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Energy, Environment and the Sustainability of Economic Development in China

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Abstract(150 words): Whether the high economic growth of China is sustainable is the matter of interest to the public, government and academic circle of China and meanwhile it catches the attention of the world because the development of China has been exerting increasing impact on the world economy. Since the high economic growth of China has been promoted by heavy and chemical industry (HCI) to a great extent, which resulted in high consumption of energy resource, high consumption of mineral resources and high emission of pollutants (the “triple highness”), the sustainability of high economic growth of China depends on a sustainable growth road for China’s HCI and effective control on the “triple highness”. We find that the contributing factors of the “triple highness” are not the growth of HCI itself but the small scale and out dated technology. We conclude that the “triple highness” can be effectively controlled if some proper measures are adopted and the high growth of China can be sustainable.

Key words: economic growth, energy, resource, pollution

JEL Code: O10, O11

Energy, Environment and the Sustainability of Economic Development in China

China has observed a new cycle of high economic growth since 2002 with a two-digit GDP growth rate each year from 2003 to 2006. During this period, Chinese government has taken many macro-control measurements to avoid rapid increase in energy and natural resource consumption as well as pollution caused by high economic growth. In 2006, the government tightened up the macro-control on the growth of energy-intense industries in order to realize the objective of energy saving in 11th Five-Year Plan, i.e. cutting down the energy consumption to 0.98 ton of standard coal per 10 thousand yuan of GDP. At the end of 2006, the government even announced an expected GDP growth rate in 2007 at 8% as a signal. Nevertheless, all the macro-control measures failed to cool down the economy, and it continues a strong growth trend to have reached a GDP growth rate of 11.5% in the first half of 2007, the new record in the 21st century.

It is generally acknowledged that the high economic growth of China has been promoted by heavy and chemical industry (HCI). However, the high growth of HCI has caused heated debates among Chinese economists. Some scholars represented by Wu (2005a; 2005 b; 2005c; 2005d), a famous economist of China, argued that the high growth of HCI consumed a lot of energy resource and natural resources and intensified the environmental pollution, so the limited resources and deteriorated environment could not support further growth of HCI. China should make major effort to develop hi-tech industry and tertiary industry instead.

Others, represented by Fan (2005), another influential economist in China, argued that HCI was an inevitable phase and China should devote major effort to develop it. Resource

supply was not an essential problem, and China could make use of the resource of the world. Economic research for the past decades found that the nations short of resources often developed well and those rich of resources frequently fell behind because the shortage of resources stimulated those to make more efforts in promoting technological innovation, such as Japan. The problem of China is low efficiency in HCI causing resources waste. HCI is not necessarily an industry of the high energy consumption and high pollution. The high resource consumption and pollution can be controlled through efficiency improvement and environment protection, (Li, 2005).

Will Chinese high economic growth rates be sustainable? What are the potential problems during the development? These problems are very important and catch the attention of the public, government and academia in China as well as that of the world because the economic development of China has been exerting increasing impact on the world economy. In this paper, we show the major contribution of HCI in Chinese economic development, find out the key contributors to the energy and resource waste and pollution, and discuss the measures to control these problems while sustain the growth of HCI and GDP.

1. The Characteristic of Chinese High Economic Growth Rate

The high economic growth of China is obviously characterized by the fast expansion of heavy and chemical industry (HCI), mainly composed of energy resource, electric power, ferrous metal, nonferrous metal, machinery, and chemical industry. This can be shown with the following three aspects.

First, the growth rates of values added by the second industry¹ as a whole and by some representative branches of HCI are higher than other sectors. In 2004, the Chinese GDP was 13,651.5 billion yuan, increased by 9.5% over the previous, among which, the value added by the secondary industry was 7,238.7 billion yuan, increased by 11.1%, a 1.6% point higher than GDP. The growth rates of the other two industries, primary and tertiary industries were 6.3% and 8.9% respectively, both lower than that of GDP.

Furthermore, the growth rates of several representative branches of HCI are even much greater than that of the secondary industry average. For example, the growth rates of manufacture of raw chemical materials and chemical products was 18.2%, smelting and pressing of ferrous metals 26.8%, smelting and pressing of non-ferrous metals 22.4%, manufacture of general purpose machinery 22.2%, manufacture of transport equipment 14.0% (see Table 1). Therefore, the second industry and likely the HCI has made the primary contribution to the high growth of GDP.

[Insert Table 1 here]

Second, within the second industry, the higher growth rates and increasing proportion of HCI is much higher than that from the light industry. The characteristic of HCI in the high growth rates of China can be reflected by the higher growth rates and rapid increase of proportion of heavy industry in the economy. Table 2 shows the total values added, their share in the second industry and their growth rates of light and heavy industries in comparison.

[Insert Table 2 here]

In 2002, the growth rates of heavy industry and light industry in industrial enterprises

(with the scale of 5 million yuan assets or above) were 13.1% and 12.1% respectively, with a small difference. However, from 2003 and on, the heavy industry has entered a channel of accelerating growth. From 2003 to 2006, its growth rates were 18.2%, 18.2%, 17% and 17.9%, higher than that of light industry by 3.6%, 3.5%, 1.8% and 4.3%, respectively. Meanwhile, there was a great change in proportion between heavy and light industry: the proportion of the heavy industry increased from 60.9% in 2002 to 69.5% in 2006, increased by 8.6 percent and the proportion of light industry declined from 39.1% in 2002 to 30.5% in 2006, decreased by 8.6 percent (see Figure 1).

[Insert Figure 1 here]

Third, the rapid increase of the output of some main products of HCI also provide evidence that HCI grows very fast. The representative products of HCI include crude steel, steel products, nonferrous metals, alumina, cement, caustic, ethylene, electricity generating equipment, automobile, tractor which are representative products of HCI. The output of these products has mostly kept over 15% growth rates since 2001. In 2006, the growth rates of output of alumina, automobile (among which car), ethylene, tractor, caustic was 59.4%, 27.6% (39.7), 24.5%, 22%, 21.9%, their growth rates were all more than 20%. (see Table 3).

[Insert Table 3 here]

There is a distinctive international background for China's high growth in HCI, i.e. it is closely related to the globalization and industrial migration in the world. The developed nations have reduced the production of HCI, even closed some factories in the energy-consumption industry since the 1990s in consideration of the high energy costs driven by

energy shortage, pollution and labor cost. Thus, a lot of HCI production has migrated to the developing nations. China has become main destination of the industrial immigration of the developed world. Meanwhile, with the economic recovery of the world since 2003, there has been increasing demand for the products of HCI in the world market. Under the double stimulation of the increasing demand and the reduction of production of the developed nations, China has gained the opportunity for developing its HCI.

The rise of HCI of China has been exerting great impact on the world market: both the market of raw materials because China imports a lot of raw materials and the market of HCI products because China exports a large quantity of HCI products. For example, there was almost no spot market of alumina in the world before only options market, but the increasing demand for alumina in China caused by the flourishing of electrolytic aluminum industry resulted in the emerge and expansion of alumina spot market in the world.

2. The Problems Aroused by the High Growth of HCI

While the accelerating growth of HCI promotes the high growth of GDP, it also causes a series of problems in the economic development and concerns from economists. The concerns mainly concentrate on three aspects. First, HCI is an energy-intense industry whose high growth has consumed a lot of energy resource, and the limited supply of China's energy resource cannot support further growth of HCI; second, HCI is a resource-intense industry whose high growth has consumed a lot of natural resources especially mineral resources, and the shortage of mineral resources in China prevents further growth of HCI; and third the high growth of HCI intensifies

the environment pollution and hence the deteriorating environment allows no further growth of HCI.

Among above-mentioned problems, the strongest reactions from the public, government and academic circle is the first one, i.e. the energy shortage. In 2003 and 2004, the high growth of HCI made serious energy shortage so as to result in frequent power cut so that factories often stopped production and residents' life met trouble.

The situation of the consumption of energy resource has close relation with the economic growth of China. From 1997 to 1999, the total consumption of energy resource was in the situation of decline and the elasticity ratio of both energy consumption and electricity consumption were less than 1 and meanwhile, the growth rates of GDP presented a trend of decline, from 8.8% in 1997 to 7.1% in 1999 – the lowest point. From 2000 to 2004, the elasticity ratio of energy consumption was 0.42, 0.41, 0.66, and 1.53 respectively and that of electricity consumption was 1.13, 1.12, 1.30, 1.56, 1.52 respectively - obviously went up. The elasticity ratio of energy consumption or electricity consumption is more than 1 means that the high economic growth establishes on a basis of more energy or electricity consumption, that is, the high economic growth of China to great extent depends on energy consumption.

According to the energy saving target in Chinese 11th Five-Year Plan, the energy consumption per 10 thousand yuan GDP should decrease by 20% over the period of 10th Five-Year Plan, which means in every year during the period of 2006 To 2010, energy consumption per 10 thousand yuan GDP should decrease by 4.4%. Nevertheless, in 2006 – the first year of 11th Five-Year Plan, the energy consumption per 10 thousand yuan GDP was 1.21

ton standard coal, decreased by only 1.23%, failing to fulfill the objective of 4.4%. Thus, to fulfill the objective of energy saving meets difficulty and many people put the blame on the high growth of HCI or energy intense industry.

In addition, from Table 4 or Figure 2 we can see that before 2003, the growth of energy consumption was lower than that of GDP and in 2003 and 2004, there was a an accelerating growth of energy consumption which was much higher than the growth of GDP, but meanwhile GDP also entered an accelerating growth phase, and after 2004, the growth of energy consumption began to fall down and was lower than that of GDP again. From a long run, the growth of energy consumption in 2000s is much higher than that in 1990s. This also means that the economic growth after 2000 is characterized by HCI.

With regard to electricity consumption, before 2000, the growth of electricity consumption was lower than that of GDP and after 2000 it was much higher than that of GDP. In brief, the consumption of electricity has gone up sharply since 2000 and the economic growth of China depends greatly on the consumption of electricity consumption.

[Insert Table 4 and Figure 2 here]

3. A prediction of GDP Growth Rates of China

Although China has kept high economic growth for more than 20 years, its total GDP is still far behind that of the US or Japan because of its low base - about one fifth of that of the US' and less than half of Japan's. The per capita GDP of China is even much lower, ranking about 100th in the world. Under this economic level, it is reasonable for a developing nation like China

to maintain a higher growth rate. On the other hand, when a developing nation enters the phase of industrialization, it usually maintains a long time of high economic growth. For example, Japan, Singapore, South Korea, Chinese Hong Kong, Chinese Taiwan once maintained a long period of high economic growth from 1950s to 1980s. Some scholars hold that it is possible for China to maintain high economic growth for next 10 to 20 years (Wei Liu and Jian Su, 2007).

Now we use the actual GDP growth rate from 1984 to 2007 to predict the GDP growth rates from 2008 to 2012. Most of the data can be found in Table 4. An Autoregressive and Moving Average with two lags (ARMA 2, 2) is fitted for the annual GDP growth rate. The fitted values are plotted against the true values in Figure 3. It can be seen that the model captures the major ups and downs of the growth rate pretty well. The predicted values for years 2007 and beyond are reported in Table 5. The model is estimated using Eviews.

[Insert Table 5 and Figure 3 here]

From Figure 3 we see that the predicted data are basically tallied with the actual data, and the predictive GDP growth rates in table 5 show that they will maintain 2 digits for the next five years. The predicted data are simple time series analysis, assuming everything (Chinese policy, international environment, etc.) follows the same dynamics for the next five years as before. Whether China's growth rates are sustainable depends on some key factors we will discuss in the following.

4. The Sustainability of High Economic Growth of China

As a developing nation, it is not surprising for China to have kept higher growth rate for more

than two decades, but the key to the problem is whether its high growth rate is still sustainable.

As discussed earlier, under the current economic development structure characterized with HCI, the sustainability of the high economic growth depends on following three factors: the sustainability of energy supply, the sustainability of natural resource or mineral resource supply, the sustainability of the environment. Now we discuss the factors one by one:

(1) The Sustainability of energy supply

The problem of energy consumption caused by the high growth of HCI is the first to be argued in the issues on the HCI. Many people worry about that the domestic energy resource or energy industry cannot support the high growth of HCI any more. With regard to this problem, we would like to emphasize following points:

Firstly, the supply of energy is determined by the usable energy resource available and the production technology. The HCI and energy industry are in the relation of supplement each other or promote each other. The demand of energy induced by the growth of HCI increases the profits of energy industry so as to promote the development of the industry. Better technology and improved production efficiency can increase the energy supply through using new energy resources that were not available or useable before and through reduction of waste during production.

Secondly, a better coordinated supply and demand of energy can reduce energy waste during distribution. Cases did exist when energy over supply and idleness was a problem. An efficient economic policy should aim to avoid the energy shortage and meanwhile avoid energy being left idle.

Thirdly, the problem of supply and demand of energy resource is very complex. The currently observed shortage of energy supply can be a temporary phenomenon, only its sudden occurrence makes strong reaction from all aspects. In fact, the supply and demand of energy resource has an obvious cycle (Fang, 2006).

At the beginning of China's reform and opening, along with the high economic growth, China once encountered a serious problem of energy shortage, but with the acceleration of energy production capacity building up, the energy shortage was gradually alleviated. In the middle and later period of 1990s, because of the rapid development of energy industry, energy supply exceeded demand so that it was difficult for power plant to sell electricity and the price of electricity fell down sharply, even under 0.1yuan/kwh. It was this situation – the very low price of electricity that induced the rapid development of the HCI.

The high growth of HCI in turn resulted in energy shortage and in 2003 and 2004, energy shortage became serious. And then, China increased the investment in energy construction and at the same time, closed some small energy-consuming enterprises which used out-of-date technology and outmoded machinery as well as caused serious pollution emission. By the end of 2005, the installed capacity of China reached 500 million KW and that being under construction or planned to be built was 300 million KW. By the end of 2007, the installed capacity will be 700 million KW. The scale of energy construction has again presented a trend of surplus.

In addition, although the hydropower resource of China ranks first in the world, it is only developed and utilized about 25% leaving great potential for further exploitation. At present, a

new development period of hydropower in the southwestern areas, the hydropower resource richest area of China, has entered a new upsurge. This may forebode a new cycle again – a phase of energy supply exceeding demand. Because of the limitation of grid system, it is impossible for all the hydropower in southwestern areas to be transmitted to the middle and eastern areas which are the highly developed and have greater demand for electricity, part of the hydroelectricity produced in the southwestern areas should be utilized locally. To develop energy intense industry or HCI in the locality will make full use of the rich hydropower in the southwestern areas, or else, the surplus hydropower will lie idle or wasted.

Fourthly, HCI does not necessarily mean “high energy consumption”. Under the situation of high growth of HCI, the relative level of energy consumption can be reduced. According to the data in Table 4, since the elasticity ratio of energy consumption reached the highest point of 1.59 in 2004, it has been presented a trend of decline, but both HCI and GDP have presented a trend of accelerating growth. In 2006, the growth rate of the value-added of heavy industry was 17.9% - the second highest point since 2000 and the growth rates of output of main products of HCI such as steel products, nonferrous metals, cement, caustic, ethylene, tractors reached the highest points since 2001, that of automobile reached the highest point since 2004, and that of crude steel and generating equipment were up to 20%, however, the elasticity ratio of energy consumption was reduced to 0.86 – the lowest point since 2004, decreased by 46% compared with that in 2004 (see Fig 4). In addition, there is great potential for China to save energy or reduce energy consumption. So it is possible to realize the objective of energy control in the 11th Five Year Plan if the key factors leading to the high energy consumption is

well dealt with.

In brief, the possibility for energy supply growth to be sustainable to support the high economic growth of China in the next 10 – 20 years is there, even before the consideration of importing energy from the world market.

[Insert Figure 4 here]

(2) The Sustainability of the Supply of Mineral Resources

Indeed, at present the reserves of domestic mineral resources cannot meet the demand of economic growth of China. Even if those were originally rich in the reserve are now quickly depleted along with the high economic growth for many years. Nevertheless, with the economic globalization, the supply of resources of China can come from other countries. A striking example is Japan which is poor in natural resources and has made use of the resources all over the world to develop itself. Similarly, China's economy has been open to the world so that it can take advantage of the resources worldwide. In fact, China has imported iron ore (mainly from Australia) for a long time and in the past several years. It also began to import a great amount of bauxite, which is used to produce aluminum because of the rapid expansion of aluminum industry as a major branch of HCI in China. The reserve of bauxite in China is not rich and it can only support the growth of aluminum industry for about 10 years, but the reserve of bauxite in the world is very rich and it can support the growth of aluminum industry of the world for about 50 years (Fang, 2007). So it is not a problem for the supply of bauxite to support the growth of China's aluminum industry for the next 10 – 20 years.

Secondly, the technological innovation will prolong the life of mineral resources for

human use. For example, in the Conference of National Scientific and Technological Reward held by the State Council of China in January 2008, a First-Class Award winning project, “The Theory and Technology of High-Efficient Utilization of Aluminum Resource and Production of High-Function Aluminum Products” has provided a solution of economically utilizing the secondary and inferior grade bauxite. The reserve of the secondary and inferior grade bauxite is about two billion tons which accounts for 80% of total reserve in China. This technology can extend the life of domestic bauxite utilization from 10 years to 60 years as predicted.

Thirdly, though mineral resources are not renewable, almost all the metals can be regenerated or recycled. The salvage or recovery of waste materials especially waste metals become a great industry in the world and the production of recycling metals consumes less energy resource and emits less pollutants which are also easier to be dealt with than that of original metals.

Taking recycling aluminum as an example: recycling aluminum requires 95 percent less energy than creating aluminum from virgin ore according to the Institute of Scrap Recycling Industries, a Washington, D.C., trade group (Gross, 2007.). In the US, Japan, Germany, Italy and Mexico, the output of recycling aluminum is even greater than that of original aluminum. In 2003, the proportion of the output of recycling aluminum to total aluminum output in Japan, Italy, the US, Germany, England, France and China was 99.5%, 75.6%, 52.0%, 50.7%, 37.5%, 35.1% and 20.7% respectively (see Table 6) – the proportion of China was much lower. This, of course, means the backwardness of China’s recycling aluminum industry but meanwhile it also means that there is great potential for China to develop recycling aluminum industry. With

the development of recycling metal industry, the consumption of mineral resources will decline and the limitation of the resource will be greatly solved.

[Insert Table 6 here]

It is deserves our attention that the industry of recycling materials in China is soaring and digesting a great quantity of trash of the US. The materials discarded by Americans – broken-down auto bodies, old screws, nails and magazines – are their second largest export to China (\$6.7 billion in 2006), second only to aerospace products. Exports of ferrous scrap such as waste iron and steel from the US to China have risen from 166,000 metric tons in 1998 to 2 million metric tons in 2006 and junk dealers reaped \$1.5 billion selling scrap copper to China in 2006. All told, China's ravenous factories hovered up 42% of US scrap exports in 2006 (Daniel Gross, 2007). At present, China is carrying out recycling economy which not only promotes the utilization of waste materials and reduction of the consumption of virgin mineral resources but also reduces the emission of pollutants so as to save the environment.

In brief, thanks to the import of mineral resources and the development of recycling materials, the supply of mineral resources will not become a serious limitation to the high economic growth in the next 10 – 20 years.

(3) The Sustainability of Environment

The toughest problem in China's economic development characterized by HCI is the deterioration of environmental pollution. Evidently, if the environmental pollution cannot be controlled, the high economic growth promoted by HCI would not be successful because the living quality is not necessarily improved. Only if the pollution can be virtually controlled and

environment is well protected, the high economic growth promoted by HCI could be regarded as sustainable. It deserves our attention that the problem of pollution in China is essentially a growth mode of HCI, i.e. the extensive growth of HCI without strong policy restriction, not the problem of HCI itself. Under the mode of extensive growth, the disorderly expansion of HCI would undoubtedly produce serious pollution, but if turning the mode into intensive growth, adopting advanced technology of environmental protection and making use of adequate facilities in the production of HCI, the pollution would be better controlled and the development of HCI would meet the demand of environmental protection in modern society.

In brief, in the three factors mentioned above, the first two factors (the supply of energy and mineral resources) will not be the serious limitation to the high economic growth of China as aforesaid, the key problem lies in the third one, which is the most difficult to be dealt with.

5. The Key Problem to Be Solved in the Economic Development of China

Although it seems like the growth of HCI itself is the cause of energy and mineral resource depletion and pollution, the actual cause of the problems is the technology as well as management structures that contributing to the “triple highness”, i.e. high energy consumption, high material consumption and high emission of pollutants. However, to control the “triple highness”, we need first of all understand its contributing factors, which is discussed in the following.

According to Energy Research Society of China (Bao, 2006) the low energy-utilizing efficiency is the major factor for high energy consumption: the energy-utilizing efficiency of

China was only 34% in 2005, 10 percent lower than that of the developed nations, equivalent to the level of the developed nation 20 years ago; the energy-utilizing efficiency of industrial boiler was 60%, 20 percent lower than that of the developed nations; the energy consumption per unit output of major products of China was 40% high than that of the developed nations. Every year the industrial sector of China wastes 200 – 300 million ton standard coal, accounting for about one-fifth of total energy consumption. Therefore, if the energy-utilizing efficiency of China can reach the advanced level in the world, then, it is not difficult to meet the objective of energy saving and resource consumption reduction in China's 11th Five Year Plan.

What make the energy-utilizing efficiency so low? Through investigation, we believe that the reason for low energy-utilizing efficiency or high energy consumption is the out-of-date production capacity which results from out-of-date technology and old equipment, which also cause resource waste and high emission of pollutants. This is also supported by publications such as Wei (2005), That is, it is the backward production capacity in all economic sectors of China that contribute to the “triple highness”. In less developed areas of western China, many factories including village-owned factories even use primitive technology and machines in production causing serious pollution.

Another reason for the “triple highness” is that the scales of enterprises in HCI are very small in general and there are too many very small factories such as small iron and steel workshops, small thermal power plants, small cement plants, small electrolytic aluminum factories, small yellow phosphorus factories and so on. For example, in 2006, China has 762 iron and steel enterprises, and only 21 of them are large enterprises with an annual output of 5

million tons or more. Furthermore, the industrial concentration rate has been even going down. The output from small enterprises has been increasing, in the first half of 2007, with an output over 0.23 billion tons and a growth rate of 18.92%, but the output from large and midsized enterprises whose annual output was over one million tons increased only by 14.5%, lower than the average level of the industry by 4.3 percent. The output of local small enterprises has been increased by 36.81%, higher than the average level by 17.89%. (Chinaview, 2007). These small plants almost all use dated technology and old equipment.

Therefore, if the small factories and backward production capacity in HCI can be replaced by large enterprises equipped with advanced technology and equipment, the “triple highness” will be reduced.

The above problems sound simple but they are difficult to deal with because they involve complex social problems. Although Chinese government has achieved some success with its policy to eliminate the backward production capacity by closing some small factories in HCI, it has a long way to go to solve the problem essentially. The backward production capacity with those small factories are mostly located in the less developed and environment-sensitive area in middle and western China, where they rely on local low cost of energy and lenient environmental control regulations. Although the resource waste and pollution in these areas are startling, these small enterprises are the major source of revenues of local governments and the employment opportunities of local town and rural citizens. If taking an intransigent measures to eliminate them without providing alternative opportunities, it would cause serious social unrest and intensify the poverty in the locality.

As we know, economic development should not be at the cost of sacrificing natural environment, but it also should be emphasized that protecting natural environment should not be at the cost of sacrificing social environment. When closing small factories and eliminating backward production capacity in the middle and western areas, the policy support should be considered to set up new large enterprises equipped with advanced technology and machinery in locality to give the areas a chance to develop their economy.

Chinese government has launched the Great Campaign of Western Development for more than 6 years and given the western areas great support mainly in the construction of infrastructures which has played an important part in the development of the west, but this support has not changed the trend of widening gap between the east and the west. Under the present circumstance, the government should change the approach of its supporting to the western areas from funding the construction of infrastructures only to supporting industrial development (or lay equal stress on both) including giving favorable policy to attract capital or funds to enter the western areas, to re-organize and merge the industrial enterprises, and to approve new HCI enterprise establishment by the Development and Reform Committee of China. The government can consider establish special fund for industrial development for middle and western China to give financial aid for existing enterprises to update equipment and technology.

Although it is an arduous task for Chinese government to narrow the gap between the east and the west, with the high economic growth for a long time, the central government revenues have grown by higher rates than GDP, which equips the government with strong financial resources to support the less developed areas in the middle and west (see table 7) .

In short, the problem of less development in the middle and western areas should be well settled as early as possible, or else, it is more difficult to deal with if regional conflicts continue to accumulate. If China realizes harmony in both natural and social environment, the high economic growth will be sustainable. [Insert Table 7 here]

6. Conclusion

From above analysis, we derive the following conclusions. There are three factors: the sustainability of energy resource, mineral resources and environment, which are regarded as the limitation to the high economic growth of China promoted by HCI. The first two factors will not become the serious limitation to the sustainable development of China, and if the third factor – the environment factor is carefully dealt with, the high economic growth of China will be sustainable.

It is only a superficial phenomenon that the growth of HCI depletes too much energy and mineral resources and produces a lot of pollution, the essential reason for the “triple highness” is the out-of-date production capacity with dated technology and old equipment primarily from small scale enterprises. So eliminating backward production capacity and closing these low-efficiency small factories will solve the problem of “triple highness” and thus, China will realize sustainable high economic growth. In consideration of the big gap between the east and the west in the economic development, the elimination of low efficiency small factories should be backed up with policies that can bring in new large enterprises equipped with advanced technology and equipment. The government should give the middle and the western areas more

support to create a harmonious social environment for the economic development as a whole.

Only both social and natural environment becomes harmonious, can the China's high economic growth be sustainable.

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Table 1: The Comparison of the Growth Rates of GDP and Value Added by Five Branches of HCI

| | Growth Rate (%) | Difference from GDP (%) |
|--|--------------------|----------------------------|
| National GDP | 9.5 | N/A |
| Value Added from the Secondary Industry | 11.1 | 1.6 |
| Manufacture of Raw Chemical Materials and Chemical Products | 18.2 | 8.7 |
| Smelting and Pressing of Ferrous Metals | 26.8 | 17.3 |
| Smelting and Pressing of Non-Ferrous Metals | 22.4 | 12.9 |
| Manufacture of General Purpose Machinery | 22.2 | 12.7 |
| Manufacture of Transportation Equipment | 14.0 | 4.5 |

Data source: Statistical Yearbook of China in 2005

Table 2: The Situation of Value-added, Proportion and Growth Rates of Light and Heavy Industry (2002—2006)

| | Values Added | | Share (%) | | Growth (%) | |
|------|----------------|--------|-----------|------|------------|------|
| | (Billion Yuan) | | | | | |
| | LI | HI | LI | HI | LI | HI |
| 2002 | 1229.4 | 1918.8 | 39.1 | 60.9 | 12.1 | 13.1 |
| 2003 | 1465.3 | 2639.2 | 35.7 | 64.3 | 14.6 | 18.2 |
| 2004 | 1776.2 | 3704.3 | 32.4 | 67.6 | 14.7 | 18.2 |
| 2005 | 2058.5 | 4584.0 | 31.0 | 69.0 | 15.2 | 17.0 |
| 2006 | 2431.4 | 5543.8 | 30.5 | 69.5 | 13.6 | 17.9 |

Note: LI—Light Industry; HI—Heavy Industry;

Data source: Statistical Bulletin of National Economy and Social Development of China (2002 – 2006)

Table3: The Growth of Some Typical Products in HCI

| Products | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|----------------------------------|--------|--------|---------|--------|--------|--------|
| <i>Output in billion yuan</i> | | | | | | |
| Crude steel | 152660 | 181550 | 222336 | 272798 | 352390 | 422660 |
| Steel products | 157450 | 192180 | 2411194 | 297231 | 396920 | 473396 |
| Ten nonferrous metals | 85.6 | 10120 | 12050 | 14300 | 16350 | 19170 |
| Alumina | | | 6094 | 6990 | 8510 | 13700 |
| Caustic | | | 9453 | 10603 | 12640 | 15118 |
| Ethylene | 4810 | 5430 | 6118 | 6266 | 7560 | 9405 |
| Cement | 640 | 725 | 862 | 970 | 106 | 124 |
| Electr. generating equipment | 13390 | 21210 | 37006 | 71379 | 92000 | 110000 |
| Automobile | 23300 | 3251 | 4444 | 5074 | 5700 | 7279 |
| Car | 7040 | 1092 | 2020 | 2314 | 2770 | 3869 |
| Tractor | 38 | 45 | 48.8 | 98.3 | 162 | 199 |
| <i>Growth Rate in percentage</i> | | | | | | |
| Crude steel | 18.8 | 19.7 | 21.9 | 22.7 | 24.6 | 19.7 |
| Steel products | 19.8 | 19.6 | 25.3 | 23.3 | 24.1 | 25.3 |
| Ten nonferrous metals | 10.5 | 14.5 | 19.1 | 16.4 | 13.2 | 17.2 |
| Alumina | | | 11.2 | 14.7 | 21.9 | 59.4 |
| Caustic | | | 7.67 | 12.2 | 21.4 | 21.9 |
| Ethylene | 2.3 | 13.0 | 12.7 | 2.4 | 20.0 | 24.5 |
| Cement | 7.2 | 9.7 | 18.9 | 12.5 | 10 | 15.5 |
| Electr. generating equipment | 7.2 | 58.3 | 74.49 | 92.9 | 28.9 | 19.6 |
| Automobile | 12.8 | 38.8 | 36.7 | 14.2 | 12.1 | 27.6 |
| Car | 16.0 | 55.2 | 85.0 | 11.7 | 19.7 | 39.7 |
| Tractor | -7.8 | 18.9 | 7.49 | 101.4 | 42.7 | 22.0 |

Note: the unit of crude steel, steel products, nonferrous metals, alumina, caustic, ethylene is thousand ton; the unit of cement is million ton; the unit of electricity generating equipment is thousand KW; the unit of automobile is thousand. Data source: Statistical Bulletin of National Economy and Social Development of China (2002 – 2006)

Table 4: The Situation of Energy Consumption and the Growth of GDP from 1992 to 2005

| Year | The growth rate of energy consumption(%) | The growth rate of electricity consumption(%) | The growth rate of GDP(%) | Elasticity of energy consumption | Elasticity of electricity consumption |
|------|--|---|---------------------------------|--|---|
| 1990 | 1.8 | 6.2 | 3.8 | 0.47 | 1.63 |
| 1991 | 5.1 | 9.2 | 9.2 | 0.55 | 1.00 |
| 1992 | 5.2 | 11.5 | 14.2 | 0.37 | 0.81 |
| 1993 | 6.3 | 11.0 | 14.0 | 0.45 | 0.79 |
| 1994 | 5.8 | 9.9 | 13.1 | 0.44 | 0.76 |
| 1995 | 6.9 | 8.2 | 10.9 | 0.63 | 0.75 |
| 1996 | 5.9 | 7.4 | 10.0 | 0.59 | 0.74 |
| 1997 | -0.8 | 4.8 | 9.3 | N/A | 0.52 |
| 1998 | -4.1 | 2.8 | 7.8 | N/A | 0.36 |
| 1999 | 1.2 | 6.1 | 7.6 | 0.16 | 0.80 |
| 2000 | 3.5 | 9.5 | 8.4 | 0.42 | 1.13 |
| 2001 | 3.4 | 9.3 | 8.3 | 0.41 | 1.12 |
| 2002 | 6.0 | 11.8 | 9.1 | 0.66 | 1.30 |
| 2003 | 15.3 | 15.6 | 10.0 | 1.53 | 1.56 |
| 2004 | 16.1 | 15.4 | 10.1 | 1.59 | 1.52 |
| 2005 | 9.9 | 13.5 | 10.2 | 0.97 | 1.32 |

The data come from: Statistical Year Book of China (2006)

Table 5: The Predicted Data of GDP Growth Rates for Next Five Years

| Year | GDP Growth Rate (%) |
|------|-----------------------|
| 2008 | 11.5 |
| 2009 | 11.0 |
| 2010 | 10.9 |
| 2011 | 11.1 |
| 2012 | 11.0 |

Table 6: The Output of Recycling Aluminum, Original Aluminum and Aluminum

Consumption in 2003(unit: thousand ton)

| | Recycling aluminum | Original aluminum | Consumption | Ratio to total output (%) | Ratio to consumption (%) |
|----------|-----------------------|----------------------|-------------|---------------------------------|-----------------------------|
| The US | 2930.0 | 2704.5 | 5667.1 | 52.0 | 51.7% |
| China | 1450.0 | 5546.9 | 5194.1 | 20.7 | 27.9% |
| Japan | 1261.4 | 6.5 | 1952.3 | 99.5 | 64.6% |
| German | 680.4 | 660.8 | 1915.6 | 50.7 | 35.5% |
| Italy | 594.0 | 191.4 | 955.8 | 75.6 | 62.1% |
| Norway | 256.8 | 11924 | 246.0 | 17.7 | 104.4% |
| Brazil | 253.5 | 1380.8 | 588.6 | 15.5 | 43.1% |
| Spain | 242.6 | 389.1 | 595.6 | 38.4 | 40.7% |
| France | 240.1 | 443.1 | 753.8 | 35.1 | 31.9% |
| Mexico | 216.4 | 17.6 | 113.1 | 92.5 | 191.3% |
| England | 205.4 | 342.7 | 302.2 | 37.5 | 68.0% |
| Canada | 185.0 | 2791.9 | 696.6 | 6.2% | 26.6% |
| Australi | 127.2 | 1867.0 | 321.9 | 6.4% | 39.5% |

t

Data source: China Import and Export Chamber of Five Minerals and Chemical Industry

Table 7: A Comparison of the Growth Rates between National Revenue and GDP

| | Growth rates of revenue(%) | Growth rates of GDP(%) | Differences (%) |
|------|----------------------------|------------------------|-----------------|
| 2001 | 15.4 | 8.3 | 7.1 |
| 2002 | 14.9 | 9.1 | 5.8 |
| 2003 | 21.6 | 10.0 | 11.6 |
| 2004 | 19.9 | 10.1 | 9.8 |
| 2005 | 19.9 | 10.4 | 9.5 |
| 2006 | 21.6 | 10.7 | 10.9 |

Figure 1: The Comparison of Growth Situation between HCI (billion yuan)

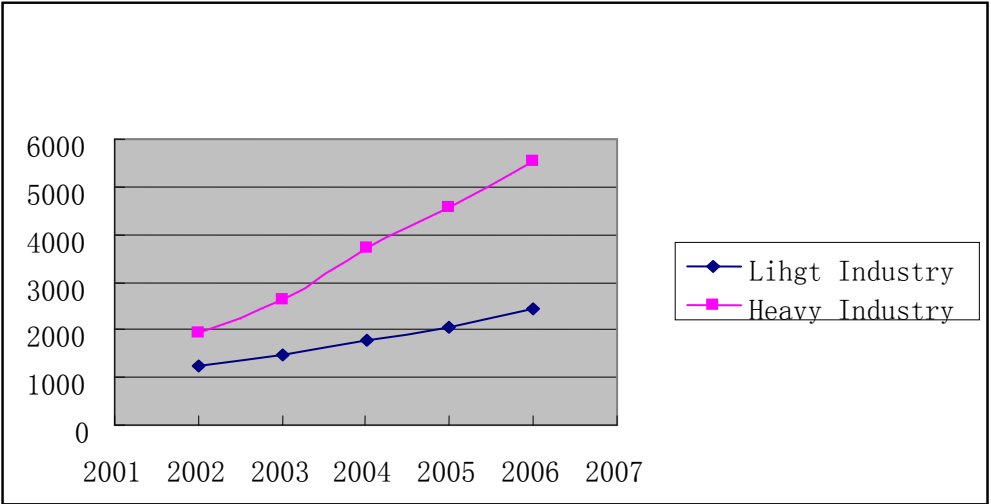


Figure 2: The comparison of the growth rate of GDP, energy and electricity consumption

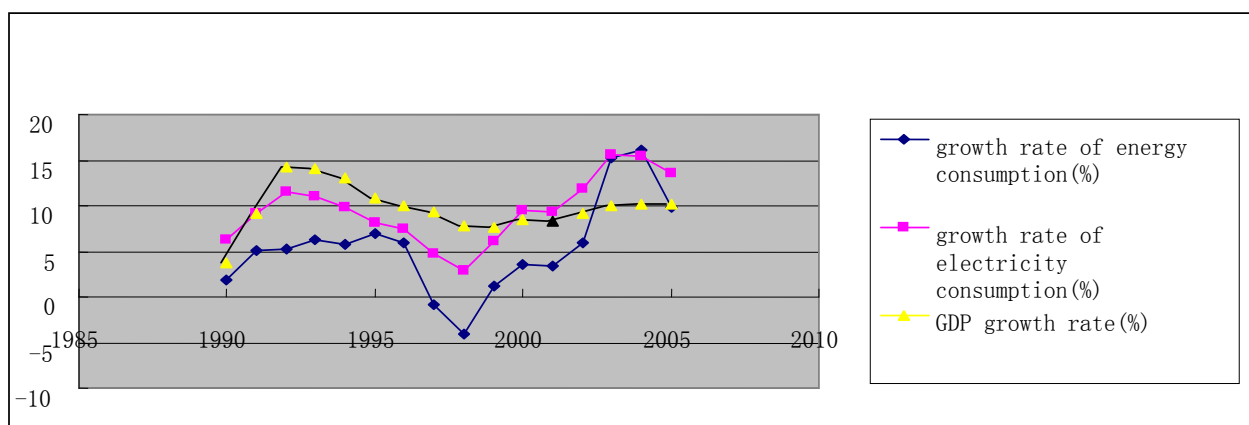


Figure 3: the Comparison of GDP Growth Rates between Predicted Data and Actual Data

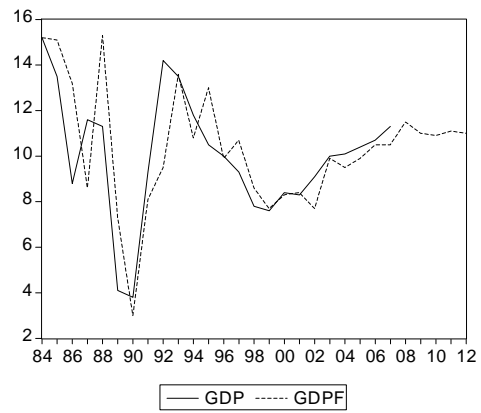
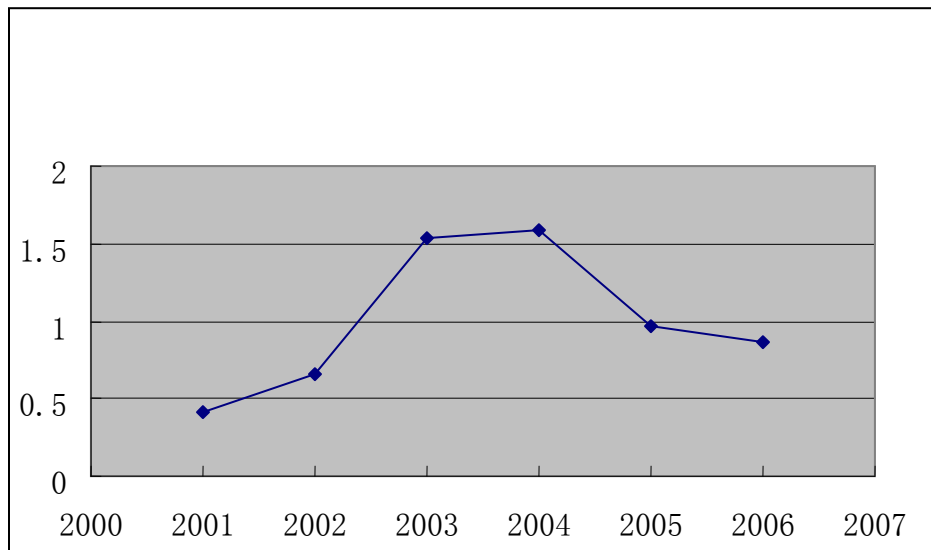


Fig 4: Elasticity Ratio of Energy Consumption (2001-2006)



Endnote

¹ The whole economy has been categorized by three industries: the primary industry includes agriculture; the second industry includes all nonagricultural production; and the third industry refers to service such as finance, marketing, education, medical, etc.