction.

The rest of the paper is organized as follows. Section 2 reviews literature related with financial development and energy consumption. Section 3 gives empirical research methods and data definitions. Section 4 presents main results and Section 5 concludes the paper.

<sup>\*</sup> Corresponding author. Tel: +86-10-68918843.

E-mail address: zyjmis@126.com.

#### **Related literature review**

Currently, there are an array of studies on energy consumption issue, mainly focusing on the causal relationship between energy consumption and economic growth. However, empirical research results are not consistent based on different countries, different sample periods and different research methods<sup>[2]</sup>.

A body of literature concentrates on the nexus of financial development and economic growth<sup>[1]</sup>, among which there are mainly three types of research objects for China. The first type focuses on the overall situation of China's financial development and economic growth<sup>[3]</sup>. The second type takes one of China's provinces as a research object and analyzes the relationship in the province<sup>[4]</sup>. And the third type compares the relationship discrepancy among different regions of China<sup>[5]</sup>.

However, only a little literature analyzes the impact of financial development on energy consumption. Mielnik and Goldemberg (2002) find that foreign direct investment increase can promote energy intensity decrease significantly<sup>[6]</sup>. And Sadorsky (2010) discusses the impact of financial development on energy consumption based on historical panel data of 22 emerging countries including China during 1990-2006, and finds that financial development promotes energy consumption increase remarkably<sup>[1]</sup>.

In our opinions, there are some limitations for Sadorsky (2010). First, the measurement of stock market development fails to distinguish market scale from market efficiency. Second, it does not have a special discussion about the situation in China. Third, the influence of stock market development on energy consumption among different industries is not the same, but it does not elaborate it specifically.

In view of these problems, the Grey Relational Analysis<sup>[7]</sup> and Granger causality test<sup>[8]</sup> approaches are used to discuss the impacting mechanism of China's stock market development on energy consumption.

#### Methodologies and data definitions

#### 3.1 Methodologies

Given the annual data of China's stock market development and energy consumption is relatively short with non-evident statistical distribution, this paper uses the Grey Relational Analysis approach to examine their relationship during 1992-2009. And main procedures are as follows.

1) Take stock market scale and efficiency as two comparative series:  $X'_i = (x'_i(1), x'_i(2), \dots, x'_i(m))$ , where

- i = 1, 2 and *m* is the year;
  - 2) Take energy consumption as a reference series:  $X'_0 = (x'_0(1), x'_0(2), \dots, x'_0(m));$
  - 3) Treat each comparative series dimensionlessly:  $x_i(k) = \frac{x'_i(k)}{x'(1)}$ , where i = 1, 2 and  $k = 1, 2, \dots, m$ ;
  - 4) Calculate two variables:  $\min_{i=1}^{2} \min_{k=1}^{m} |x_0(k) x_i(k)|$  and  $\max_{i=1}^{2} \max_{k=1}^{m} |x_0(k) x_i(k)|$ ;
  - 5) Calculate correlation coefficient:  $\zeta_i(k) = \frac{\min_{i \neq k} |x_0(k) x_i(k)| + \rho \cdot \max_{i \neq k} \max_{k} |x_0(k) x_i(k)|}{|x_0(k) x_i(k)| + \rho \cdot \max_{i \neq k} \max_{k} |x_0(k) x_i(k)|} , \text{ where }$

 $k = 1, 2, \dots, m$  and  $\rho$  denotes the discriminating coefficient and often takes 0.5.

6) Calculate relational order: 
$$r_{0i} = \frac{1}{m} \sum_{k=1}^{m} \zeta_i(k)$$
, where  $i = 1, 2$  and evaluating results are obtained.

Additionally, the Granger causality test approach is used to ascertain the lead-and-lag relationship between China's stock market development and energy consumption. Take the causality between stock market scale and energy consumption for example, we suppose *S* as stock market scale and *E* as energy consumption, and make a hypothesis test on Equation (1), with  $H_0: \lambda_{1j} = 0$  ( $j = 1, 2, \dots, q$ ). If  $H_0$  is rejected, we may say stock market scale Granger causes the change of energy consumption; similarly, we can judge whether energy consumption Granger causes the change of stock market scale on Equation (2), with *q* the maximum lag order determined by the minimum AIC and SC values in a VAR model. And the causality test between stock market efficiency and energy consumption is conducted similarly.

$$E_{t} = k_{10} + \sum_{i=1}^{q} k_{1i} E_{t-i} + \sum_{j=1}^{q} \lambda_{1j} S_{t-j} + \varepsilon_{1t}$$

(1)

$$S_{t} = k_{20} + \sum_{i=1}^{q} k_{2i} S_{t-i} + \sum_{j=1}^{q} \lambda_{2j} E_{t-j} + \varepsilon_{2t}$$
(2)

#### 3.2 Data definitions

The ratio of China's stock market capitalization (turnover) to Gross Domestic Product (GDP) is used to measure stock market scale (efficiency). It should be noted that energy consumption is in the logarithmic item and stock market capitalization, turnover and GDP are taken in the current values.

China's GDP and energy consumption data are from China Statistical Yearbook, and China's stock market data is from the Wind database. The data for various industries is collected according to the industrial standards in China Securities Regulatory Commission and China Statistical Yearbook. The sample period ranges from 1992 to 2009, with industry data during 2004-2007. All data is in annual item.

#### **Empirical research result analysis**

#### 4.1 The correlation between China's stock market development and energy consumption

First, we use the Grey Relational Analysis approach to analyze the correlation between China's stock market scale and efficiency and energy consumption respectively and results are shown in Figure 1.

The results indicate that the grey relational grades between China's stock market and energy consumption are relatively high during 1992-2009, with 0.84 and 0.73 for scale and efficiency respectively. This shows that the rapid development of China's stock market has become an important driver for energy consumption. Besides, the impact of China's stock market scale on energy consumption is always greater than that of stock market efficiency in the sampling period.



Fig. 1: The grey relational grade between China's stock market development and energy consumption, 1992-2009

Additionally, the Granger causality test results are shown in Table 1. We find that there is only one-way causality. Specifically, stock market scale enlargement results in energy consumption increase, and energy consumption leads to stock market efficiency change.

Table 1 Granger causality between China's stock market development and energy consumption

Null hypothesis	F statistic	Probability
Energy consumption does not Granger cause stock market scale change	1.4454	0.4571
Stock market scale does not Granger cause energy consumption change	17.3898	0.0553
Energy consumption does not Granger cause stock market efficiency change	7.6029	0.0100
Stock market efficiency does not Granger cause energy consumption change	1.8478	0.2167

This results from that fact that stock market attracts more savings and the proportion of savings transformed into investment increases, leading to growing economy and increasing energy consumption. Additionally, energy consumption increase promotes economic growth, and economic growth provides a sound macroeconomic environment for stock market operation, improving trading efficiency.

However, China's stock market efficiency promotion does not make a statistically significant contribution to energy consumption increase. This reflects in some extent that China's stock market operates in a non-standardized way and its resource allocation function appears relatively weaker.

4.2 The relational grades between stock markets development and energy consumption by industry

We use the ratio of stock market capitalization (turnover) for each industry to its total added value to represent stock market scale (efficiency) of the industry. The sample period ranges from 2004 to 2007. And the results are shown in Figure 2.

The results show that, for one thing, there exists close relationship between stock market development and its energy consumption for each industry during 2004-2007, with the grey relational grade between stock market scale (efficiency) and energy consumption over 0.87 (0.75). And the contribution of stock market scale on energy consumption by industry appears greater than that of stock market efficiency.

For another, the impact of stock markets scale increase of the Farming, Forestry, Animal Husbandry, Fishery industry on its energy consumption is the largest. And the relationship appears the most close between stock market efficiency promotion and energy consumption of the Electric Power, Gas and Water Production and Supply industry.



Fig. 2: The grey relational grades between China's stock markets development and energy consumption by industry, 2004-2007

#### Conclusions

We find that the grey relational grade is relatively higher between China's stock market development and energy consumption. Meanwhile, the contribution of China's stock market scale enlargement on energy consumption increase is greater than that of stock market efficiency. This fact exists not only in the aggregate level but also makes sense by industry. Therefore, when predicting energy demand and setting energy saving targets, we should attach great importance to energy consumption increase caused by stock market development, particularly the impact of stock market scale development.

#### References

[1] Sadorsky P. The impact of financial development on energy consumption in emerging economies. Energy Pol 2010; 38: 2528-35.

[2] Ozturk I. A literature survey on energy-growth nexus. Energy Pol 2010; 38: 340-9.

[3] Li GZ, Chen P. Financial intermediation and economic growth via a VAR model. Manage World 2002; 3: 52-9. (in Chinese).

[4] Zhang B, Hu JW. On financial development and economic growth. J Nanjing Agric University 2003; 3: 72-5. (in Chinese).

[5] Zhou HW, Zhong YH. China's financial intermediation and economic growth. J Finan Res 2004; 6: 130-7. (in Chinese).

[6] Mielnik O, Goldemberg J. Foreign direct investment and decoupling between energy and gross domestic product in developing countries. *Energy Pol* 2002; 30: 87-9.

[7] Liu SF, Xie NM. Grey System Theory and Its Applications. Beijing: Science Press; 2008. (in Chinese).

[8] Granger CWJ. Causality, cointegration and control. J Econ Dyn Control 1988; 12: 551-9.