Regional Energy Demand:
An Analysis of Substitution Possibilities for China

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February 9-11, 2008

Acknowledgement:
We would like to thank the reviewers of this journal for helpful comments and suggestions. This research was partially supported by The College of Business, University of Canterbury and the Marsden Fund. Any errors and all views expressed remain our own.

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1. Introduction

China's share of global energy consumption has almost doubled over the past 20 years. China's oil production averaged 25% more than consumption in the 1980s, however, now nearly half of total oil consumption is imported to ensure security of supply from overseas, which has caused political tensions (Stokes, 2005). China's energy demand is also changing due to a rising environmental awareness. Public policy now aims to see the share of coal (which China has large stocks of) consumption gradually decline with electricity increasing. As a result, rising energy use and declining reliance on coal will affect both world energy markets and the nature of China's future economic growth.

Many studies (Shiu and Lam, 2004; Zou and Chau, 2006; Han et al., 2004; Wang et al., 2005; Garbaccio et al., 1999; Fisher-Vanden et al., 2004; Price et al., 2001; Sinton and Levine, 1998; Sinton and Fridley, 2000; Hu and Wang, 2006) provide a variety of forecasts, however, more informed estimates of how rising energy prices, coupled with technical change, will affect the Chinese economy require knowledge of the ease with which energy can be substituted for other types of inputs (including substitution between different energy inputs) and the actual and potential effects of technological change on the efficient use of energy.

More importantly, the economic development is uneven across regions in China due to preferential policy and geographical location. For the sectoral economic development, the distribution of natural resources can be one of the most critical determinants. In fact, the distribution of energy production is extremely uneven across provinces. For example, large quantity of coal is produced in Shanxi province, accounting for 25% of national total coal production. In addition, coal production in Shandong, Neimeng and Henan provinces also account for about 10% of national total. On the other hand, coal is not consumed evenly across regions, which is mostly depends upon regional economic growth. Therefore, all these characteristics in energy production and consumption are expected to lead to significant differences in technological change, demand and factor substitution for energy economic sector.

The focus of this poster estimates technological change, factor demand and interfactor and interfuel substitutability using a new and appropriate dataset and rigorous econometric methods for seven regions in mainland China. Meanwhile, we decompose changing energy intensity to ascertain the driving forces in energy intensity increase by regions.

2. Methodologies

We employ a translog cost function to estimate energy demand elasticities (Cho, et al., 2004; Berndt and Wood, 1979; Debertin, et al., 1990; Christopoulos and Tsionas, 2002; Welsch and Ochsen, 2005). Moreover, the translog cost function is a convenient specification of duality theory and as a second order approximation, it allows one to avoid the need to specify a particular production function (Stratopoulos et al., 2000). Nor is it necessary to assume constant or equal elasticities of substitution (Woodland, 1975).

We model how a change in an individual fuel price affects fuel consumption through the feedback effect between interfuel and interfactor substitution, assuming that the production function is weakly separable in the major components of energy, capital and labor. This assumption allows us to construct an aggregate energy-price index from fuel prices. We can then assume that energy, capital and labor are homothetic in their components so that we can specify a homothetic fuel cost share equation. Thus, a second-order approximation of cost as a function of time, the logged input price and log output is used for the non-homothetic translog total factor cost function.

Following a two-stage approach suggested by Pindyck (1979), we first estimate the homothetic translog fuel cost share equation assuming constant returns to scale. The resulting parameter estimates yield the partial own- and cross-price elasticities of the fuel sources. The fitted fuel cost is computed using the estimated parameters and serves as an instrumental variable for the aggregate price of energy. We then estimate the non-homothetic translog factor cost function and factor share equations simultaneously with the relevant restrictions imposed.

The Allen partial elasticities of substitution (σ_{ij}) and own-price elasticities (η_{ii}) and cross-price elasticities (η_{ij}) of factor demand for the production process are calculated (Allen, 1938; Uzawa, 1962). Following Welsch and Ochsen (2005), we decompose the energy intensity (e) to various driving forces, such as factor substitution and technological change.

3. Data

We use three factor inputs: aggregate energy use (E), capital stock (K) and labor use (L). The total cost series (TC) is constructed as the sum of aggregate energy use, capital stock and labor use. Three factor share series are calculated based on total cost series and three factor inputs. The aggregate energy input (E) is the sum of four fuel inputs: coal (CO), electricity (EL), gasoline (GA) and diesel (DI). Each fuel input cost is the product of its consumption and price. Individual fuel consumption and price data are used to construct four fuel cost share series. The labor input cost is based upon the total wage payment.

Three factor price indices are constructed. The aggregate energy price index (P_E) is computed using the estimated parameters. The capital stock price index (P_K) is obtained from the China Statistical Yearbook (CSY). The labor price index (P_L) is used as the labor wage rate, which is obtained by dividing total wage payment by total employment. All three factor price indices use 1995 as the base year.

Total output (Y) is represented by real GDP. We use a weighted index of the consumer price index and the fixed assets price index to deflate GDP based on the fact that GDP in China mainly consists of labor and capital costs.

All the above indicators are obtained for each of the 31 provinces (autonomous regions or municipalities) and for each year from 1995-2004, giving us a panel database with a total of 310 observations.

The three main sources of data for this study are CSY (for general statistics), the China Energy Yearbook (for energy price data) and the State Development Planning Commission of China (SDPC). We construct a capital stock series by employing the following equation:

$$K_t = K_{t-1}(1 - \mathrm{d}) + I_t$$

where K_t is current capital stock, K_{t-1} is previous year capital stock, d is the capital depreciation rate, and I_t is current year capital investment. The total capital stock in 1994 comes from Table 4 of Li (2003). This total stock is disaggregated into agriculture, industry, construction, transportation and commerce, based on the allocation of capital replacement investment in 1994. The total capital depreciation is taken as capital at factor cost, which is consistent with the current cost accounting system in China and the use of GDP as an output indicator.

4. Results

To conduct our estimates, we present the shares of both factor cost and aggregate energy cost by seven regions (Table 1). These shares are average during the study period 1994-2004. First, it can be seen from Table 1 that there are apparent difference in the composition of factor cost across seven regions. For example, the labor share is the lowest (45%) while energy and capital shares are the highest (31% and 24%, respectively) in region 2. In contrast, energy and capital shares are the lowest (25% and 11%, respectively) while the labor share is the highest (64%) in region 1. Second, it can be seen from table 1 that there also are apparent difference in the structure of aggregate energy cost across seven regions. For instance, the coal shares range from the lowest 11% in region 2 to the highest 20% in region 1; the gasoline shares range from the lowest 9% in region 1 to the highest 15% in region 3; the electricity shares range from the lowest 54% in region 3 to the highest 61% in region 2; the diesel shares range from the lowest 12% in region 1 to the highest 17% in region 5.

4.1 Interfactor substitution

Using the estimated parameters (not reported here) and shares of Table 1, we can calculate the implied elasticities of substitution (s_{ij}) and price elasticities (h_{ij}) of factor demand for the interfactor substitution to be calculated. The results of these calculations are shown in Table 2, where several important features are apparent:

First, both demand and substitution elasticities vary in magnitude across seven regions. In general, the elasticities of substitution of energy and capital are larger than of energy and labor and also vary more apparently across regions. For example, the elasticity of substitution of energy and capital are the largest (s_{EK}=0.90) but the elasticity of substitution of energy and labor is the smallest (s_{EL}=0.56) in region 2. In contrast, there is not significant substitution of energy-capital and capital-labor in regions 1, 4, 5 and 6.

Second, estimated own-price elasticities of energy are extremely similar and significant across seven regions, h_{EE}=-0.47. Energy is more responsive to a change in labor price than in capital price. The former are all statistically significant, but the later are partially significant, only in regions 2, 3 and 7. No complementary is found among energy, capital and labor in this study in any region. All the cross-price elasticities are less than one, suggesting that the scope for substituting capital and labor for energy in China is somewhat regionally limited.

4.2 Interfuel substitution

The implied elasticities of substitution (s_{ij}) and price elasticities (h_{ij}) of fuel regional demand are presented in Table 3. Several important features are apparent in Table 3:

(i) coal and electricity have substantial substitution possibilities – the estimated s_{CO-EL} range from 1.38 in region 1 to 1.67 in regions 2. This finding has something to do with regional energy production and preferential policy. Namely, the substitution of coal-electricity is slower in coal producing areas (e.g., region 1), while it is faster in non-coal producing areas (e.g., region 2, including Beijing Tianjin and Shanghai) due to environmental regulation.

(ii) in contrast, coal and other fuel sources appear to be complementary. Specifically, coal and diesel are significant complementary with an elasticity of more than one. Coal and gasoline show to be complementary but not to be significant. Regional variations in magnitude of complementarities of coal-diesel are also apparent. For example, the largest complementarity of coal-diesel can be found in region 2 (s_{CO-DI}=2.68), while the smallest can be found in region 3 (s_{CO-DI}=1.36, three northeast provinces).

(iii) gasoline and electricity are slightly significantly substitutable (s_{GA-EL} is about 0.60), but they are insignificant for all of regions. Gasoline and diesel are substitutable for some regions but they are complementary in other regions. However, these elasticities are all less than one;

(iv) likewise, electricity and diesel are slightly significantly substitutable for all seven regions.

(v) The own-price elasticities are statistically significant only for coal and electricity, but they are all less than one. It seems that no much variation in magnitude of the own-price elasticites can be found across regions for both coal and electricity. However, it can be found that price change of coal is more sensitive in producing areas and northeast provinces.

(vi) In addition, cross-price elasticities are all less than one and most of them are insignificant across regions.

Total own- and cross-price elasticities of fuel demand are presented in Table 4, which provides several notable conclusions:

(i) The estimated results suggest that some fuel sources are substitutable and others are complementary. However, their magnitudes vary by fuels and by regions apparently. For example, coal-gasoline and coal-diesel are all complementary, while coal-electricity and electricity-diesel are all substitutable. Of all cross-price elasticities, coal and electricity have the most possibility of substitution, with h^*_{EL-CO} =0.73 in region 2 and h^*_{EL-CO} =0.54 in region 6;

(ii) The fuel demands of coal and electricity are more sensitive to their own price change than of gasoline and diesel. In other words, the former are elastic while the later are inelastic. It is also clear that demand of fuel elements vary across region. For example, the largest elasticity of demand of coal can be found in regions 1 and 6 (h^*_{CO-CO} =0.64) while the smallest in region 2 (h^*_{CO-CO} =0.50).

4.3 The roles of substitution, technologies and production

The change in energy intensity is decomposed into budget, substitution, technology and output effects, which is displayed in Table 5. It can be seen from Table 5 that the general pattern of the change in energy intensity is similar across regions, which shows "budget" and technological change are two major drivers. However, the variations are also apparent in the changing pattern of energy intensity across regions.

First, region 3 actually reduces its energy intensity by about 4.3%, which is mainly due to combination of "budget" effect and technological change. The increasing energy price forces enterprises to reduce energy use, which reduce energy intensity by more than 35% in region 3. In fact, the aggregate energy price increased by 45% (which is almost twice of national average) during the study period and theoretically hinders energy use in region 3. This region is the old industrial heartland in China's northeast (China's equivalent of the "rustbelt") and unsurprisingly this region has the smallest effect of technological change. Until recently, this region lacked investment so that its energy intensity reflects the minimum effect of technological change and the continuing importance of heavy industry and military industry bases. Price changes will contribute more to changes in energy intensity in regions such as this where the energy intensity (at given cost shares) is high.

Second, regions 1, 2, 5 and 7 increase their energy intensity by about 6%, while regions 4 and 6 increase twice as much as regions 1, 2, 5 and 7, which is about 13%. This mainly causes by the “budget effect”. For example, the increasing energy price forces regions 4 and 6 to reduce their energy use only by about 10%, while it forces regions 1, 2, 5 and 7 to reduce their energy use by more than 15% (-24%, 15%, 22% and 17%, respectively).

At last, the effect of the substitution of energy and labor also varies across regions. For instance, the effect of the substitution of energy makes region 3 increase its energy intensity by 9%, while it only makes region 4 increase its energy intensity by about 4%. Likewise, the effect of the substitution of labor makes region 2 reduce its energy intensity by 12%, while it only makes region 5 reduce its energy intensity by less than 4%.

5. Conclusion

We calculate the missing technological change, factor demand and interfactor and interfuel substitutability by regions in China using a new and appropriate dataset and rigorous econometric methods. In particular, we use individual fuel price data, obtained from 150 city price bureaus covering a variety of energy sources and a two-stage approach, total factor cost functions and fuel share equations were estimated and the parameters used to calculate implied elasticities of substitution (s_{ij}) and price elasticities (h_{ij}) for interfactor substitution and interfuel substitution.

We decomposed regionally changing energy intensity to ascertain the driving forces of the recent increases in energy intensity. Taken together, the new results presented here provide the inputs necessary to construct informed forecasts of the potential for regional governments to adapt to the rising dependency on energy in a climate of rising fuel prices while, at the same time, attempting to minimize the effects on the environment, economic growth.

Energy is Allen substitutable for all capital and labor in all regions. Some fuel sources are substitutable, while our results suggest that others are complementary.

Energy intensity changes are apparently different during the past five years across regions, but the major driver seems to be “budget effect” and the growth of energy-intensive technologies. Whether this trend in increasing energy intensity continues or declines will be significant and important for China and the rest of the World.

Table 1. Comparison of structure of both factor cost and aggregate energy cost across regions in China, 1995-2004 [a]

	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7
Mean of share of factor cost							
S_E	0.25	0.31	0.27	0.27	0.26	0.27	0.30
S_K	0.11	0.24	0.18	0.12	0.11	0.11	0.16
S_L	0.64	0.45	0.55	0.61	0.63	0.62	0.54
Mean of share of aggregate energy cost							
S_{CO}	0.20	0.11	0.17	0.15	0.12	0.19	0.15
S_{GA}	0.09	0.13	0.15	0.10	0.13	0.12	0.13
S_{EL}	0.60	0.61	0.54	0.60	0.58	0.57	0.57
S_{DI}	0.12	0.15	0.16	0.15	0.17	0.13	0.14

[a] Region 1 includes Hebei, Shanxi, Anhui, Shandong and Henan; Region 2 includes Beijing, Tianjin, and Shanghai; Region 3 includes Liaoning, Jilin and Heilongjiang; Region 4 includes Jiangsu, Zhejiang, Jiangxi and Hubei; Region 5 includes Fujian, Hunan, Guangdong, Guangxi and Hainan; Region 6 includes Chongqing, Sichuan, Shaanxi, Gansu, Guizhou and Yunnan; Region 7 includes Mongolia, Tibet (data unavailable), Qinghai, Ningxia and Xinjiang.

Table 2. Implied elasticities of substitution (σ_{ij}) and price elasticities (η_{ij}) of factor demand for the interfactor substitution for the regional aggregate economy from equations (7) and (8)

	Region 1		Region 2		Region 3		Region 4		Region 5		Region 6		Region 7	
	Elas	t	Elas	t	Elas	t	Elas	t	Elas	t	Elas	t	Elas	t
σ_{EE}	-1.87	-6.2	-1.50	-7.5	-1.74	-6.6	-1.73	-6.7	-1.81	-6.4	-1.75	-6.6	-1.56	-7.3
σ_{EK}	0.72	1.0	0.90	3.4	0.85	2.2	0.77	1.3	0.74	1.1	0.75	1.1	0.85	2.2
σ_{EL}	0.61	5.2	0.56	4.0	0.58	4.4	0.62	5.3	0.62	5.3	0.63	5.4	0.61	5.1
σ_{KK}	-2.99	-1.9	-2.12	-6.8	-2.64	-5.0	-3.09	-2.6	-3.04	-2.1	-3.03	-2.1	-2.83	-4.3
σ_{KL}	0.21	0.8	0.50	3.1	0.46	2.6	0.27	1.1	0.23	0.9	0.21	0.8	0.39	1.9
σ_{LL}	-0.28	-5.1	-0.64	-5.9	-0.44	-5.9	-0.33	-5.5	-0.30	-5.3	-0.31	-5.3	-0.46	-5.9
η_{EE}	-0.47	-6.2	-0.47	-7.5	-0.47	-6.6	-0.47	-6.7	-0.47	-6.4	-0.47	-6.6	-0.47	-7.3
η_{EK}	0.08	1.1	0.21	3.8	0.16	2.4	0.09	1.4	0.08	1.2	0.08	1.3	0.14	2.4
η_{EL}	0.39	5.9	0.25	4.6	0.32	5.1	0.38	6.1	0.39	6.0	0.39	6.2	0.33	5.9
η_{KE}	0.18	1.1	0.28	3.8	0.23	2.4	0.21	1.4	0.19	1.2	0.20	1.3	0.25	2.4
η_{KK}	-0.32	-1.4	-0.50	-4.9	-0.48	-3.6	-0.37	-1.8	-0.34	-1.5	-0.33	-1.5	-0.46	-3.1
η_{KL}	0.14	0.9	0.23	3.3	0.25	2.8	0.16	1.2	0.14	1.0	0.13	0.9	0.21	2.1
η_{LE}	0.16	5.9	0.17	4.6	0.16	5.1	0.17	6.1	0.16	6.0	0.17	6.2	0.18	5.9
η_{LK}	0.02	0.9	0.12	3.3	0.08	2.8	0.03	1.2	0.03	1.0	0.02	0.9	0.06	2.1
η_{LL}	-0.18	-5.1	-0.29	-5.9	-0.24	-5.9	-0.20	-5.5	-0.19	-5.3	-0.19	-5.3	-0.25	-5.9

Note: E denotes aggregate energy, K denotes capital and L denotes labour. Elasticities are calculated at the mean of each factor share. Regional classification refers to table 1.

Table 3. Implied elasticities of substitution (s_{ij}) and the price elasticities (h_{ij}) of fuel demand for the interfuel substitution of the regional aggregate economy from equations (7) and (8) [a]

	Region 1		Region 2		Region 3		Region 4		Region 5		Region 6		Region 7	
	Elas	t	Elas	t	Elas	t	Elas	t	Elas	T	Elas	t	Elas	T
s_{CO-CO}	-2.71	-6.0	-3.88	-2.7	-3.19	-4.8	-3.47	-4.1	-3.80	-3.1	-2.84	-5.7	-3.35	-4.4
s_{CO-GA}	-0.89	-1.6	-1.32	-1.9	-0.43	-1.0	-1.28	-1.9	-1.26	-1.9	-0.51	-1.2	-0.72	-1.4
s_{CO-EL}	1.38	9.6	1.66	6.7	1.52	7.7	1.52	7.7	1.65	6.7	1.43	8.9	1.52	7.7
s_{CO-DI}	-1.51	-2.8	-2.68	-3.4	-1.36	-2.7	-1.80	-3.0	-2.03	-3.1	-1.42	-2.7	-1.79	-3.0
s_{GA-GA}	-0.40	-0.1	-2.02	-1.5	-2.13	-1.9	-1.26	-0.6	-1.94	-1.3	-1.83	-1.1	-2.02	-1.5
s_{GA-EL}	0.49	1.9	0.65	3.7	0.64	3.5	0.55	2.4	0.62	3.2	0.59	2.8	0.63	3.3
s_{GA-DI}	-0.49	-0.3	0.14	0.1	0.28	0.3	-0.06	0.0	0.21	0.2	-0.04	0.0	0.12	0.1
s_{EL-EL}	-0.65	-7.7	-0.61	-7.6	-0.84	-8.0	-0.64	-7.7	-0.69	-7.8	-0.74	-7.8	-0.72	-7.8
s_{EL-DI}	0.65	2.5	0.72	3.4	0.70	3.1	0.72	3.5	0.74	3.8	0.66	2.7	0.69	3.0
s_{DI-DI}	-0.21	- [a]	-0.99	- [a]	-1.16	- [a]	-1.05	- [a]	-1.25	- [a]	-0.65	- [a]	-0.91	- [a]
h_{CO-CO}	-0.55	-6.0	-0.44	-2.7	-0.53	-4.8	-0.51	-4.1	-0.46	-3.1	-0.54	-5.7	-0.52	-4.4
h_{CO-GA}	-0.18	-3.6	-0.15	-1.7	-0.07	-1.2	-0.19	-2.7	-0.15	-1.9	-0.10	-1.8	-0.11	-1.7
h_{CO-EL}	0.28	3.2	0.19	1.2	0.25	2.4	0.22	1.9	0.20	1.4	0.27	3.0	0.24	2.1
h_{CO-DI}	-0.31	-4.6	-0.31	-2.6	-0.23	-2.8	-0.26	-2.9	-0.25	-2.2	-0.27	-3.9	-0.28	-3.2
h_{GA-CO}	-0.08	-0.7	-0.17	-2.2	-0.06	-0.9	-0.13	-1.3	-0.16	-1.9	-0.06	-0.7	-0.09	-1.2
h_{GA-GA}	-0.04	-0.1	-0.26	-1.5	-0.31	-1.9	-0.13	-0.6	-0.24	-1.3	-0.22	-1.1	-0.26	-1.5
h_{GA-EL}	0.04	0.3	0.09	0.8	0.09	1.0	0.06	0.4	0.08	0.7	0.07	0.6	0.08	0.8
h_{GA-DI}	-0.04	-0.2	0.02	0.1	0.04	0.3	-0.01	0.0	0.03	0.2	0.00	0.0	0.02	0.1
h_{EL-CO}	0.83	28.4	1.02	35.8	0.81	24.9	0.92	31.6	0.96	32.2	0.81	26.1	0.87	28.7
h_{EL-GA}	0.29	12.3	0.40	17.3	0.34	13.0	0.33	14.1	0.36	14.9	0.33	13.3	0.36	14.6
h_{EL-EL}	-0.39	-7.7	-0.37	-7.6	-0.45	-8.0	-0.39	-7.7	-0.40	-7.8	-0.42	-7.8	-0.41	-7.8
h_{EL-DI}	0.39	12.3	0.44	14.3	0.37	10.6	0.43	13.7	0.43	13.3	0.37	11.2	0.40	12.0
h_{DI-CO}	-0.18	-1.7	-0.40	-4.4	-0.22	-2.5	-0.27	-3.1	-0.34	-4.3	-0.19	-1.9	-0.26	-2.8
h_{DI-GA}	-0.06	-0.4	0.02	0.2	0.04	0.3	-0.01	-0.1	0.04	0.3	0.00	0.0	0.02	0.1
h_{DI-EL}	0.08	0.5	0.11	0.8	0.11	0.9	0.11	0.9	0.12	1.1	0.09	0.6	0.10	0.8
h_{DI-DI}	-0.03	- [a]	-0.15	- [a]	-0.18	- [a]	-0.16	- [a]	-0.21	- [a]	-0.09	- [a]	-0.13	- [a]

Note: CO, GA, EL and DI denote coal, gasoline, electricity and diesel, respectively; elasticities are calculated at the mean of each share. Regional classification refers to Table 1.

[a] Due to adding up, no statistical tests were given for them.

Table 4. Total own- and cross-price elasticities (η^{*}_{ij}) of fuel demand for the interfuel substitution of the regional aggregate economy from equation (9)

	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7
η^{*}_{CO-CO}	-0.64	-0.50	-0.61	-0.58	-0.52	-0.64	-0.59
η^{*}_{CO-GA}	-0.27	-0.20	-0.15	-0.26	-0.21	-0.19	-0.18
η^{*}_{CO-EL}	0.18	0.14	0.17	0.15	0.14	0.18	0.16
η^{*}_{CO-DI}	-0.40	-0.36	-0.30	-0.33	-0.31	-0.36	-0.35
η^{*}_{GA-CO}	-0.12	-0.23	-0.13	-0.18	-0.22	-0.12	-0.15
η^{*}_{GA-GA}	-0.08	-0.32	-0.38	-0.18	-0.30	-0.27	-0.32
η^{*}_{GA-EL}	0.00	0.02	0.02	0.01	0.02	0.01	0.02
η^{*}_{GA-DI}	-0.09	-0.04	-0.03	-0.05	-0.03	-0.06	-0.05
η^{*}_{EL-CO}	0.55	0.73	0.56	0.63	0.69	0.54	0.60
η^{*}_{EL-GA}	0.01	0.11	0.09	0.05	0.09	0.07	0.09
η^{*}_{EL-EL}	-0.67	-0.66	-0.70	-0.67	-0.68	-0.69	-0.68
η^{*}_{EL-DI}	0.11	0.15	0.12	0.15	0.16	0.11	0.13
η^{*}_{DI-CO}	-0.24	-0.47	-0.29	-0.34	-0.42	-0.25	-0.33
η^{*}_{DI-GA}	-0.12	-0.05	-0.03	-0.08	-0.04	-0.07	-0.05
η^{*}_{DI-EL}	0.02	0.04	0.04	0.04	0.05	0.03	0.03
η^{*}_{DI-DI}	-0.08	-0.22	-0.26	-0.23	-0.29	-0.15	-0.20

Note: CO, GA, EL and DI denote coal, gasoline, electricity and diesel, respectively; elasticities are calculated at the mean of each fuel share. Regional classification refers to Table 1.

Table 5. Decomposition of the change in energy intensity for the regional aggregate economy

Region	$\Delta\hat{e}/\hat{e}$	Budget	Substitution				GDP	Tech.
			Sum	Energy	Capital	Labor		
Region 1	0.0702	-0.2387	0.0363	0.0701	-0.0014	-0.0324	0.0387	0.2340
Region 2	0.0550	-0.1540	-0.0581	0.0641	-0.0010	-0.1212	0.0153	0.2517
Region 3	-0.0429	-0.3589	0.0214	0.0916	-0.0019	-0.0683	0.0647	0.2299
Region 4	0.1336	-0.1123	-0.0099	0.0409	-0.0014	-0.0494	0.0071	0.2487
Region 5	0.0638	-0.2242	0.0195	0.0594	-0.0008	-0.0391	0.0341	0.2343
Region 6	0.1345	-0.1161	0.0069	0.0523	-0.0026	-0.0428	0.0095	0.2342
Region 7	0.0602	-0.1686	-0.0143	0.0656	-0.0027	-0.0771	0.0113	0.2318

Note: to make the estimate more stable and reliable, we take three year averages of 1995-1997 and 2002-2004 for the base year and reporting year to calculate the growth rate of energy intensity. Regional classification refers to Table 1.