Why did China's Energy Intensity Increase during 1998-2006: Decomposition and Policy Analysis

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Abstract

Despite the fact that China's energy intensity has continuously decreased during the 1980s and mostly 1990s, the decreasing trend has reversed since 1998 and the past few years have witnessed rapid increase in China's energy intensity. We firstly conduct an index decomposition analysis to identify the key forces behind the increase. It is found that: 1) the high energy demand in industrial sectors is mainly attributed to expansion of production scale, especially in energy-intensive industries. 2) energy saving mainly comes from efficiency improvement, with energy-intensive sectors making the largest contribution; 3) a heavier industrial structure also contributes to the increase. This study also makes the first attempt to bridge the quantitative decomposition analysis with qualitative policy analyses and fill the gap between decomposition results and policy relevance in previous work. We argue that: 1) energy efficiency improvement in energy-intensive sectors is mainly due to the

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industrial policies that have been implemented in the past few years; 2) low energy prices have directly contributed to high industrial energy consumption and indirectly to the heavy industrial structure. We provide policy suggestions in the end.

Keywords: China's energy consumption; Industrial policy; Energy price policy

JEL: Q43; Q48

1. Introduction

China's energy demand has been increasing for decades. The growth has clearly speeded up in the new century, from 1386 million tons of standard of coal equivalent (sce) in 2000 to 2463 million tons of sce in 2006 (CSY, 2007). Moreover, industrial consumption increased more rapidly due to expansion in energy-intensive industries. China's industrial energy consumption reached 1751.4 million ton of coal equivalent (mtce) in 2006, which was 95.66 percent more than that in 2000 (CESY, 2007). The contribution of industrial sector to the total energy consumption increased from 64.59 percent in 2000 to 71.10 percent in 2006 (Fig. 1). Since 2003, China has become the world's largest consumer for coal and second largest for oil and electricity (China Digit, 2004). China's high demand for primary energy has outpaced its energy production since 2001 (Fig. 2). Despite the fact that China's energy intensity has continuously decreased during the 1980s and mostly 1990s, the decreasing trend has reversed since 1998 and the past few years have witnessed rapid increase in

China's energy intensity (Fig. 3). The facts of high demand are accompanied by a heavily coal-dependent consumption structure (Fig. 4) and low per capita energy endowments. China's coal use takes up about 70 percent of the total energy consumption. Per capita oil, natural gas and coal deposits of China are only 6.1, 6.5, and 79 percent of the world average (Jiang, 2008).

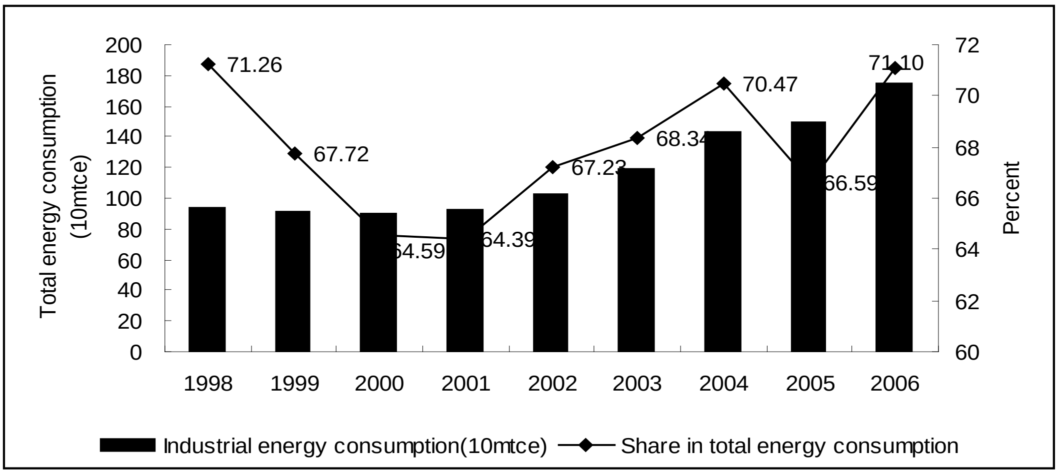

Fig. 1. Industrial Energy consumption

Sources: China Statistical Yearbooks (CSYs), various issues.

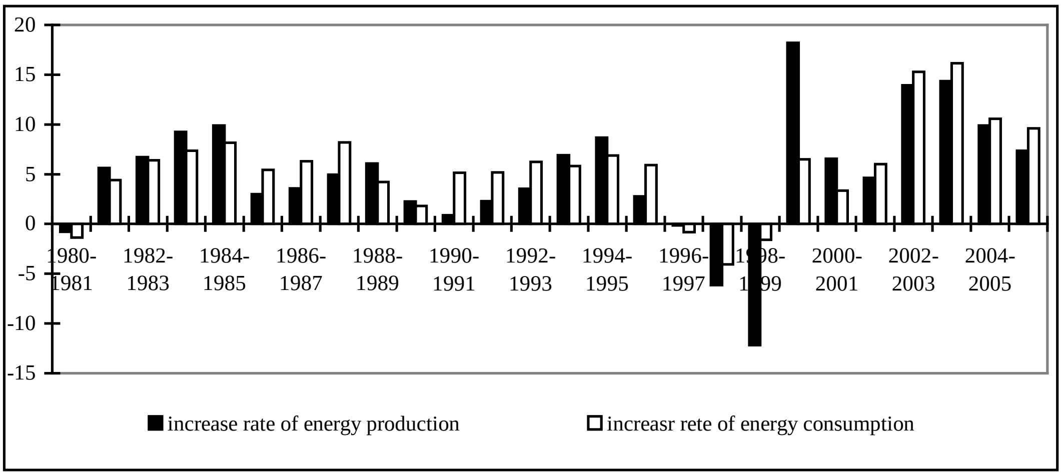

Fig. 2. Growth of primary energy production and consumption (%)

Sources: authors' calculation according to CSYs.

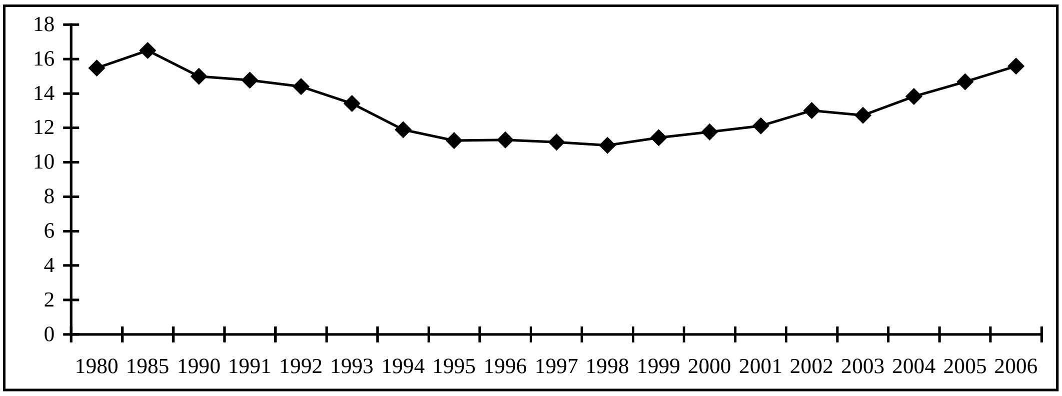

Fig. 3. China's energy intensity 1980-2006 (tce/10,000 Yuan)

Sources: authors' calculation in constant 1978 prices.

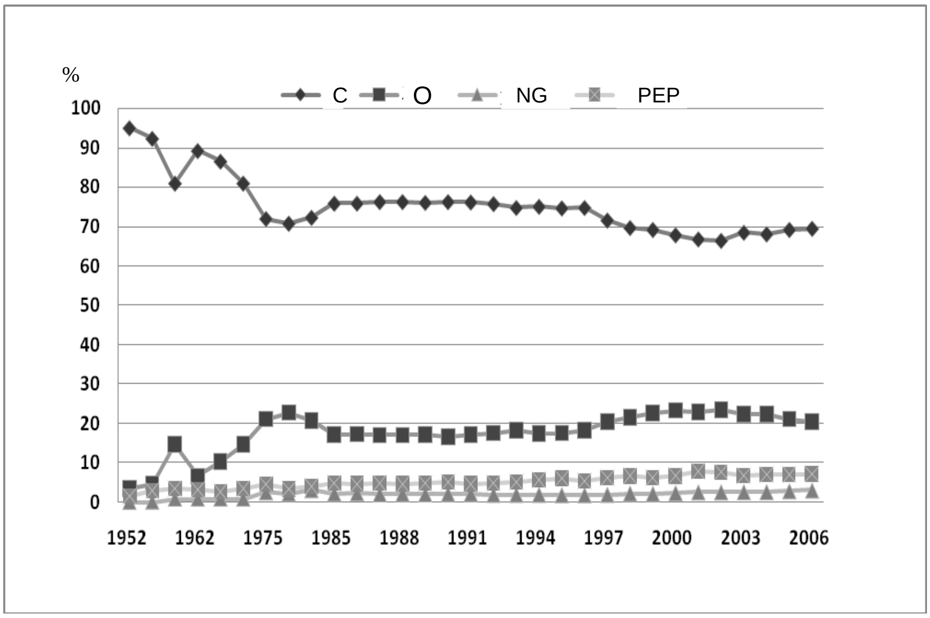

Fig. 4. Composition of China's Energy Consumption (1952-2006)

Sources: CSYs, various issues.

Note: C – Coal; O – Oil; NG – Natural Gas; PEP – Primary Electric Power

The Chinese government is facing severe challenges from energy supply gap, low endowments and greenhouse gases (GHGs) pressure due to heavy dependence on coal use. The energy issue has become critical and strategic for China's long-term development. To achieve sustainable development, the Chinese government has no other choices but energy-saving practices (Wang et al., 2008). In fact, the government has long been looking for sustainable energy policies and strategies particularly in the industrial sector. Zhang (2003) has correctly pointed out that a deeper understanding of how energy consumption evolves in the sectors is very important in formulating future policies. This includes identification of key factors affecting energy consumption of the sectors under study. Such insights are also valuable to evaluate the performance of past policies. Since the industrial sector plays such a dominant role in total energy consumption, this paper studies the key forces behind the increase in China's industrial energy consumption using index decomposition analysis (IDA) and link the results to analysis of related industrial policies and energy price policies that have been implemented in the past years.

The paper proceeds as follows. The opening section introduces current energy situation and challenges and Section 2 goes through main studies and results applying decomposition methods. The next section introduces decomposition methodologies and discusses the data to be used and the way of data disposal. Our results and analysis are presented in the fourth section. Section 5 studies China's energy-related industrial policies and Section 6 reviews and evaluates energy price policy development. And the last section concludes.

2. Past Studies: A Literature Review

Decomposition of China's industrial energy demand has recently become an actively researched topic. Many studies have attempted to identify quantitatively the structural effect and energy intensity effect of industrial energy consumption, which respectively capture the contribution of industrial structure change and the contribution of energy intensity change (also interpreted as technology change or efficiency change) to the change in total industrial energy consumption. Results can be categorized into three groups: 1) early studies show that structural shift plays more important role to China's energy consumption. Smil (1990) and Kambara (1992) have argued that structural shifts away from more energy-intensive industrial sub-sectors have been the major causal factor; 2) real intensity change and structural shift play different roles over different periods of time. Zha et al. (2009) analyzed the structural and intensity effects that affect energy consumption of 36 industrial sub-sectors from 1993 to 2003. The results showed that the real intensity change had played a more important role before 1998 while structural shift dominated after 1999; 3） most other studies have found that real intensity change accounted for a dominant proportion of the change in total energy consumption. Sinton and Levine (1994) examined the same issue for the period of 1980 - 1990 and they found that real intensity change accounted for 85% of the country's overall industrial energy intensity change. Zhang (2003) found that 88% of China's cumulative energy savings in the industrial sector were attributed to real intensity change for the period of 1990 - 1997. Similar results were also found by Lin and Polenske (1995) for the period of 1981-1987, Garbaccio et al. (1999) for the period of 1987-1992, Qi and Chen (2006) for the period of 1993—2003, Li and Zhou (2006) for the period of 1980-2003, and Ma and Stern (2008) for the period of 1980-2003.

This study differs from previous analyses in three important aspects. Firstly, previous studies all have essentially examined the decreasing trend of energy intensity; however, the most salient characteristic of China's energy consumption in the past few years was an increasing intensity. To our best knowledge, the rather abnormal phenomenon has not been systematically studied. Our paper makes the contribution through an examination of China's industrial energy consumption during the period of 1998-2006. Secondly, there has been a substantial gap between decomposition results and policy relevance in previous work. This study makes the first attempt to fill the gap. We integrate the quantitative analysis of factors affecting energy consumption and the qualitative analysis of related policies with an emphasis on industrial and energy price policies. Such an integrated analysis is valuable not only because it provides policy makers with information on the performance of past policies, but also because a good understanding of the issue helps to improve policy making in the future. Lastly, previous work examined the relative contributions of structural change and real intensity change to China's energy consumption for periods before 1998, or across the year of 1998. Ma and Stern (2008) pointed out that there was a major change in the statistical coverage in 1998 as compared with 1997. China's statistical coverage of industrial sub-sectors is on the basis of independent accounting enterprise before 1997 (including 1997), which has been changed to the value-added of industrial enterprises above designed size (i.e. all state-owned enterprises and those non-state-owned enterprises with an annual sales income over 5 million Yuan). Our selected study period (1998-2006) avoids biases possibly incurred by the inconsistency of statistical coverage.

3. Decomposition Methods and Data

3.1 Methods

Two broad categories of decomposition techniques have been developed in the literature, namely the input output techniques – structural decomposition analysis (SDA) and the disaggregation techniques – index decomposition analysis (IDA)[1].Within the broad category of IDA, a variety of different indexing methods have been used. Ang (2004) provides a comprehensive summary of the various indexing methods and their advantages and disadvantages. In fact, selection of indexing method, to a large extent, is arbitrary and there is little consensus as to which one is the superior method. Ang and Choi (1997), Ang et al. (1998), Ang and Liu (2001), and Ang (2004) argued that the logarithmic mean Divisa index (LMDI) method should be preferred to other decomposition methods with the advantages of path independency, ability to handle zero values and consistency in aggregation. We thus adopt the method in this study to analyze changes in China's energy consumption during the period of 1998-2006.

We define the following terms:

E_t : total industrial energy consumption in year t

$E_{i.t}$: energy consumption in industrial sector i in year t

Y_t: total industrial production in year t (1998 constant prices)

$Y_{i,t}$: production of industrial sector i in year t (1998 constant prices)

$S_{i,t}$: production share of industrial sector *i* in year *t* $(= Y_{i,t} / Y_t)$

$I_{i,t}$: energy intensity of industrial sector *i* in year *t* $(= E_{i.t} / Y_{i,t})$

The total industrial energy consumption can be specified as follows:

$$E_t = \sum_i Y_t \times \frac{Y_{i,t}}{Y_t} \times \frac{E_{i.t}}{Y_{i,t}} = \sum_i Y_t \times S_{i,t} \times I_{i,t} \tag{1}$$

And the change in total industrial energy consumption between base year 0 and year t can be decomposed in the following format:

$$\Delta E_{tot} = E_t - E_0 = \Delta E_{out} + \Delta E_{str} + \Delta E_{\text{int}} \tag{2}$$

According to LMDI I approach (Ang, 2004), we have:

$$\Delta E_{out} = \sum_i w_{i,t} \ln(Y_t / Y_0) \tag{3}$$

$$\Delta E_{str} = \sum_i w_{i,t} \ln(S_{i,t} / S_{i,0}) \tag{4}$$

$$\Delta E_{\text{int}} = \sum_i w_{i,t} \ln(I_{i,t} / I_{i,0}) \tag{5}$$

$$\Delta E_{tot} = E_t - E_0 = \sum_i w_{i,t} \ln(\frac{Y_t S_{i,t} I_{i,t}}{Y_0 S_{i,0} I_{i,0}}) \tag{6}$$

Where, ΔE_{out} , ΔE_{str} and ΔE_{int} are the production effect (or output effect), structural effect and efficiency effect (or intensity effect), representing the contribution of change of industrial production level, change of industrial sector composition and change of sector energy intensity to the change of total industrial energy consumption from base year *0* to year *t* —ΔE_{tot} . And $w_{i.t}$ is the logarithmic weighting scheme, specified in the following:

$$w_{i,t} = L(E_{i,t}, E_{i,0}) = \frac{(E_{i,t} - E_{i,o})}{\ln(E_{i,t} / E_{i,0})} \tag{7}$$

Where $L(x,y) = (y-x) / \ln(y/x)$, $x \neq y$.

3.2 Data Collection and Disposal

We have selected 1998-2006 as our study period and the sub-sector data on industrial final energy consumption and industrial production from 1998 to 2006 are collected accordingly. Since 1998, the trend of China's energy intensity has reversed and started to increase after a continuous decrease for nearly two decades. We intend to study the dominant drivers for this rather "abnormal" increase. Meanwhile, the choice of such study period can avoid biases possibly incurred by statistical inconsistency. There was a major change in Chinese national statistical coverage in 1998 as compared with 1997 (Ma and Stern, 2008). China's statistical coverage of industrial sub-sectors is based on the enterprises with independent accounting system at or above township level before 1997 (including 1997), which has been changed to enterprises above designed size (i.e. all state-owned enterprises and those non-state-owned enterprises with an annual sales income over 5 million Yuan). The inconsistency does not pose a problem for our analysis. In this study, energy refers to final energy consumption which measures direct energy demands and leaves out indirect energy demands. We use gross output value as the indicator of industrial production, following Huang (1993) and Sinton and Levine (1994)[2].

The selection of sector disaggregation level is mainly based on two aspects: data availability and purpose of analysis (Zhang, 2003). China's industrial sector has traditionally been disaggregated into 39 sub-sectors, which is roughly equivalent to the 2-digit standard industry classification (SIC) level. Many macroeconomic data are only available at this level.

For this study, we have dropped the three sub-sectors of “other mining industry”, “arms and ammunition manufacturing” and “waste of resources and waste materials recycling industry” because gross output data for these sub-sectors are not officially released for some years. Such practice should not have significant impacts on final results due to minimal gross output shares of these sub-sectors in the whole industry. To illustrate the impact of change in energy-intensive industries such as “nonferrous metals processing”, “ferrous metals processing”, “nonmetal mineral products”, and “chemicals” etc. on energy consumption, we categorized all sub-sectors into 15 larger sectors as listed in Table 2.

Industrial output data and final energy consumption data are collected from China Statistical Yearbooks (CSY, 1999-2007) and China Energy Statistical Yearbooks (CESY, 1999-2007). In this study, we take 1998 as the base year, i.e. year *0*. Gross output values for each industrial sector are converted to constant prices using ex-factory price index of associated industrial products. Such practice has the advantage of taking into account heterogeneous sector development over using a general deflator (Ma, forthcoming). Final energy consumption of all energy carriers are aggregated by standard coal equivalents for each industrial sector. The unit of industrial output value is 10,000 constant Yuan. We can now present the results from applying the above-described method and data and discuss the key factors that have affected China’s industrial energy consumption over the period of 1998-2006.

Table 2

Decomposition of China's industrial energy consumption by sector 1998-2006 (10,000tce)

Sectors	Structural effect	Efficiency effect	Production effect	Aggregate effect	Sequence of Impact
Nonferrous metals processing	3624.4	-19135.79	41311.41	25800.01	1
Electric power, gas, hot water	1617.85	-14160.8	20956.1	8413.15	2
Nonmetal mineral products	-6965.41	-7507.59	22786.62	8313.62	3
Chemistry[1]	-2531.98	-19587.82	27939.36	5819.55	4
Refined petroleum	-6267.52	-2052.73	13812.16	5491.91	5
Ferrous metals processing	1814.35	-4850.26	8283.9	5247.98	6
Machinery	2185.49	-7951.37	9972.05	4206.17	7
Textiles & garments	-1211.65	-2374.15	6787.84	3202.04	8
Mining & extraction	-5834.31	-8231.85	17037.79	2971.63	9
Paper	-150.21	-2386.55	4187.56	1650.8	10
Metal products	-627.16	-332.55	2499.09	1539.37	11
Food & beverage	-1192.85	-4452.02	6293.03	648.16	12
Forestry[2]	84.1	-470.11	906.19	520.18	13
Leather & furs	-65.46	-185.36	396.29	145.47	14
Cultural articles	-30.42	-157.48	247.46	59.55	15

Note: [1] includes chemicals, chemical fiber, rubber products, plastic products and pharmaceuticals; [2] includes wood, bamboo, timber processing and furniture.

4. Decomposition Results and Discussions

4.1 Comparison of Decomposed Effects

As shown in Table 1, the industrial energy consumption increased 805.52 mtce from 1998 to 2006. The contribution of production effect is 1763.33 mtce, which is the main driving force for the increase of China's industrial energy consumption. China's aggregate industrial production increases 20.29 percent annually during this period[3], which substantially drives up energy demand and consumption. On the other hand, the efficiency or intensity effect is the main contributor on the decreasing side. The efficiency improvement contributes a decrease of 812.27 mtce to the total change - that is to say, the actual industrial energy consumption would have doubled without energy efficiency improvement.

To make further comparison of the different effects on energy consumption, we propose the definition of "effect intensity" which captures the relative contribution of each decomposed effect to the aggregate effect. The three effect intensity are defined as:

Production effect intensity (PEI) = Production effect / Aggregate effect

Structural effect intensity (SEI) = Structural effect / Aggregate effect

Efficiency effect intensity (EEI) = Efficiency effect / Aggregate effect

Fig. 5 shows the three effect intensities on energy consumption. The efficiency improvement of industrial sub-sectors is the dominant contributor on the decreasing side while the expansion of industrial production explains most of the increase. The industrial structural shift also contributes to the energy consumption decrease but to a much lesser extent. These results are consistent with those from previous studies for different periods as reviewed in Section 2.

Table 1

Decomposition of China's industrial energy consumption 1998-2006 (10,000tce)

Period	Change of energy consumption	Production effect	Structural effect	Intensity effect
1998-1999	-3718.80	8763.33	-597.73	-11884.40
1999-2000	-1142.41	12454.24	-2357.35	-11239.30
2000-2001	2699.25	11514.47	-1936.79	-6878.44
2001-2002	9790.13	17176.73	-3231.13	-4155.47
2002-2003	17372.61	26702.91	-2983.78	-6346.52
2003-2004	23835.14	27732.63	1641.49	-5538.97
2004-2005	6313.88	38084.30	-973.22	-30797.20
2005-2006	25401.98	33904.12	-4115.65	-4386.49
1998-2006	80551.78	176332.73	-14554.2	-81226.8

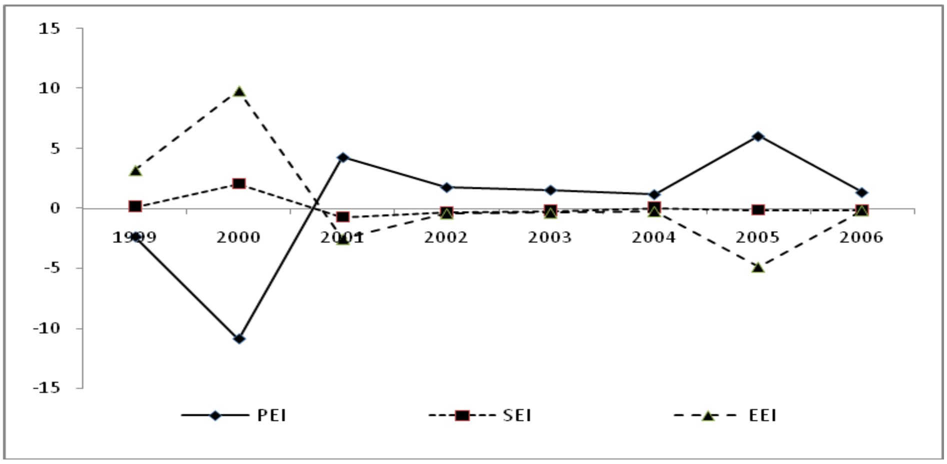

Fig. 5. Production, Structural and Efficiency Effect Intensity

4.2 Identification of Influential Sectors

Table 2 shows the decomposition results by industrial sectors. The first important finding here is that energy-intensive sectors contribute the most to the change of total industrial energy consumption. The top four contributing sectors are “nonferrous metals processing”, “electric power, gas and hot water”, “non-mental mineral products”, and “chemistry”, each contributing 34.85, 11.36, 11.23 and 7.86 percent (65.31 percent in total) of the total change in industrial energy consumption. All four sectors are notorious for their energy intensiveness. The energy consumption increase in these sectors is mainly attributed to expansion of production scale. For instance, Fig. 6 illustrate the fast growth in the sector of “nonferrous metals processing”, which is possibly driven by the fast expansion of real estate sector and auto industry.

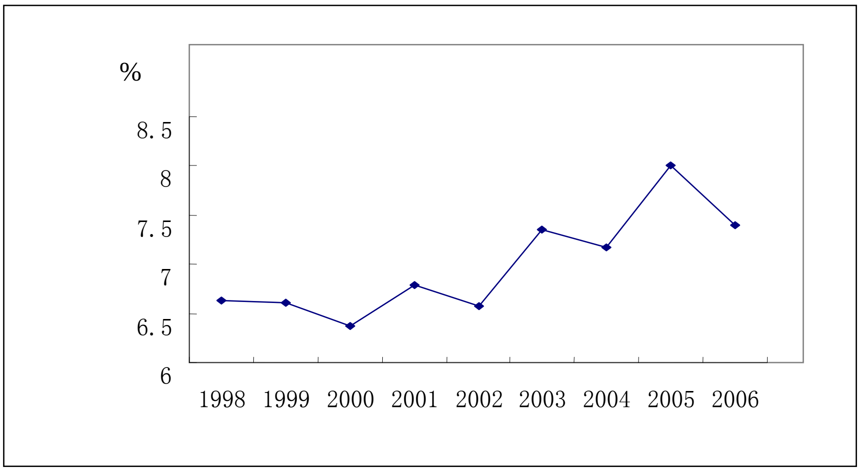

Fig. 6. Output share of "nonferrous metals processing" in total industry

Sources: CSYs, various issues

The second important finding is illustrated in Table 2 and Fig. 7: energy-intensive sectors also make the most contribution to efficiency improvement though all 15 sectors have improved energy efficiency over this period. As further discussed in our policy analysis, this is a result of policies eliminating obsolete technologies with low energy efficiency which have had the most significant impact on the energy-intensive sectors. The sectors of "chemistry" (including chemicals, chemical fiber, rubber products, plastic products and pharmaceuticals), "nonferrous metals processing", and "electric power, gas and hot water" contribute only 23% of total industrial output while they account for 54% of total industrial energy consumption during the study period. Of the total efficiency effect of 938.36 mtce, 528.84 mtce or 56.36% are attributed to the above three sectors. On the other hand, Fig. 7 also shows signs of industrial structural shift towards the sectors of "nonferrous metals processing", "ferrous metals processing", "machinery", and "electric power, gas and hot water", evidenced by the positive structural effects in these sectors.

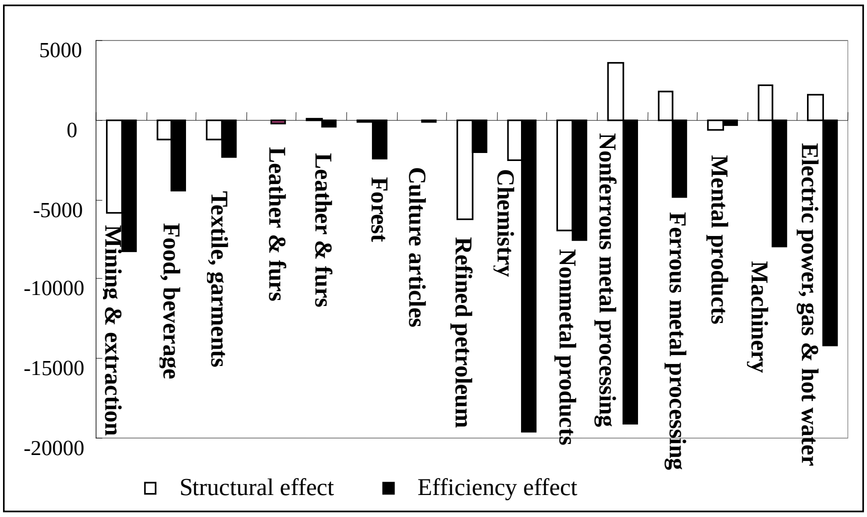

Fig. 7. Structural effect and intensity effect by industrial sector (10,000tce)

5. Analysis of Industrial Policies

Previous studies have also found that the improvement of energy efficiency is the main driver of the decrease of China's industrial energy consumption; however, explanations vary for different study periods. We argue that in the past few years, energy efficiency improvement in China's industrial sector was mainly policy driven. Yang (2008) mentioned that about half of the overall energy efficiency (economy-wide energy intensity) improvement is expected to come from energy consumption reduction in energy-intensive industrial sectors during the 11th Five-Year Plan (2006-2010). In fact, the government has started to adjust industrial polices to reduce energy consumption since 2003. Related measures and pilot practices have been taken even further ahead. Table 3 presents some of the relevant policies and their actual effects. These policies focus on energy-intensive sectors and the objectives are two-fold: to phase out obsolete technologies and associated production capacity, and to optimize industrial product structure.

Table 3

Main Polices to Phase out Low Efficiency Technologies

Sub-sectors	**Policies**	**Effects**
Electrolytic Aluminum	*On Stopping Unauthorized Construction and Blind Investment in the Electrolytic Aluminum Industry* (2003, GOSC [103]); *The Development Policy of Aluminum Industry* (2005, SC)； *On Strengthening the Structural Adjustment of the Aluminum Industry* (2006, NDRC [589])	Soderberg process of aluminum smelting fully eliminated by July 2007.
Steel	*On Stopping Blind Investment in the Steel Industry* (2003, GOSC [103]); *The Development Policy of Steel* (2005, NDRC [35]); *On Controlling Gross Output, Eliminating Obsolete Production & Speeding up Structure Adjustment of the Steel Industry* (2006, NDRC [1084])	29.4 and 15.21million tons of iron-making capacity and steel-making capacity shut down by the end of Nov., 2007 on an accumulative basis; Overall energy consumption and fresh water consumption per ton of steel dropped by 2.32 and 16.24 percent； The emissions of SO2, industrial smoke and dust by 0.4, 2.78 and 3.11 percent respectively in the first ten months of 2007.

Cement	*On Stopping Blind Investment and Speeding up Structural Adjustment in the Cement Industry* (2003, GOSC [103]); *On Structural Adjustment of the Cement Industry* (2006, NDRC [609]); *The Development Policy of the Cement Industry* (2006, NDRC [50])	The capacity proportion of new-type process of cement production increased from 12 percent in 2000 to 40 percent in 2006; Old and energy-consuming wet kiln process of cement production substantially reduced by July 2007.
Coke	*On Overhauling the Coke Industry* (2004, NDRC [941]); *On Speeding up Structural Adjustment of the Coal Industry* (2006, NDRC [328])	Beehive oven coke dropped from 34.5 million tons in 2000 to 10 million tons in 2005; its share dropped accordingly from 28.3 percent to less than 5 percent.
Iron Alloy & Carbide	*On Overhauling the Carbide & Iron Alloy Industry* (2004, GOSC [22]); *On Speeding up the Structural Adjustment of the Iron Alloy Industry* (2006, NDRC [567]); *On Speeding up the Structural Adjustment of the Carbide Industry* (2006, NDRC[699])	Iron Alloy: production capacity using electric furnace under 5,000 kilowatt (kw) reduced by 1.11 million since 2000; Carbide: 103 enterprises using obsolete technologies shut down by the end of 2007.
Coal	*On Healthy Development of the Coal Industry* (2005, SC [18]); *On Speeding up the Structural Adjustment of the Coal Industry and Resolving the*	11,155 small coal mines shut down and production capacity with low efficiency

	Production Capacity Surplus (2006, NDRC [593]); *The Development Policy of the Coal Industry* (2007, NDRC [80])	reduced by 250 million tons during 2005 and 2006.
Electricity	*On Overhaul and Recent Construction Arrangement of Power Stations* (2005, SC [18]); *On Survey of Closure of Small Thermal Power Units* (2006, NDRC [392]); *On Coordination Measures for Energy Saving in Power Generation* (2007, NDRC [53]); *On Speeding up the Structural Adjustment and Promoting Healthy and Orderly Development of the Electricity Industry* (2006, NDRC [593]); *On Reducing Small Thermal Power Unit's Grid Access Price and Promoting its Closure* (2007, NDRC [703]).	Small thermal power units shut down by 3.14, 14.38 and 8.36 million kw in 2006, 2007 and 2008 (January to June) respectively; Standard coal consumption decreased from 367 gram/kwh in 2006 to 356 gram/kwh in 2007 for those coal-fired power plants with a minimum capacity of 6,000 kw.

Notes: NDRC – National Development and Reform Commission; SC – State Council; GOSC – General Office of State Council

Sources: authors' collection from NDRC and China News: http://www.chinanews.cn/

Related policy measures include: 1) build large-scale group enterprises to achieve economy of scale and improve efficiency (steel and cement sectors); 2) remove or reduce tax return at the stage of export and strengthen export administration (electrolytic aluminum, coke and iron alloy sectors); 3) implement differential power prices (electrolytic aluminum, iron alloy and carbide sectors); 4) shut down small and coal- and pollution-intensive thermal power units (power sector).

The effectiveness of these policies are firstly evidenced by the substantial improvement of energy efficiency in energy-intensive sectors during the period of our study (Table 2 and Fig. 7), and secondly evidenced by the achievement of the national energy-saving target, which is 20% reduction in overall energy intensity during the 11th Five-Year period （2006-2010）. The target has been widely regarded as a difficult task; however, provincial evidences show that policies have been effective in reducing energy consumption. Under the national target of 20% reduction, each province, municipality, or autonomous region in China has a specific target of saving energy. The NDRC has recently published information on provincial performance of energy saving in 2007 (Fig. 8): 6 regions over-fulfilled their targets; 14 regions completely fulfilled; 3 regions mostly fulfilled and only 7 regions cannot fulfill their predetermined targets.

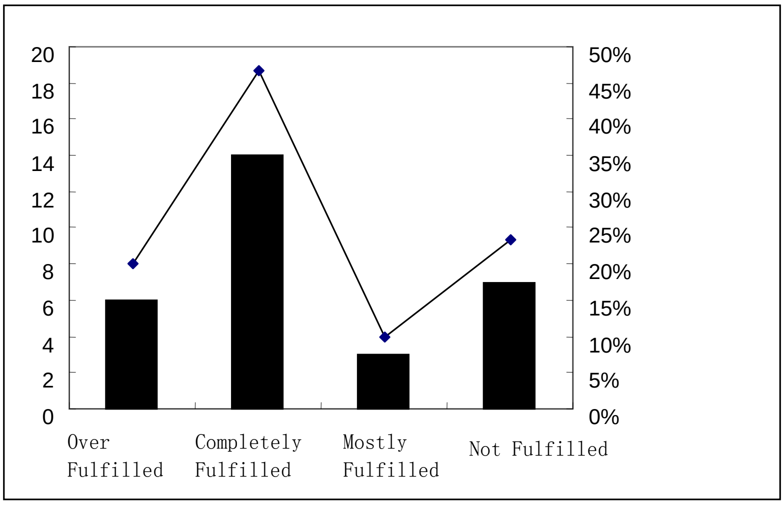

Fig. 8. Fulfilment of energy-saving targets by region (2007)

Source: NDRC

It is worth to mention that these industrial policies have been effective only with regard to sectoral energy efficiency improvement. Structural adjustments are mostly implemented at the product level within each sector, which also helps to improve sectoral energy efficiency. Little attention has been paid to cross-sector structural adjustments. We have seen a production shift towards energy-intensive sectors (Fig. 7) which has actually offset part of the benefits from efficiency effect.

6. Analysis of Energy Price Policies

China's energy price policies have experienced three stages with different policy focuses. We discuss the three stages in the following and illustrate associated policies in Fig. 9. The theme of energy price policies changes from stage to stage, but the main characteristic remains the same - low prices for energy products. Firstly, such low energy prices contribute directly to the rapid growth in energy consumption, and secondly, low prices particularly favor the development of energy-intensive industries and contribute indirectly to the structural shift from light industries to energy-intensive industries.

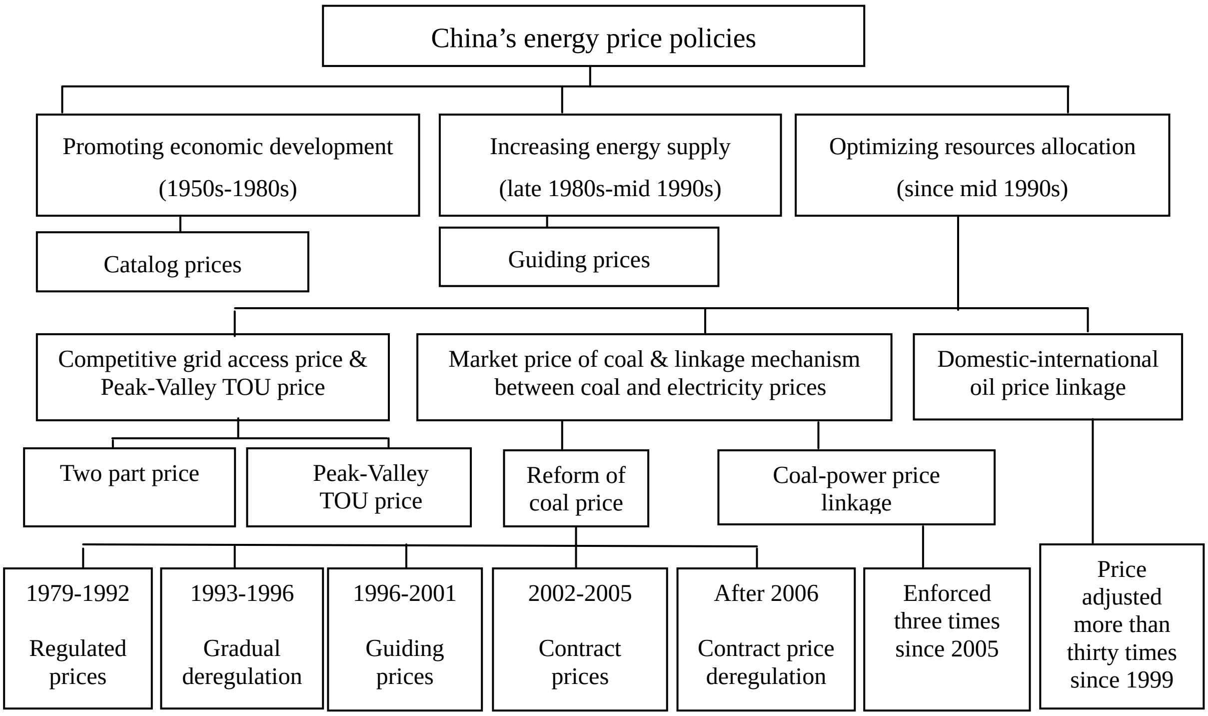

Fig. 9. Evolution of China's energy price policies

6.1 Stage I: promoting economic development

Following the establishment of the new China in 1949, economic development became one of the immediate policy priorities. Energy prices were artificially kept low and were sometimes even lower than the production cost. The average catalog electricity price in China during the 1980s was only one third of that in Japan and U.S. State-owned coal mines and oil enterprises often found them facing deficits (Wang, 2001). The low energy prices lasted for about four decades until the late 1980s.

6.2 Stage II: increasing energy supply

Partially due to the low energy prices, there was a substantial investment shortage in energy sectors[4]. Energy supply fell short severely by the mid 1980s. In order to increase the energy production capacity, especially the power generation capacity, the government implemented several investment stimulation policies which include the introduction of guiding electricity prices as well as the reforms in investment institution ((Ma and He, 2008; Du, et al., 2009). Under the guiding electricity prices, the payoff period for electricity investment is improved to 10 years (Liu, 2005). Thanks to the stimulations policies, the severe power shortage in 1985 had turned to a surplus by 1995. The coal market was deregulated as well in 1993 except the “within plan” coal which is to serve the coal-fired power plants. China’s oil price was also increased several times over the period of 1988-1996; however, it was still lower than the international level. The international crude oil price was between $15 and $20 per barrel in 1996 (Mo., 2007) which is equivalent to 1245 Yuan per ton5 while China’s crude oil price at that time was only 1020 Yuan per ton (Fan, 1999).

6.3 Stage III: optimizing resources allocation

In order to optimize resources allocation, the government launched several market-oriented reforms in the energy sectors. As discussed above, China’s coal market was deregulated in

1993; however, the price for "within plan" coal was still artificially kept low to promote electricity generation. The government further launched the "Coal and Electricity Price Linkage" program in 2004 with two objectives: 1) to deepen energy price reforms and 2) to cushion the pressure from coal price increases. If the average coal price during a six-month period increases by 5 percent or more than that of the previous period, the electricity price should be adjusted accordingly; otherwise, the increase would be accumulated to the next period. Market-oriented price reform in the oil sector was introduced in *The Reform Scheme of Crude Oil and Processed Oil* (SPC[6], 1998[52]), which established the linkage oil price mechanism. Domestic oil price will be periodically adjusted and linked to the international market. In the electricity sector, the General Office of State Council (GOSC) issued the *Scheme of Electricity Price Reform* (2003, [62]) and complementary interim measures for regulation of grid access prices, transmission prices and sales prices were further detailed in *Measures for Implementation of Electricity Price Reform* (NDRC, 2005[514]). The Scheme introduced the two-part electricity price, namely capacity price and volume price. The volume price is formed by market competition. For the first time, competition is introduced in the electricity price: the least-cost power plant obtains generation priority. To further optimize resource allocation, the Peak-Valley Time of Use (TOU) prices were introduced in 2003 (NDRC, 2003[124]) which aims to coordinate power usage and time of use.

From catalog prices to guiding prices and to Peak-Valley TOU prices and from highly central-controlled market to the coal-power price linkage program and to the domestic-international oil price linkage program, China has gone a long way to reform its energy policies. Yet, it is not finished. For example, although the domestic-international oil price linkage program aims to link domestic oil price with price fluctuation in the international market, it is not a real-time linkage. When international oil price flied high to about $140 per barrel in the June of 2008, China's petrol price was only about 7,000 Yuan per ton which is roughly only 85 percent of the international level. Low energy prices are believed to be one of the important drivers behind the rapid increase of industrial energy consumption (Yang, 2008). To increase allocation efficiency, reduce energy consumption, and to promote structural shift towards lighter industries, low energy prices need to be further addressed and price reform remains a focal subject of future energy policies.

7. Conclusions

This study examines China's industrial energy consumption during 1998-2006 using the LMDI method. We intend to identify the key factors that influence China's industrial energy consumption and bridge the quantitative decomposition analysis with the qualitative policy analysis. We found that on the one hand, the high energy demand in industrial sectors is mainly attributed to expansion of production scale, especially in energy-intensive industries. On the other hand, energy saving mainly comes from efficiency improvement, with energy-intensive sectors making the largest contribution. We argue that energy efficiency improvement in energy-intensive sectors is mainly due to the industrial policies that have been implemented in the past few years, which has substantially reduced obsolete production capacity and improved product structure within each sector. However, these policies have paid little attention to structural adjustments across sectors, which is evidenced by a production shift towards energy-intensive sectors. A review of energy price policies shows that energy prices have been artificially kept low and have not been completely rectified by recent market-oriented reforms. The low energy prices have directly contributed to high industrial energy consumption and indirectly to the heavy industrial structure. To continuously improve energy efficiency and reduce energy consumption, we suggest the government: 1) enhance current industrial policies and further improve energy efficiency; 2) deepen energy price reforms and reduce price distortions; and 3) address structural adjustments across sectors in future policy-making.

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Footnotes:

1 See Hoekstra and Van der Bergh (2003) and Ma and Stern (2008) for discussions of the advantages and disadvantages of each category.

2 Ideally, we could use added value which measures net economic contribution of each sub-sector; however, such data is not available for all years during the period of our study. Added value at the sector level is not officially released for the year of 2004.

3 Authors' calculation according to the CSYs in constant 1998 price.

4 Investment shortage is also partially due to the high central control investment system in the electricity

industry (Du et al., 2009).

5 Authors' calculation, $1=8.2982 Yuan on Dec.31st, 1996.

6 State Planning Commission (SPC) now becomes the National Development and Planning Commission (SDPC) and the National Development and Reform Commission (SDRC).

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