Related factors and regional differences in energy consumption in China[*]

QU Xiao-e[1], ZHU Qing[1], YANG Yang[2]

(1. School of Finance and Economics, Xi'an Jiaotong University, Xi'an 710061, China;

2. Geography Department, Humboldt State University, Arcata CA 95521, USA)

Abstract: This article used the Cluster analysis of statistical method to separate China's 30 provinces and municipalities into three categories according to their energy consumption discrepancies and characteristics from 1985 to 2007. The categories were high, moderate and low energy consumption areas and they had significant differences in energy consumption. Based on this classification, the authors analyzed the influencing factors of energy consumption in the three areas by means of panel data econometric model. The results showed that the influencing factors were obviously different. In order to support national goal of energy conservation and emission reduction, the energy measures and policies should be distinctly taken.

Key words: energy consumption; Cluster analysis; panel model; econometric analysis

1. Introduction

Energy resources are very important material basis and strategic assurance to the national economy and social development in a country. As human beings came to the era of industrialization, energy resources had played an irreplaceable role all around the world. The developed countries' historical experience showed that, in the special era of one country entering into the industrialization and urbanization, tremendous energy investment and consumption demand would be created, which would inevitably increase the high energy consumption speed. From 1978 to 2000, China's average GDP growth rate was 9.5% and the increase rate of average energy consumption was 3.82%, which was less than half of the GDP growth rate and the elastic coefficient of energy consumption remained less than 1.0. Meanwhile, from 1996 to 1999, the consumption elastic coefficient kept negative, which indicated the relative high economic development with low energy consumption. However, China's energy consumption increased drastically since 2001. The average GDP growth rate was 10.2% and average increase rate of energy consumption was 13.9%, higher than the GDP growth rate. This phenomenon reflected that China's economic growth sacrificed higher energy consumption as cost and relied on the energy consumption a lot.

Confronted with the increasing serious energy problem, the *National 11th Five-Year Plan* put forward the target of decreasing energy consumption by 20%. Foreign and domestic research institutions and scholars studied China's energy issues and their impact on economic growth research from different point of view. ZHAO and FAN (2007) claimed that China' economic growth had obvious stage characteristics by establishing econometric model. From 1956 to 1976, the relation between economic growth and energy consumption showed nonlinear

characteristics, while that was apparently linear relation from 1977 to 2005. PENG, WU and WANG (2007) pointed out that the industry sector was the major energy consumption sector and had a high proportion and impact on the whole energy consumption. WANG and LIU (2007) studied the relationship between China's energy consumption and economic growth by co-integration analysis and Granger causality test. They found that China's energy consumption and economic kept volatile growth in the short run and stable equilibrium relation in the long term. They also investigated that it was one-way causality from energy consumption to economic growth. ZHOU (2007) used Granger causality, dynamic correlation coefficient, small sample test model and other econometric methods to analyze the China's energy consumption and economic growth mechanism since China's reform and opening up. He maintained that the economic increase was the reason why energy consumption increased. WANG, TIAN and JIN (2006) studied China's energy consumption and economic growth by variable parameter model and found that they remained a long-term equilibrium relationship (variable parameter cointegration relationship), which didn't change over time. LIN (2001) utilized the cointegration and error correction model to come to the conclusion that total energy consumption, GDP, energy price and energy structure had long term equilibrium relation. Not only the price and income, but also the heavy industry sector share in GDP, which reflected structure change, was all critical determinants of energy demand.

The above investigations mainly took the time series data and discussed China's energy issues from the country's point. In fact, if we considered all the areas as homogeneous and took the one-fits-all framework, neglecting each region's resources and economic level's discrepancies, it would be bound to hamper the achieving of energy conservation and emission reduction goal and harmonious development.

In this article, the authors discussed the energy consumption from China's different regions and utilized panel data model. The result would be more reliable and comprehensive because panel data model composed of three dimensions of individuality, index and time, which could take the region difference and time trend into consideration.

In the investigation, the authors used the Cluster analysis of statistical methods to separate the China's 30 provinces and municipalities (Tibet was not concluded because of lack of energy data) according to their energy consumption level. It was more reliable when classified the regions, which had similar energy consumption level, into one category because it overcame the defect of traditional region classifying (eastern, western and the middle regions) method.

2. Index selection and data explanation

The authors selected the following indices for analysis and investigation according to the data availability, including studies' results and all the possible influencing factors in energy consumption.

2.1 Total energy consumption quantity (eng)

Total energy consumption quantity referred to the primary energy consumption quantity in the nature, which was the sum consumption of coal, oil, natural gas and hydropower. The authors had changed all of them into "equivalent of ten thousand tons of standard coal" as measurement unit.

2.2 Economic growth (GDP)

Economic growth highly relied on energy consumption. Most studies showed that GDP was a main determinant to the energy demand. So the authors expected that the relation was positive between economic

growth and energy consumption.

2.3 Total fixed assets investment (INV)

According to the definition of *Statistical Yearbook of China*, total fixed assets investment composed of state-owned economic investment, urban and rural collective ownership unit and urban and rural individual ownership unit investment. This article used the ratio of regional fixed assets investment in GDP to represent investment status, and the authors expected that the relation was positive between the fixed assets investment and the energy demand.

2.4 Population growth (POP)

Because of the improvement of economic development and citizens' income, the living standard of urban and suburban citizens had been improved gradually. In fact, the denser the population was and the higher the income level was, the more energy was demanded. Meanwhile, the speedup of local industrialization and urbanization process would raise the average energy consumption rate. Therefore, high population growth rate would certainly increase the energy demand. This article used the total population of each region to represent population growth and the authors also expected that it was positive to the energy demand.

2.5 Industrial structure (STR)

Industrial structure and its change were important factors influencing energy consumption. Among the three industry sectors, the secondary industry was the main influencing factor, while the tertiary industry had high added value and low energy consumption. Therefore, the authors could mitigate the energy consumption by increasing the tertiary industry proportion. This article used the ratio of output value of the secondary and tertiary industry in GDP to represent industrial structure change. The authors expected that it was positive for the secondary industry and negative for the tertiary industry regarding to the energy consumption.

2.6 Energy price (EP)

Energy price directly influences the quantity of energy consumption. In China, raw materials, fuels and power purchasing price indices were comprehensively considered by the relative price of production input. The authors expected that energy price was negative to the energy consumption. However, Chinese energy price was very low because the energy pricing mechanism had not realized marketization. Price distortion made it impossible for the supply and demand sides to get correct market signal, which in turn brought the consumption distortion. In addition, this kind of price mechanism caused low efficiency and excessive use of energy because it couldn't regulate the energy's production and consuming behavior. Eventually, the law of demand was violated.

Our statistical data came from *Statistical Yearbook of China, China Energy Statistical Yearbook, Fifty-Five Years of New China's Statistics Compile* and each province, municipality and self-governing district's statistical yearbook. The base period was selected as 1990 and all the data was deflated to the year 1990.

3. Cluster analysis of energy consumption in 30 provinces and municipalities

3.1 Comparison of energy consumption

In this article, the authors firstly calculated the average energy consumption of the 30 provinces and municipalities from 1985 to 2007 (see Table 1).

From the calculation results, we could see that the top 3 energy consumption provinces in eastern areas were Shandong (10,016), Hebei (9,643), Liaoning (9,174) and their average consumption quantity were more than or

close to equivalent of 10,000 ten thousand tons of standard coal. However, in Hainan province, which was also from eastern area, the number was equivalent of 454 ten thousand tons of standard coal and was the least. That meant 1/22 of Shandong, 1/21 of Hebei, 1/20 of Liaoning. For the middle areas of China, the number was: Henan (7,570), Shanxi (6,729) (the most), Jiangxi (2,306) (the least). For the 11 western provinces, the extreme number was: Sichuan (6,470) (the most), Qinghai (792) (the least), that was 1/8 of Sichuan.

We could clearly conclude from the above analysis, discrepancies existed not only among different areas, but in the internal regarding to China's energy consumption. Therefore, we deduced that the traditional region classifying method was no longer adequate to analyze China's provincial energy consumption problem. We could also know that the 8 largest (economy) regions classifying method was too finesorted to present a clear-cut comprise and also made great difference in the same region's energy consumption quantity.

Table 1   Average energy consumption (1985-2007) (equivalent of ten thousand tons of standard coal)

Provinces	Mean	Standard deviation	Provinces	Mean	Standard deviation
Beijing	3,596	1,045	Hubei	5,568	2,038
Tianjin	2,585	751	Hunan	5,034	1,842
Hebei	9,643	4,572	Jilin	3,956	9,508
Liaoning	9,174	2,517	Heilongjiang	6,045	1,043
Shanghai	4,596	1,872	Inner Mongolia	3,594	2,475
Jiangsu	8,362	3,796	Guangxi	2,371	1,264
Zhejiang	5,003	3,259	Chongqing	2,142	909
Fujian	2,648	1,563	Sichuan	6,470	2,470
Shandong	10,016	5,437	Guizhou	3,434	1,630
Guangdong	6,649	3,538	Yunnan	2,989	1,459
Hainan	454	229	Shaanxi	2,991	1,133
Shanxi	6,729	2,508	Gansu	2,771	776
Anhui	4,175	1,493	Qinghai	792	417
Jiangxi	2,306	846	Ningxia	1,005	665
Henan	7,570	3,258	Xinjiang	2,852	1,178

Notes: the analysis software was SPSS 15.0; Hainan's data was from 1990-2007, others were 1985-2007.

3.2 Cluster analysis of provincial energy consumption

Regarding to the drawbacks of the traditional region classifying method in studying the energy consumption problem, the authors used the Cluster analysis of statistical methods in our article. The authors carried out systematic Cluster to the energy consumption level of the 30 provinces and municipalities. Meanwhile, the authors standardized the data to [-1, 1] (see Fig. 1) and separated the 30 provinces and municipalities into three categories pursuant to the Euclid distance. The first category was high energy consumption areas and they incorporated Hebei, Liaoning, Jiangsu, Shandong and Henan province, with average energy consumption quantity from 7,570 to 10,016 equivalents of ten thousand tons of standard coal. The second category was the moderate energy consumption areas and they incorporated Guangdong, Shanxi, Hubei, Heilongjiang and Sichuan province, with the quantity from 5,568 to 6,729. The last category was the low energy consumption areas, including Beijing, Tianjin, Shanghai, Zhejiang, Fujian, Hainan, Anhui, Jiangxi, Hunan, Jilin, Inner Mongolia, Guangxi, Chongqing,

Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang, from 454 to 5,034. The ration of energy consumption level among the three areas was 8953: 6304: 2963 (3.02: 2.23: 1) (the lowest was 100).

The Cluster analysis results contributed to understand the discrepancies and characteristics internal and between the categories. The results also provided grounds to the policy drawing up in support of the goal of energy conservation and emission reduction. In addition, these results provided new references to later investigation on the energy consumption issues.
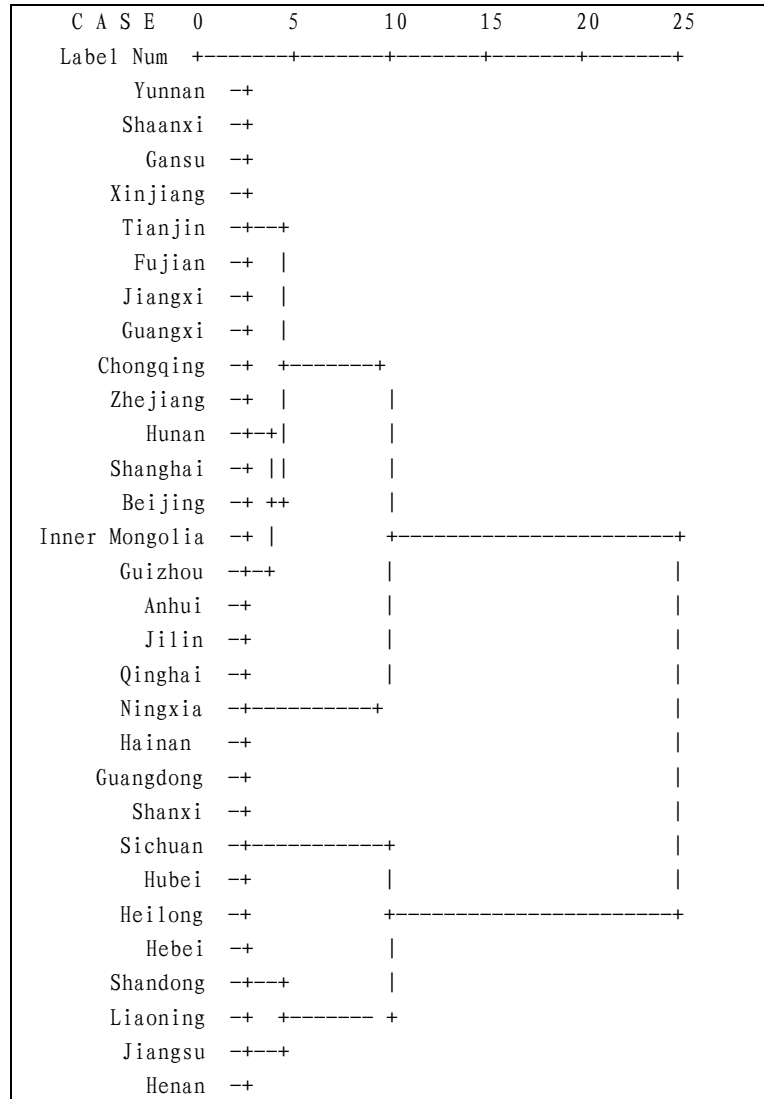
```
         C A S E    0       5      10      15      20      25
        Label  Num  +-------+-------+-------+-------+-------+
           Yunnan  -+
          Shaanxi  -+
           Gansu   -+
         Xinjiang  -+
          Tianjin  -+--+
           Fujian  -+  |
          Jiangxi  -+  |
          Guangxi  -+  |
        Chongqing  -+  +-------+
         Zhejiang  -+  |       |
            Hunan  -+-+|       |
         Shanghai  -+ ||       |
           Beijing -+ ++       |
   Inner Mongolia  -+  |       +----------------------+
          Guizhou  -+-+        |                      |
            Anhui  -+          |                      |
            Jilin  -+          |                      |
          Qinghai  -+          |                      |
          Ningxia  -+---------+                       |
           Hainan  -+                                 |
        Guangdong  -+                                 |
           Shanxi  -+                                 |
          Sichuan  -+----------+                      |
            Hubei  -+          |                      |
          Heilong  -+          +----------------------+
            Hebei  -+          |
         Shandong  -+--+       |
          Liaoning -+  +------- +
          Jiangsu  -+--+
            Henan  -+
```

Fig. 1   Cluster tree of 30 provinces and municipalities (1995-2006)

3.3 Basic features of the energy consumption in the three categories of regions

Fig. 2 showed a great difference on energy consumption among the three categories of regions. The overall energy consumption amount was taking an upward trend, however, before 2001, the spread was small and after that, energy consumption had a drastic increase. In Fig. 2, the fist (more than 20,000 equivalent of ten thousand tons of standard coal after year 2006) and second (more than 12,000) categories of regions had the largest increase spread, while the low energy regions was below 5,000 equivalent of ten thousand tons of standard coal after year

2006. Although it gradually increased, the spread was quite small. The gap between the three categories of regions was taking an expending trend. It was really important to realize the disparity in taking targeted measures to enhance efficiency of energy utilization and control the energy waste.
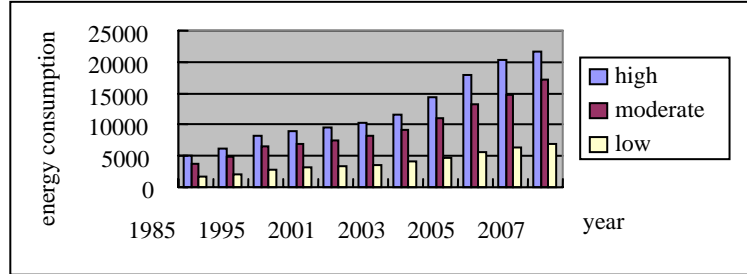

Fig. 2   Comparison of energy consumption among three categories (1985-2007)

4. Econometric model and empirical analysis

4.1 Econometric model designing and selecting

According to the discussion of influencing factors of energy consumption in part 2, the authors designed the following panel data model:

$$\textbf{eng}_{j,it} = f(GDP_{j,it}, INV_{j,it}, POP_{j,it}, ST2R_{j,it}, ST3R_{j,it}, EP_{j,it}) + u_{j,it} \tag{1}$$

In the equation (1), j represented the 3 categories of regions, i represented the provinces included in the region, t represented time; $\textbf{eng}_{j,it}$, $GDP_{j,it}$, $INV_{j,it}$, $POP_{j,it}$, $ST2R_{j,it}$, $ST3R_{j,it}$ and $EP_{j,it}$ represented the same as the definition in part 2, $u_{j,it}$ represented the effect of stochastic disturbances on energy consumption. The authors performed logarithmic transformation to $\textbf{eng}_{j,it}$, $GDP_{j,it}$, $INV_{j,it}$, $POP_{j,it}$, $EP_{j,it}$ so as to eliminate the heteroscedasticity. At last, we came to the following empirical investigation model:

$$\textbf{lneng}_{j,it} = \alpha_{j1} + \alpha_{j2} \ln GDP_{j,it} + \alpha_{j3} \ln INV_{j,it} + \alpha_{j4} \ln POP_{j,it} + \alpha_{j5} ST2R_{j,it}$$
$$+ \alpha_{j6} ST3R_{j,it} + \alpha_{j7} \ln EP_{j,it} + u_{j,it} \tag{2}$$

In the equation (2), α_{j2}, α_{j3}, α_{j4}, α_{j7} successively represented the elastic coefficient of economic growth, total social fixed assets investment, population growth, energy price fluctuating; α_{j5}, α_{j6} successively represented the units of energy consumption change when the ratio of the secondary and tertiary industry changed one unit, which reflected the impact on energy consumption of industrial structure change.

The authors estimated the model (2) and used F statistics to test the model form.

H0: the individual had the same α_j, which was mixed regression model.

H1: the individual had different α_j, which was Entity fixed effect model.

Under level of significance 5%, critical value of $F > F_{\alpha=0.05}$, which denied $H0$ and we chose the Entity fixed effect model (the authors omitted the test process to save space because the process was too complex and long).

4.2 Panel model estimating results

We estimated the equation (2) by means of Generalized Least Squares (Cross-section SUR (PCSE)), (see the results in Table 2).

Table 2   Panel model estimating results

	High category	Moderate category	Low category
α_{j2}	0.9346 (3.2878, 0.0009)	0.2576 (4.7834, 0.0000)	0.1172 (2.1352, 0.0572)
α_{j3}	0.0265 (3.2009, 0.0215)	0.2268 (4.0974, 0.0017)	0.2441 (3.1657, 0.005)
α_{j4}	-0.5073 (-3.0174, 0.0021)	0.4366 (2.8831, 0.0120)	0.2011 (1.7037, 0.1079)
α_{j5}	0.4789 (2.2264, 0.0335)	0.6018 (2.8503, 0.0255)	0.3657 (1.8975, 0.1035)
α_{j6}	0.1556 (1.8445, 1.0892)	0.6645 (2.9873, 0.0032)	-0.0326 (-1.7721, 0.1102)
α_{j7}	0.5578 (2.8202, 0.0332)	0.6704 (4.8818, 0.0007)	1.0848 (5.0876, 0.0032)
α_{j1}	2.9872 (4.0476, 0.0000)	-1.4003 (-2.7843, 0.0069)	-1.1077 (-1.8955, 0.1002)
R^2	0.9803	0.9889	0.9924
Adjusted-R^2	0.9753	0.9976	0.9895
Sample size	115	115	460
F statistics	238.1291	283.1129	736.4276
D.W.	1.8764	1.8972	2.0238

Notes: the authots used the software of Eviews 5.0. In the bracket, the first number was *t* statistics and the second one was probability.

4.3 Empirical analyses

From Table 2, we could see that all the regression coefficients passed the significance level test of 1%, 5% or 10%. R^2 was 98.03%, 98.89%, 99.24% respectively; *F* statistics was big; in the D.W. test, autocorrelation didn't exist. Above all, we could conduct the following statistical analysis:

(1) Economic growth had significant diversified impact on the energy consumption in the three categories

GDP increase of 1 percent would bring 0.93% and 0.26%'s increase to the high and moderate energy consumption areas respectively, while it had little influence on the low energy consumption area. Except for Henan province, high energy consumption area was all developed eastern region. They occupied 50% of whole nation's energy consumption, although with relatively high efficiency of energy utilization. So we could say the economic growth was the main actor to increase energy consumption. For the moderate energy consumption area, there were 3 backward middle and western regions and 2 relatively developed provinces (Shandong, Guangdong). The backward areas had low efficiency of energy utilization, but they were usually important production bases of energy, which indicated that their economic growth relied to excessive energy consumption. As for the low energy consumption area, they were mainly composed of backward minority areas and the developed areas with high efficiency of energy utilization, such as Beijing, Tianjin, Shanghai, Fujian and Hainan. Because the minority areas were in the early stage of industrialization, they had low level of economic development, high proportion of the first industry in GDP and low level of urbanization, they objectively had small energy demand as a result. However, we should realize that we could give play to the resources advantage and turn it to economic advantage for the minority areas possessing abundant energy resources. Meanwhile, because the developed areas with high efficiency of energy utilization were in the advanced stage of industrialization, with their fast technology progress, the economic growth mode transformed from "extensive" to "intensive", their dependence on energy consumption was relatively low.

(2) Fixed asset investment increase had positive impact on the energy consumption

The influence coefficient of fixed asset investment increase had close impact on the low and moderate energy consumption areas, which was 0.0023 and 0.0024 respectively. But for the high areas, the coefficient was 0.0265. The analysis were the following: Since 1990s, the low and moderate energy consumption areas, which were the major production bases of energy, had a fast increase of fixed asset investment, and they were mostly invested to energy, raw material and other high energy consumption industries. Their investment mode was mainly "extensive", which had little effect to enhance efficiency of energy utilization. However, on the one hand, the high energy consumption areas, enhanced efficiency of energy utilization by technological improvement because of their developed economic; On the other hand, their investment went mainly to the higher technology industries such as electronic information, electrical apparatus, machinery manufacture and pharmaceutical industry, which had low energy consumption and high added value. Consequently, these areas' energy demand had declined.

(3) Population growth had significant impact on the regional energy consumption

Population increase of 1 percent would bring 0.44% and 0.20% of increase to the low and moderate energy consumption areas respectively, 0.51% of decline to the high energy consumption areas. Our explanation was: Population was a traditional influencing factor to energy consumption and their relation was positive. Recent years had witnessed fast energy consumption in daily life, which happened as the increase of income and improvement of quality of life, popularization of household appliances, more uses of private cars, which changed people's life style and correspondingly the average energy consumption quantity. Although China's average energy consumption quantity was only account for 25% of the developed country, population's impact on the regional energy consumption would be long-term and stable as the energy demand increases.

(4) Industrial structure had significant diversified impact on the energy consumption

The authors found that the secondary industry's structure change affected the moderate energy consumption regions most and the elastic coefficient was 0.6018. The high and low energy consumption region was 0.4789 and 0.3657 respectively. The analysis was below:

The moderate energy consumption regions had a fast secondary industry, especially heavy industry growth, which led to a tremendous energy demand. For the high energy consumption regions, although the industrial structure had a relatively high level, the industry sector was still the leading industry of secondary industry, which made it a main factor to increase energy consumption. However, we could see that its elastic coefficient was less than the moderate regions thanks to its rational industry distribution and high structure level. At last, the authors discussed the low energy consumption regions, of which industrial structure level was very low. Since the 20th century, China witnessed a fast economic growing period. Although still below the high and moderate regions, the energy demand presented a positive change as the secondary industry's fast growing.

The tertiary industry's structure change affected the moderate energy consumption regions most and the elastic coefficient was 0.6645. Successively, the high energy consumption region was 0.1556, which was contrast with our expectation, and the low region was negative, which accorded with our expectation. We knew that the tertiary industry's leading industry was service sector possessing high added value and low energy consumption. So the higher portion of tertiary industry, the more energy consumption quantity. All in all, optimization of industrial structure would have more energy conservation potential and mitigate the energy demand of the three categories of regions.

(5) Energy price had the same influencing direction to the energy demand of the three categories of regions, but significant degree diversities, which was opposite with our expectation

Energy price rising one percent would bring 0.56%, 0.67% and 1.1% of increase to the high, moderate and low energy consumption areas respectively. This estimated result showed that rising of energy price in short run would have little inhibition effect on energy demand, and have even lesser impact on the low energy consumption areas with enrich energy resources. This in turn proved that China's regional economic growth had strong driving effect on the energy demand. Chinese energy price was very low because the energy pricing mechanism had not realized marketization. This kind of price mechanism leads to low efficiency and excessive use of energy. Therefore, strengthening the reform of energy pricing formation and giving full play to market mechanism would be a problem which is desperately needed to be resolved in the current and future period.

5. Conclusions and economic implications

According to the above analysis, the authors came to the conclusions as below:

(1) This article used the Cluster analysis of statistical methods to separate 30 provinces and municipalities of China into three categories according to their energy consumption level and characteristics from 1985 to 2007. The categories of regions were high, moderate and low energy consumption areas. From the vertical point of view, the energy consumption level, resource endowment and social economic development level in the same category presented certain commonness. From the horizontal point, there were significant differences among the three categories of regions in energy consumption level, their consumption ratio was 3.02：2.23：1. We also had to point out that the discrepancies among them would be obvious as time went on.

(2) From the estimating result from panel model of energy demand, it can be concluded that the main influencing factors to high energy consumption areas were economic growth, ratio of output value from secondary industry in GDP and energy price. For the low energy consumption areas, the main factors were fixed asset investment, population growth, ratio of output value from secondary industry in GDP and energy price. Meanwhile, the influencing factors to the moderate energy consumption areas were comprehensive and various.

There was one point worthy of mentioning, that was the obvious effect on regional energy consumption coming from population and energy price factors. Because China had a large population base, the lifestyle was modified and people's income increased, the average energy demand would go upward. So regulators should propagandize the energy conserving concept and advocate choosing products with high efficiency of energy utilization to mitigate life energy consumption. Chinese energy price could not reflect the adequacy and the status of supply and demand because the energy pricing mechanism had not realized marketization. Consequently, energy could allocate resources effectively in the short run, and it would be more serious for the high resource endowment areas. Therefore, China should first promote the reform of energy pricing mechanism so as to make the price reflect the status of supply and demand and allocate resources effectively.

(3) According to the influencing factors and degree of energy consumption from the three categories of regions, we had to implement differential policies to conserve energy.

● The high energy consumption areas, based on its fine economic foundation, should build a resource-saving society and develop recycling economy to mitigate dependence of economic growth on energy consumption. This objective could be accomplished by the science and technology innovation, popularization and application of new technology, new equipments and new products and energy conserving industry's development.

● The moderate energy consumption areas, in a fast developing and transformation period, had great potential

to carry on energy conserving. They should vigorously rearrange and optimize the structure of industry and develop the third industry with low energy consumption and high added value. In addition, fixed asset investment should be controlled and the investment structure should be adjusted.

● The low energy consumption areas should emphasize the enhancement of efficiency of energy utilization, speed up the transformation of economic growth mode and accelerate modifying, optimizing and upgrading of regional economic structure and industrial structure. Besides, overspreading of heavy industry should be controlled to lay a foundation for the energy conservation and emission reduction. All in all, the three categories should break boundaries to aggressively cooperate with each other and take the sustainable development approach to build a resource-saving society.

References:

LIN, B. Q.. (2001). The econometric research on energy demands of China. *Statistical Research,* 10, 34-38.

PENG, Z. L., WU, Y. & WANG, H. Y.. (2007). Research on the relationship between energy consumption and GDP Growth. *Statistical Research,* 7, 6-10.

WANG, H. P. & TIAN, P. & JIN, P.. (2006). The study of the relationship between China's energy consumption and economic growth based on time varying parameter model. *Application of Statistics and Management,* 3, 252-258.

WANG, X. H. & LIU, Y.. (2007). China energy consumption and economic growth: A study based on the cointegration analysis and granger causality test. *Resources Science*, 5, 57-62.

ZHAO, J. W. & FAN, J. T.. (2007). Empirical research on the inherent relationship between economy growth and energy consumption in china. *Economic Research Journal*, 8, 31-42.

ZHOU, J.. (2007). The researches on China s energy utilization efficiency improvement during "the eleventh five" layout. *Journal of Finance and Economics,* 7, 82-91.

(Edited by Ruby and Chris)

(continued from Page 26)

Kotler, P.. (1991). Philip Kotler explores the new marketing paradigm. *Marketing Science Institute Review*, 1, Spring, 4-5.

Lafley, A. G. & Charan, R.. (2008). *The game changer: How you can drive revenue and profit growth with innovation*. New York: Crown Business.

Leask, G. (2007). Marketing strategy—Making sense of industry dynamics: Is there still value in strategic group research? *Journal of Medical Marketing, 7*(3), 189-202.

Levitt, T.. (1969). *The marketing mode*. New York: McGraw Hill.

Levitt, T.. (1986). *The marketing imagination* (revised ed.). New York: McGraw Hill.

Miles, R. E. & Snow, C. C.. (1978). *Organization strategy, structure and process*. New York: McGraw Hill.

Mintzberg, H.. (1988). Generic strategies: Toward a comprehensive framework. In: Lamb, R. & Shrivastava, P. (Eds.), *Advances in strategic management*, 5, Greenwich, CT: JAI Press.

Mintzberg, H.. (1994). *The rise and fall of strategic planning: Reconceiving roles for planning, plans, planners*. New York: Free Press.

Porter, M. E.. (1980). *Competitive strategy: Techniques for analyzing industries and companies*. New York: Free Press.

Porter, M. E.. (1985). *Competitive advantage: Creating and sustaining superior performance*. New York: Free Press.

Prahalad, C. K. & Hamel, G.. (1990). Core competence of the corporation. *Harvard Business Review, 68*(3), 79-91.

Stalk, G., Evans, P. & Shulman, L. E.. (1992). Competing on capabilities: The new rules of corporate strategy. *Harvard Business Review, 70*(2), 57-69.

Thomas, H. & Venkatraman, N.. (1988). Research on strategic groups: Progress and prognosis. *Journal of Management Studies, 25*(6), 537-555.

Wheelwright, S. C.. (1981). Japan—Where operations are really strategic. *Harvard Business Review, 59*(4), 67-74.

Womack, J. P. & Jones, D. T.. (1994). From lean production to lean enterprise. *Harvard Business Review, 72*(2), 93-103.

(Edited by Ruby and Chris)