The 7th Keio and Tsinghua Student's Environmental Symposium

Importance of Energy Efficiency Improvement in China

～New proposal for automobile sector～

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Introduction

In recent years, constructions are seen all the day everywhere in Beijing in which the Summer Olympic Games will be held in 2008. Road is being repaired and new buildings are being constructed one after another. This situation proves Chinese rapid economic growth. Since the “reform opening policy” in 1978, China has continued economic growth steadily and now China has become the seventh largest GDP country in the world.

However, in China, some energy problems have become big issues. The present condition is that the energy supply cannot meet the expanding energy demand. With such expansion of the energy demand, the most important point to be focused on is the increase in the oil consumption. At last, the domestic oil consumption exceeded the domestic oil production in 1993, and China became a net oil importing country. And, the amount of consumption is also increasing steadily now. However, the amount of oil production in China has not been increased. So, China became a country, which has to import oil from abroad, especially from the Middle East. This is a very serious problem for Chinese energy security. In such situation, Chinese government says, “China has to act for energy saving.”

With this background, we decide to study about the measure for oil saving in China. In particular, we will observe the Chinese auto industry and the Chinese fuel economy standard. Now there are the "weight approach" and the "fleet average approach" which are taken as the oil saving measure. At first, we want to see which measure should be chosen in China and then, we want to suggest that how the measure should be introduced in the future in China as our proposal.

Chapter 1 Importance of oil, and Importance of oil saving in China

In this chapter, we want to describe why oil is important for economic growth and we want to describe the importance of oil saving in China. And then, we suggest that especially in which sector oil saving should be carried out.

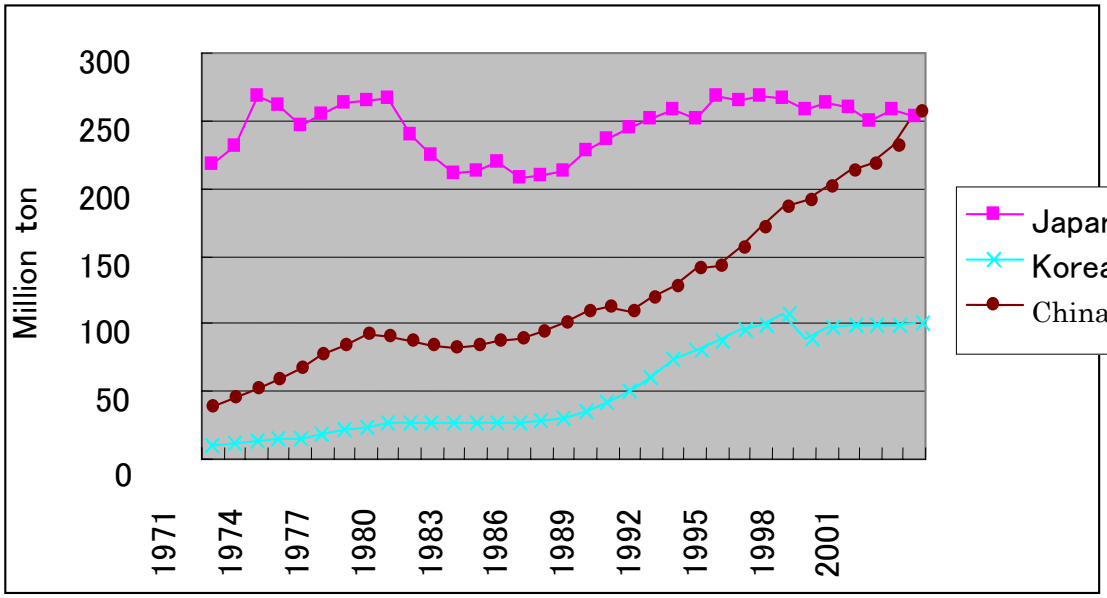
1－1　The usefulness and risk of oil

Oil is very useful energy. The use is various and it also changes into various things. It changes into gasoline, light oil, the materials such as plastic, chemical product and so on. Therefore, the higher economy grows, the more important oil becomes. On the other hand, oil has the big risk. Generally speaking, oil-extracting area is limited and most of oil is extracted in the Middle East now, which has the risk for stable oil supply. If once war occurs in the Middle East, supply may stop or decrease. It will have a big influence on economic activities. The higher China depends on imports from overseas for oil supply, the more the risk becomes. Then, what is the current Chinese oil situation like?

1－2　Rapid increase in oil consumption in China

Economic growth of China has been achieved with rapid speed since the “reform opening policy” in 1978. Please see the next figure.

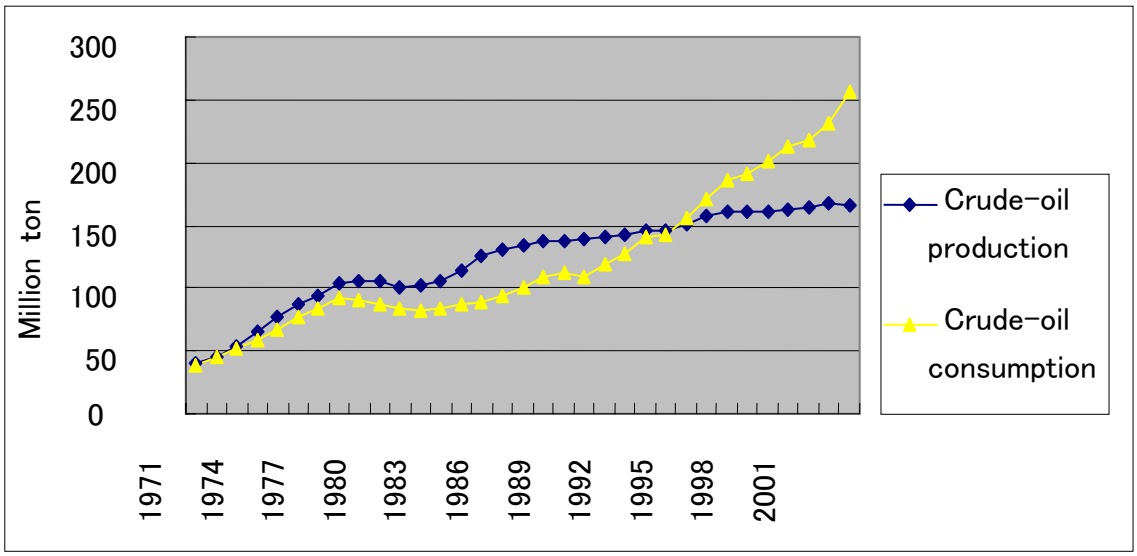
【Chart 1-1】Transition of the amount of crude-oil consumption in Japan, Korea and China from 1971 to 2003



Source : IEA DATABASES Key World Oil Statistics.

This figure shows the increase in oil consumption in Japan, Korea and China from 1971. You can understand the increase in oil consumption in China is great. And it finally exceeded that in Japan in 2003. Then, please see the following graph.

【Chart 1-2】Transition of the amount of crude-oil production and consumption in China



Source : IEA DATABASES Key World Oil Statistics.

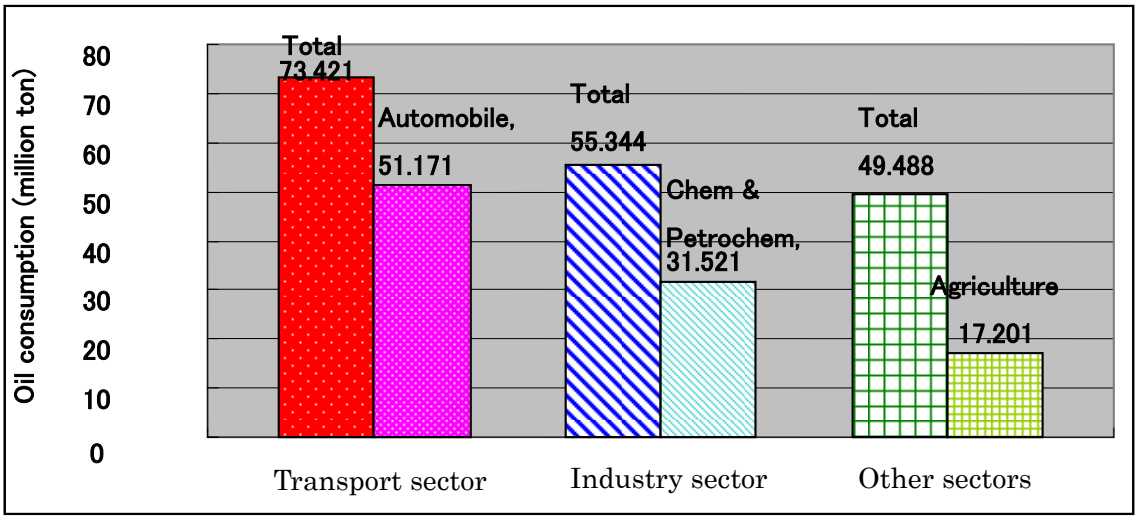
China was able to meet the domestic oil consumption by domestic oil production. However, finally the increasing oil consumption exceeded the production, and China became a net oil importing country in 1993 and a net crude oil importing country in 1996. This means that dependence on foreign countries becomes higher. If oil consumption continues to increase like this, China will have to import oil twice the amount of current Japanese oil consumption in 2030. The amount is so big. This will affect the economy of the oil importing country, not only China but other countries in the world. Therefore, it is thought that the measure for saving Chinese oil consumption is required. Next, we will see which factor especially needs oil saving.

1－3　Main factor of oil consumption and expanding automobile market in China.

Although China made oil consumption increase steadily in economic growth, what is the main oil consumption factor? I would like you to see the following tables. According to this table, in China, the transport sector consumes most oil, and it is understood that most of oil consumption in transport sector is occupied by that in automobile sector. It is predicted that the number of cars will also increase further from

now on. China auto market becomes the third market scale in the world now, and will exceed the Japan auto market in the future. If it really happens, the oil consumption in this sector will increase further. We thought that a certain measure should be taken especially in Chinese automobile sector.

【Chart 1-3】Breakdown of oil consumption by sector in China (2002)



Source：IEA Energy Balances Non-OECD Countries 2001-2002（2004）

Especially we will focus on the passenger cars. I would like you to see the following table.

【Chart 1-4】Number of all vehicles and share of passenger cars

	Number of all vehicles (1999)	
	Total (Million cars)	Share of passenger cars (%)
US	214.3	62.1%
Japan	71.7	71.3%
Germany	45.8	92.6%
Italy	35.5	90.2%
France	33.1	83.0%
Great Britain	30.9	89.0%
Spain	20.6	81.6%
China	16.1	53.1%
Korea	11.2	70.2%

Source：UFJ Institute（2002）

This table shows the share of passenger cars in all vehicles (trucks, buses, passenger cars and so on) in main countries. According to this, it turns out that the share of passenger cars become higher as the motorization promotes. Therefore, the share of passenger cars will be considered to become higher in the future in China as well. It means the number of passenger cars will increase further. So we focus on the measure for oil saving in passenger cars sector in China.

1－4　The factor of increase in oil consumption and measure in automobile section.

What are the factors, which affect the increase in oil consumption in automobile sector? If the distance traveled per car increases, oil consumption in automobile sector will also increase. Moreover, oil consumption will increase if the number of cars owned increases. Moreover, if actual drive conditions get worse or in-the-car equipment increases, oil consumption will also increase. However, regulating these factors is very difficult for China because regulating these factors is against the current Chinese auto policy which promotes the motorization and development of Chinese auto industry.

Energy efficiency improvement, in other words, fuel economy improvement can be achieved if a technology is improved or car weight becomes light. It is possible to save the oil consumption by improving fuel economy. And such measures are already taken in car producing countries. Therefore, for oil saving in automobile sector, fuel economy improvement seems to be the most effective.

In the next chapter, focusing on the fuel economy, we will see what kind of standard is set in China. Then we will introduce two approaches for improving fuel economy, and decide which.is more suitable for China.

Chapter2　Weight approach and fleet approach

2－1　New Auto Industrial Development Policy

In chapter 1, we insist the importance of improving fuel economy in China. This chapter will outline which approach should be adopted for improving fuel economy in China, and discuss whether the approach is useful or not. Then, does the Chinese government adopt any approach to improve fuel economy? The Chinese government adopted the New Auto Industrial Development Policy on the 1st, June, 2004, and this policy mentions improving fuel economy. According to New Auto Industrial Development Policy, fuel economy standard has been set for the first time in China and the standard will be introduced since 2005, and 2008. This policy also mentions that it is necessary to categorize all cars by car weight, and all cars' fuel economy must be improved above the standard level in each car weight class. Chart 2-1 shows the fuel economy standards in New Auto Industrial Development Policy.

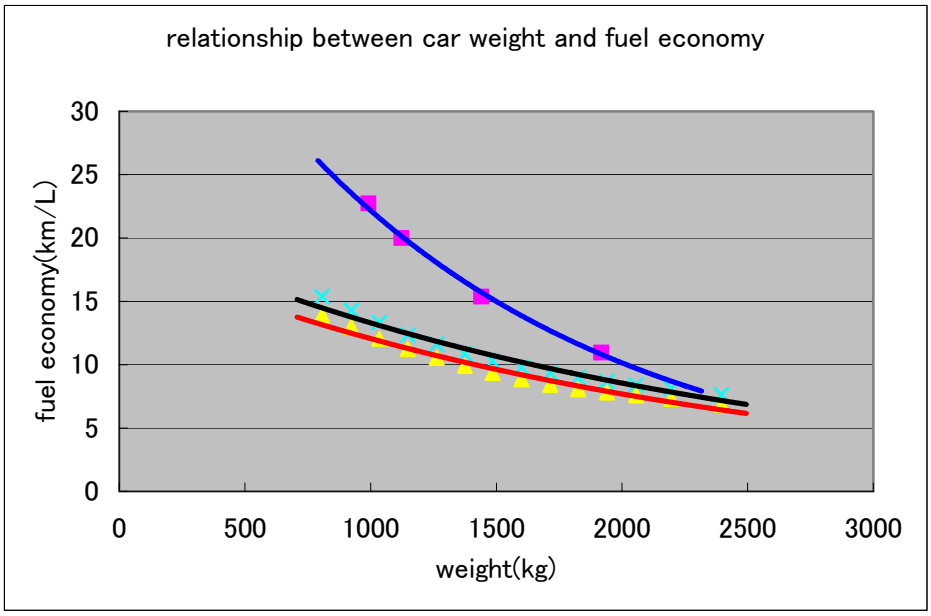
【Chart2-1】The fuel economy standard in New Auto Industrial Development Policy

weight(kg)	Normal car 2005 year standard (km/L)	Normal car 2008 year standard (Km/L)	AT installation car or 3 row sheets car 2005 year standard (km/L)	AT installation car or 3 row sheets car 2008 year standard (km/L)
Below 750	7.2	6.2	7.6	6.6
750～865	7.2	6.5	7.6	6.9
865～980	7.7	7	8.2	7.4
980～1090	8.3	7.5	8.8	8
1090～1205	8.9	8.1	9.4	8.6
1205～1320	9.5	8.6	10.1	9.1
1320～1430	10.1	9.2	10.7	9.8
1430～1540	10.7	9.7	11.3	10.3
1540～1660	11.3	10.2	12	10.8
1660～1770	11.9	10.7	12.6	11.3
1770～1880	12.4	11.1	13.1	11.8
1880～2000	12.8	11.5	13.26	12.2
2000～2110	13.2	11.9	14	12.6
2110～2280	13.7	12.3	14.5	13
2280～2510	14.6	13.1	15.5	13.9
Over 2510	15.5	13.9	16.4	14.7

Reference: China auto industry 2004-2005(2004)

Then, how severe is the fuel economy standard in the New Auto Industrial Development Policy? We want to compare the fuel economy of the cars with the fuel economy of the most efficient cars lately produced in China. Please look at chart 2-2. The blue line is the fuel economy of the most efficient cars lately produced in China, and black line is the fuel economy standard which will be introduced in 2008, and red line is the fuel economy standard which will be introduced in 2005.

【Chart2-2】Fuel economy standard in China



Reference: China auto industry yearbook(2003), China auto industry 2004-2005(2004)

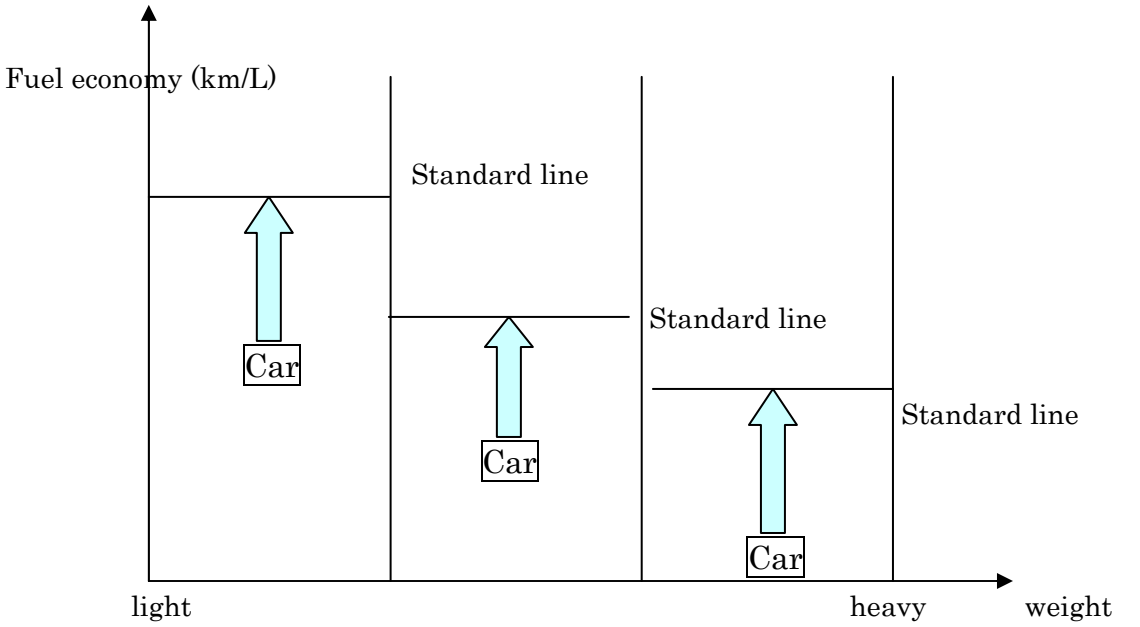
Chart2-2 shows that how low the fuel economy standard in New Auto Industrial Development Policy is. Considering that energy consumptions will increase rapidly with the increase in number of cars, it seems to be indispensable to improve fuel economy in China. Even if the fuel economy standard in New Auto Industrial Development Policy is introduced, the target[1] of saving much energy consumption will not be achieved. We want to consider approaches to improve fuel economy taken in the world, and propose the most suitable approach for China.

[1] Above mentioned in chapter 1, China is faced to be the tight supply-demand situation for energy, and so the consciousness to energy efficiency improvement has also been increasing in China. The tenth five-year plan includes the necessity of energy efficiency improvement, therefore in the Energy medium and long-term plan until 2020, and it is the first priority in China to improve energy efficiency.

2－2　Two approaches

What kinds of approaches are introduced to improve fuel economy in the world? Today, there are two types of approaches to improve fuel economy in the world[2]. One is the categorizing car by the car weight, and each car's fuel economy must be improved in each weight class (we call it weight approach). Weight approach is introduced in China in New Auto Industrial Development Policy and in Japan in Energy Conservation Law[3].

【Chart2-3】The image of weight approach

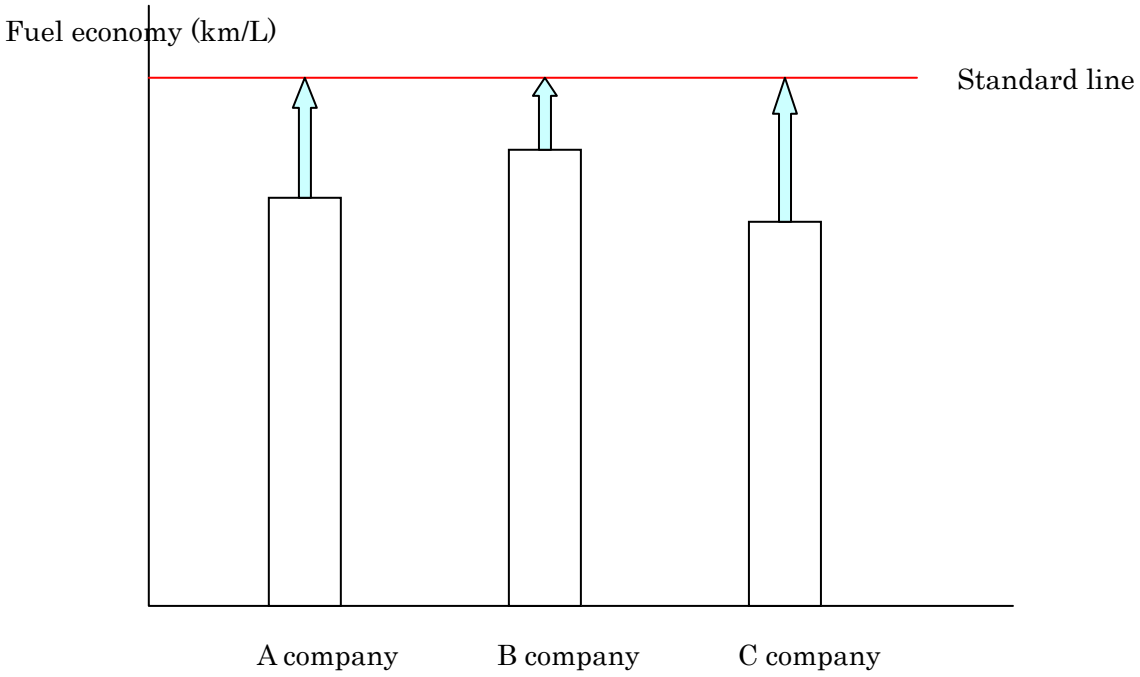


Reference: The Energy Conservation Center, Japan (1994)

The other is that the average fuel economies of all the cars produced by each manufacture must be improved to achieve the standard level (we call it fleet approach). Fleet approach was introduced in the United States as Corporate Average Fuel Economy Standards (we call it CAFÉ standard)[4].

[2] Strictly speaking, there is the labeling institution in European Union. But this is the incentive for consumers to buy environmental cars, and so this policy cannot work for carmakers to make energy efficiency cars.
[3] In Japan, after the oil crisis, it was recognized the necessity of energy efficiency, and Energy Conservation Law was introduced in 1979(following we call old law of energy efficiency improvement). United Nations Framework Convention on Climate Change the 3rd Conference of the Parties (COP3) in 1997 was held, and in 1998 old law of energy efficiency improvement was reconsidered and the law was revised.
[4] In the United States CAFÉ standard introduced by the effect of oil crises. In this paper, we can not consider the trade problem because of deviating from main issue.

【Chart2-4】The image of fleet approach



Then, which approach should be introduced in China, weight approach or fleet approach? We want to compare the effect of the former Energy Conservation Law in Japan with the effect of CAFÉ standard in US, and consider four criteria such as oil saving, technology development, equity, and feasibility.

Oil saving and technology

If weight approach is introduced, what is the effect of it on oil saving and technology development? In Japan weight approach was introduced in the former Energy Conservation Law in 1979. This law suggested that fuel economy had to be achieved at the standard level until 1985. Chart 2-5 shows that the change in fuel economy from 1979 to 1985.

【Chart2-5】Fuel economy improvement by the former Energy Conservation Law in Japan

year	10 mode fuel economy[5] (km/L)
1979	11.6
1980	12
1981	12.3
1982	13
1983	12.8
1984	12.8
1985	12.4

Reference: The Energy Conservation Center, Japan(1994)

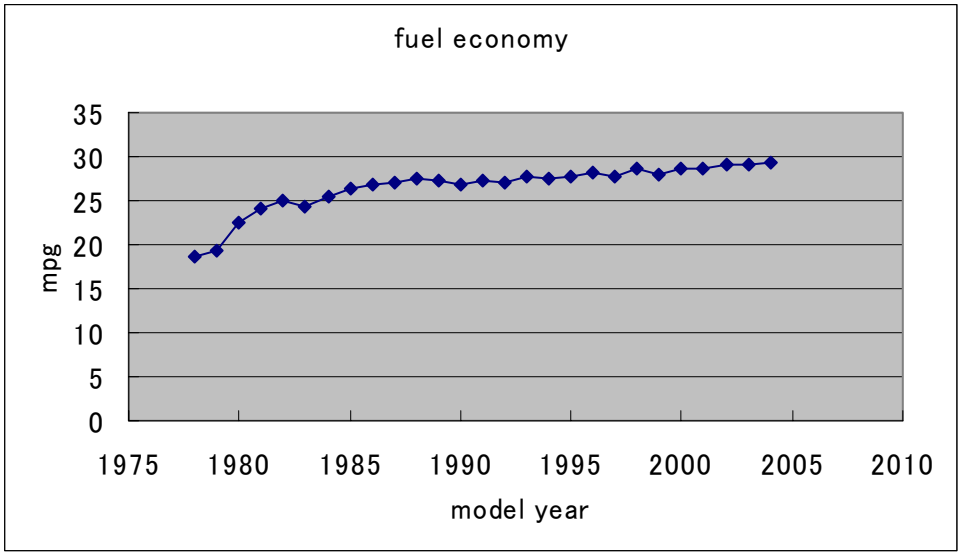
What is the factor of fuel economy improvement by the former Energy Conservation Law? In general, in order to improve fuel economy, it is important to lighten car's weight and to improve fuel economy technology[6]. In the former Energy Conservation Law, the fuel economy of each car in each weight class must be improved and car manufacturers had no incentive to shift car production from heavy weight cars to lighter weight cars. So by developing the fuel economy technology, improvement of fuel economy could be achieved. Above mentioned, by introducing weight approach, saving oil consumption and technology development could be achieved.

Then, if introducing fleet approach, what kinds of effect can be seen? In the United States, CAFÉ standard, which is fleet approach, was introduced in 1975. Chart2-6 shows that fuel economy improved gradually.

[5] 10 mode run is the measurement mode of the mpg which took in 10 pattern run supposing the run in cities, such as a stop of a car, acceleration, a stable run, a slowdown, and a stop. In addition, 10 and 15 mode run which mode-used the run of a total of 15 patterns of the run in a city and a high-speed run are adopted as measurement mode of mpg in 1991 and afterwards.

[6]According to The Energy Conservation Center, Japan (2004), for fuel economy improvement, "the device which raises reduction and the fuel economy of mechanical energy losses (wear loss etc.) (Electronic control fuel injection equipment etc.) To make the car weight lighter is important, and is supposed "Although it can be coped with about reduction and lightweight-using of mechanical energy loss, without needing many additional charges, about the addition of a device, the part serves as cost."

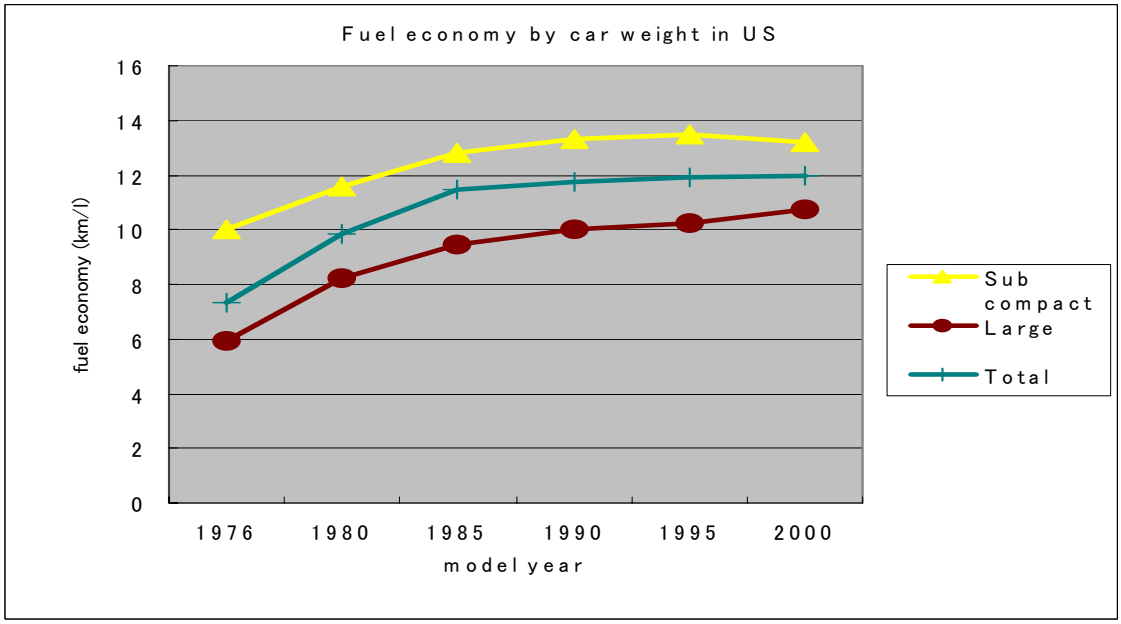
【Chart2-6】Fuel economy improvement by CAFÉ standard



Reference: U.S. Department of Transportation (2004)

Then what is the main factor of improving fuel economy by CAFÉ standard? Chart 2-7 shows that change in fuel economy in each weight class. In this chart it can be seen that fuel economy of each weight class was improved and that technology development happened.

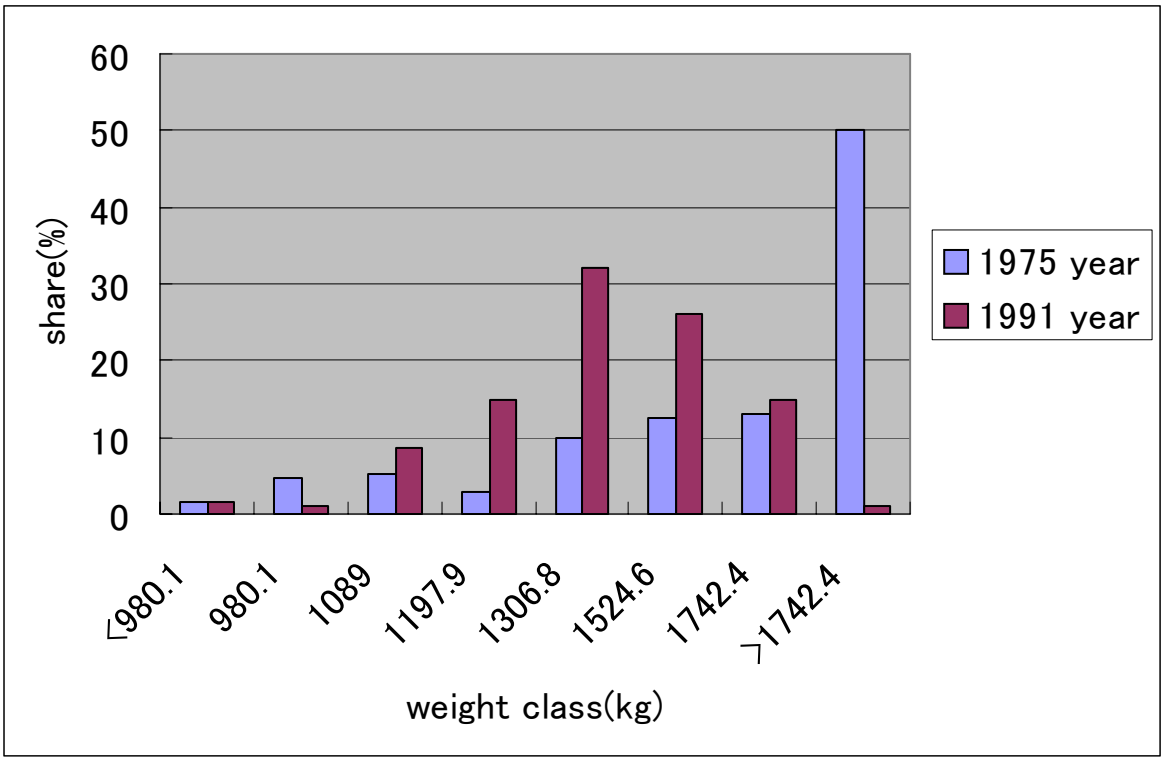
【Chart2-7】Fuel economy improvement by CAFÉ standard



Reference：Oak Ridge National Laboratory(2001)

By having introduced CAFÉ approach, that technology development could be promoted and that car weight shifted to lighter brought the improvement fuel economy, too. Chart 2-8 shows the share of each weight class in 1975 and in 1991. In this chart, it can be seen that car weight shift brought fuel economy improvement.

【Chart2-8】Car weight change by CAFÉ standard



Reference: U.S. Department of Transportation (1991)

Above mentioned, it can be said that by introducing fleet approach, saving oil consumption[7] and technology development can be promoted. Namely, considering oil saving and technology development, both weight approach and fleet approach can be achieved. How about equity and feasibility?

Equity and feasibility

In the case that Chinese government chooses fleet approach to improve fuel economy, carmakers, which make lightweight cars mainly, will not effort to improve fuel economy. In this case they have no incentive to improve fuel economy, and so the policy

[7] In the United States, introducing CAFÉ standard in the case of passenger cars energy consumption could be restrained in spite of growing the distance of car running and growing car units. In 1975 gasoline consumption was 74,140million gallons, but in 1999 gasoline consumption was 73,160 million gallons. (Oak Ridge National Laboratory (2001))

cannot work well. But on the other hand, carmakers, which make heavy weight cars mainly, will make a great effort to achieve the standard level . Considering these cases, there might be a problem in terms of equity between auto companies. However, why does CAFÉ standard work well in the United States? In the United States, Ford, General Motors, and Daimler Chrysler occupied market share at that time. So, it was required to improve fuel economy at the same degree for each company. But on the other hand, The situation of China is different from that of the United States. In China over 100 companies exist. Therefore carmakers, which make only light cars[8], which make only heavy cars[9], and which make all weight class cars[10], exist in China. Considering this situation, there might be a problem occurred in terms of equity between auto companies by introducing fleet approach. Moreover, the inequity will lead to fall feasibility, because carmakers will reject fleet approach. Above mentioned, it might be difficult for China to introduce fleet approach in terms of equity and feasibility.

Then, does China accept weight approach in terms of equity and feasibility? Weight approach can affect all cars at the same degree, and equity can be achieved so carmakers will not oppose against the weight approach. Above mentioned, in terms of oil saving and technology development both of approaches can be accepted, however, in terms of equity and feasibility China will not accept fleet approach. Therefore, it can be considered that Chinese government should introduce weight approach.

[8] Kishu kouten, Changan Suzuki etc. correspond to it.
[9] Beijing Jeep etc. correspond to it.
[10] The first automobile, the Shanghai automobile and tonpu automobile called "Big3" correspond to it.

Chapter3 Chinese fuel economy standard and Top Runner Approach

In Chapter2, we compared weight approach with fleet approach, and we figured out that weight approach is more suitable for China. In Chapter3, we will compare two weight approaches; Chinese fuel economy standard and Top Runner approach, and we will decide which approach is more suitable for China.

3－1 What is Top Runner Approach?

In this section, we will explain Top Runner approach. Top runner approach is not introduced in other countries in the world except Japan. We will explain about Japanese situation for a while. Japan relies on imports for most of our energy consumption, making energy supply especially fragile. Japan experienced the oil crisis twice in 1973 and 1979. Thus, from the view point of energy security in Japan, saving energy and using it efficiently are very important policy targets. So, the "Law concerning the Rational Use of Energy" (Energy Conservation Law) was adopted in 1979. In the 1990s, global warming issues became very serious problems, raising the importance of energy conservation to prevent global warming. The "Joint Meeting of the Councils concerned for Domestic Policies concerning Global Warming Issues" held in 1997 stated public lifestyle improvements and obligations towards energy saving, and proposed the "obligation to improve the energy efficiency of vehicles and consumer equipments above the highest level of products that are already sold in the market". Based on this proposal, Japanese government revised the Energy Conservation Law in 1998, and established tougher energy consumption efficiency standards on equipments by adopting the "Top Runner Approach"[11]. Until 2004, the Top Runner standards have been established for 18 items[12]. The standards of "Top Runner Approach" require that

[11] Energy conservation Law article18:For some machinery or equipment consuming energy, such as motor vehicles (limited to those motor vehicles stipulated by a government ordinance as especially requiring the improvement of performance as provided in the preceding Article) or other machinery or equipment used in large quantities in Japan and consuming a considerable amount of energy in their operation which are stipulated by a government ordinance as especially requiring the improvement of performance (hereinafter referred to as "Designated Machinery"), the Minister of Ministry of Economy, Trade and Industry (the Minister of Ministry of Economy, Trade and Industry and the Minister of Ministry of Land, Infrastructure and Transport in the case of motor vehicles; hereinafter the same in this chapter and Paragraph 5 of Article 25) shall determine and make public the matters to be used as standards for judgment by Manufacturers, etc. with regard to the improvement of such performance for each Designated Machinery.
The matters to be used as standards for judgment as provided in the preceding paragraph shall be determined in consideration of the performance of such Designated Machinery whose performance as provided in the preceding Article is the best, of future prospects for the technical development of such Designated Machinery and of other circumstances, and shall be amended as needed according to changes in these circumstances.

[12] The 18 items are as follows; Passenger Vehicles, Air Conditioners, Fluorescent Lights, TV Sets, Video Cassette Recorders, Copying Machines, Computers, Magnetic Disk Units, Freight Vehicles, Electric Refrigerators/Freezers, Space Heaters, Gas Cooking Appliances, Gas Water Heaters, Oil

all targeted equipment meet the target standard as a weighted average per category. Regarding the concept of Top Runner, please refer to Box1.

Then we want to outline passenger vehicles. Vehicles weight, as shown in chart3-1, is divided into nine stages. Target fiscal year of gasoline passenger vehicles is till 2010, and target fiscal year of diesel passenger vehicles is till 2005. With this target, 23% energy efficiency improvement is expected in gasoline passenger vehicles, and 15% energy efficiency improvement is expected in diesel passenger vehicles (1995 actual-result ratio).

【Chart3-1】 Vehicle fuel economy standard of Top Runner Approach

Category	Fuel economy standard of gasoline passenger vehicles	Fuel economy standard of diesel passenger vehicles
Vehicles weighing less than703kg	21.2	18.9
Vehicles weighing 703kg or more and up to 828kg	18.8	18.9
Vehicles weighing 828kg or more and up to 1016kg	17.9	18.9
Vehicles weighing 1016kg or more and up to 1266kg	16	16.2
Vehicles weighing 1266kg or more and up to 1516kg	13	13.2
Vehicles weighing 1516kg or more and up to 1766kg	10.5	11.9
Vehicles weighing 1766kg or more and up to 2016kg	8.9	10.8
Vehicles weighing 2016kg or more and up to 2266kg	7.8	9.8
Vehicles weighing 2266kg	6.4	8.7

Source: Energy Conservation Center HP

In this paper, in comparing Top Runner Approach with Chinese fuel economy standard, we assume Top Runner Approach's fuel economy standard is set at the most efficient fuel economy in Chinese automobile market in 2003.

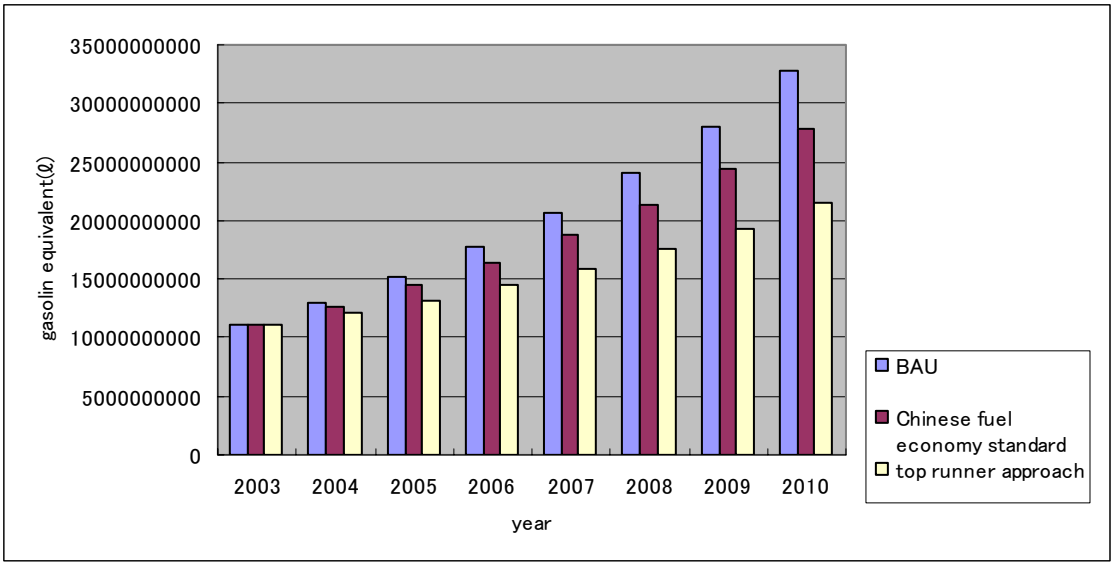
3－2 Top Runner Approach vs Chinese fuel economy standard

This section will compare Top Runner Approach with Chinese fuel economy standard in terms of 4 points. Those 4 points are energy security, environment, economy meaning effect of oil saving and global competition. First of all, we will discuss the effect of oil saving.

Water Heaters, Electric Toilet Seats, Vending Machines, Transformers

The way of trial calculation of oil saving is not related to the point of this section, so we will discuss it in ANNEX. This section just describes its result. Chart 3-2 shows the amount of the energy consumption of 3 cases. The first one is the case introducing no fuel economy standard, the second one is the case introducing Chinese fuel economy standard, and the third one is the case introducing Top Runner Approach. This chart illustrates the case introducing Top Runner Approach can save more oil than the case introducing Chinese fuel economy standard. The difference in each amount is quite obvious. For 8 years from 2003 to 2010, China can save 4 million t[13] oil by introducing Chinese fuel economy standard. On the other hand, China can save 10 million t[14] oil by introducing Top Runner Approach.

【Chart 3-2】 Energy consumption of 3 cases



Source: Made by author

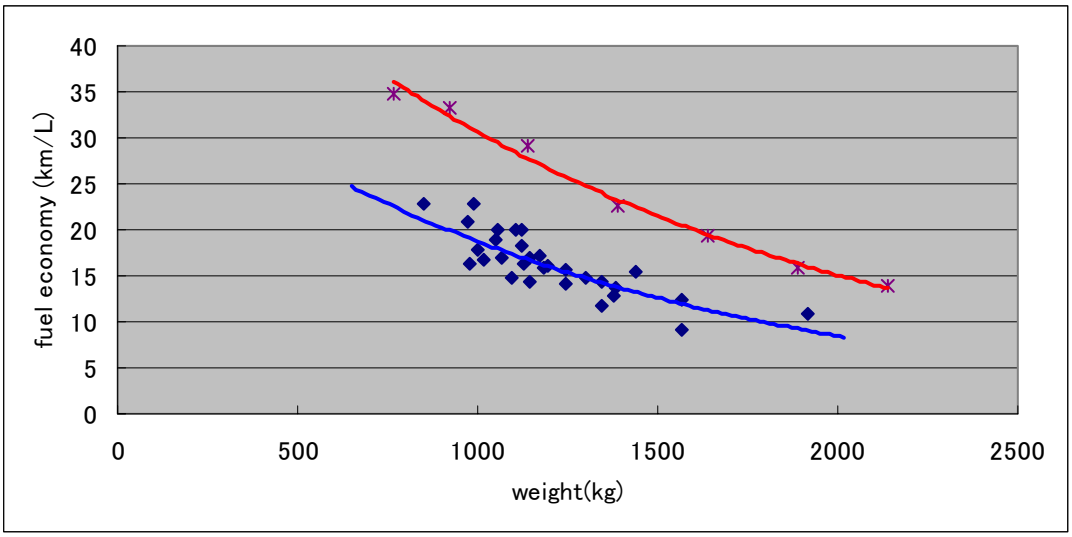
How about the energy security, environment, and economy which are affected by oil saving? As we referred before, saving oil leads to decreasing demand of energy, and solving the shortage of energy demand – supply problem, so saving oil can improve energy security. Saving oil can decrease energy origin CO2, so it can improve environment as well. Saving oil leads to saving fuel cost and can improve economy. Top Runner Approach can save more oil than Chinese fuel economy standard, so it means that Top Runner Approach has much better effect on environment, energy security, and economic growth.

[13] Refer to ANNEX Ⅱ
[14] Refer to ANNEXⅢ

Finally, how about global competition? China became a member of World Trade Organization (WTO) in 2002. By affiliation to WTO, China can receive most-favored-nation treatment [15] and member national treatment [16] and so on. Most-favored-nation treatment is when a certain country can receive advantageous treatment of low import duties from a member nation; other member nations can receive the same treatment. The national treatment is that once foreign products enter at home, they are not discriminated from domestic products in terms of customs duty and so on. With the national treatment, most-favored-nation treatment is the basis of exports of domestic products. As a result, the China industry that had been kept by various regulations such as a customs duty began to be exposed to global competition. It is not an exception in the auto industry. Various regulations, which had surrounded the Chinese automobile market, also began to be eased and abolished[17]. By abolition of such regulations the better fuel economy cars with low cost will be imported to China. In addition to those abolition, there is a view that the limit of the rate of investment which foreign company can invest only 50% to joint ventured company is abolished[18]. If such regulations are eased and abolished, and the regulation of investment rate is abolished, there is a possibility that Chinese automobile company of national capital will disappear. What is the key for automobile company of national capital to survive from now on? First of all, see a chart 3-3.

[15] GATT article1, 13,17
[16] GATT article3
[17] The following 4 points are mentioned. First point is reducing a customs duty gradually. Specifically, 80%(3000cc of displacement volume)- 100% (over 3000cc of displacement volume) of customs duty on passenger vehicles will be made 25% until July 1, 2006. The parts of customs duty also made 10% or less from 28% until July 1, 2006. Second point is raising the amount of province investment approval money from 15 thousand US $ to 3 million US$ after affiliation to WTO. Third point is type of a car restriction of investment abolished within two years. Fourth point is the funding interest to an engine joint ventured pulled up from 49% to 100%.
[18] FOURIN「Chinese automobile market 2004－2005」 p 110

【Chart 3-3】 Fuel economies of the newest cars in Japan and China



source: Made by author based on the date of "China automobile yearbook", "automobile fuel economy list"

Chart3-3 shows the fuel economy of the newest cars in Japan and China[19]. Fuel economy of Chinese cars is much worse than that of Japanese cars. If the bad fuel economy cars continue to exist, and technology of Chinese automobile industry is not improved, the Chinese automobile market will be replaced by the foreign companies which make better fuel economy cars with low price. It is because that for Chinese consumer, fuel economy and price is important element in purchasing a car[20], Chinese consumer purchases a car which has better fuel economy with low price. Therefore, it seems that China should introduce Top Runner Approach, and improve technology of Chinese automobile sector. Furthermore, Top Runner Approach is in accord with the goal of New auto policy in China because the goal of new auto policy is that automobile industry become core industry[21] in China. In terms of global competition, Top Runner Approach is better than Chinese fuel economy standard.

Accordingly, in terms of energy security, environment, economy, and global competition, Top Runner Approach seems to be better than Chinese fuel economy standard[22]. So, we can conclude China should introduce Top Runner Approach.

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[19] In Japanese fuel economy standard expressed as a mileage per liter when driven in 10-15 mode. 10-15 mode is city driving and highway driving model. On the other hand Chinese fuel economy standard expressed as a mileage per liter when driven on pavement street by fixed street. So, in this graph Japanese fuel economy adopt Chinese fuel economy measure.

[20] 「The china automobile news」(2003.7)

[21] preface of new automobile policy

[22] This paper doesn't compare Top Runner approach and Chinese fuel economy standard in terms of

BOX 1　Concept of Top Runner Approach

(1)Target items

Target items that are used in large quantities in Japan, and consume substantial quantities of energy use, and particularly required to improve energy consumption efficiency.

(2)Categorization and Target year

Categorization means that it is possible to aim at the same energy efficiency, and the classification of a suitable basic index is said. Target year sets for every apparatus around 4-8 years considering product development period, and the prospect of future technical progress.

(3)Evaluation methods

Evaluation methods is that weight averages for every classification Using the weighted average method enables manufactures to enjoy flexibility because manufactures can put equipment whose levels are lower than the target standard value on the market by shipping many products that far surpass criteria. So, manufactures receive incentives to offer products with high- energy consumption efficiency on the market, sot further increases in the efficiency of products can be exposed.

(4)Measuring Energy consumption efficiency

Items whose energy consumption efficiency measurement methods have already been decided under International Standards and Japanese Industrial Standards(JIS),etc, shall continue to be governed by such criteria as a general rule.

(5)Display

Energy consumption efficiency values are displayed in catalogues and so forth in the following two ways so that consumers can consider energy consumption efficiency as a purchasing factor.

(1) Display of numeric values as a legal obligation

cost. Because, the cost of R&D cost improving fuel economy unknown. But if it thinks in the log run, Top Runner approach is better than Chinese fuel economy standard. First it sees from company side, low cost and low price car will dominate Chinese market and Chinese company will weaken, so companies improve technology even if companies spend high R&D cost. So, from company side Top Runner Approach has merit. On the other hand, it sees from consumer side, car price will rise by R&D cost, but low fuel economy car can float fuel cost, so in the ling run consumer can get benefit. In addition, scale of economics work and transfer price imputation is also comparatively small. In the long run, from company and consumer side, Top Runner approach is better than Chinese fuel economy standard in terms of cost.

(2) Voluntary labeling system

Conclusion

This paper has discussed about the importance of energy efficiency focusing on automobile sector which consumes the most amount of oil in China. Still now Chinese economic growth is continuing at high speed. According to the announcement of the World Bank, the economic growth rate of China in 2004 is predicted to be 8.8%[23]. World Bank analyzes that China continues to maintain such high growth rate[24]. In addition, Chinese population continues to grow[25]. So, energy consumption will continue to increase in the future. Especially, the growth of oil consumption in recent years is frightful. Although China is greatest oil producing countries in Asia, now it has become a net oil importing country[26]. It means unless China takes a certain energy policy, China can not attain sustainable economic growth.

Then we have discussed the usefulness of improving energy efficiency which is one of the energy policies. Energy efficiency yields a merit in three fields. The first field is energy security. Oil can be especially vulnerable in energy security. Once OPEC was strong, and had dominated oil market by deciding the price and amount of supply. But OPEC has become weak, and on the other hand, the futures market of oil has grown rapidly in recent 20 years[27]. As a result, oil price is influenced by speculative factor, and oil is vulnerable in terms of energy security. So, in order to avoid this situation, decreasing energy consumption is important. Thus, energy efficiency improvement that leads to energy saving improves energy security.

The second field is environment. When using energy, CO2 emission is not avoidable. In addition, CO2 emission is thought to be one of the causes of global warming. China doesn't take a cap of CO2 emission reduction. Global warming may lead to extreme weather, the rise of sea level and so on, so it is a serious problem for China. To avoid this situation is important. Thus improving energy efficiency that leads to CO2 emission reduction will improve environment.

The third field is economy. Energy efficiency leads to reducing energy consumption which means saving fuel cost. Thus improving energy efficiency that leads to saving fuel cost will lead to economic growth.

Improving energy efficiency yields good impact on energy security, environment, and economy, and it leads to sustainable development. We wish this paper gives the

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[23] World Development Indicators2004
[24] World Development Indicators2004 announce Chinese economic growth will be 7.8% in 2005, and will be 7% in 2006
[25] UNEP announce the number of Chinese population will be 1450521000. The number of Chinese population is 1284530000. So, China increases by 200 million people in 30 years.
[26] From 1993
[27] In 1983 crude oil listed for the first time in NYMEX.

recognition of the importance of energy saving in China, and becomes a help to sustainable development by solving energy supply- demand problem.

ANNEX

ANNEX I ：Proof of vehicle energy consumption change factor

Vehicle energy consumption is illustrated as follows:

Energy consumption = (total distance traveled) × (actual fuel consumption)

=(average distance traveled per car× number of car ownership)

×(actual run factor×theoretical fuel consumption)

From the above formula, energy consumption change factor is analyzed as follows[28].

Δ Energy consumption = Δ total distance traveled×actual fuel consumption

+total distance traveled× Δ actual fuel consumption

+ Δ total distance traveled× Δ actual fuel consumption

= (Δ total distance traveled×actual fuel consumption

+1/2 Δ total distance traveled× Δ actual fuel consumption)

+(total distance traveled× Δ actual fuel consumption

+1/2 Δ total distance traveled× Δ actual fuel consumption)[29]

So, term1 in formula1shows total distance traveled change factor and term2 shows actual fuel consumption change factor.

And other factors are analyzed as follows.

Δ total distance traveled= Δ average distance traveled per car

×number of car ownership

+average distance traveled per car

× Δ number of car ownership

+ Δ average distance traveled per car

× Δ number of car ownership

= (Δ average distance traveled per car

×number of car ownership

+1/2 Δ average distance traveled per car

× Δ number of car ownership)

+(average distance traveled per car

× Δ number of car ownership

+1/2 Δ average distance traveled per car

× Δ number of car ownership)[30]

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[28] Change factor of two changeable numbers such as XY is generally analyzed as follows. Δ(XY)=(X+ΔX)(Y+ΔY)−XY=ΔXY+ΔYX+ΔXΔY=(ΔX+1/2ΔXΔY)+(ΔY+1/2ΔXΔY) So term1 in this formula is the change factor of X and term2 is the change factor of Y.

[29] say formula1

[30] say formula2

So term1 in formula2 shows change factor of average distance traveled per car and term2 shows change factor of number of car ownership.

$$\begin{aligned}\Delta\text{actual fuel consumption} = {} & \Delta\text{actual run coefficient} \times \text{theoretical fuel consumption} \\ & + \text{actual run coefficient} \times \Delta\text{theoretical fuel consumption} \\ & + \Delta\text{actual run coefficient} \times \Delta\text{theoretical fuel consumption} \\ = {} & (\Delta\text{actual run coefficient} \times \text{theoretical fuel consumption} \\ & + 1/2\,\Delta\text{actual run coefficient} \times \Delta\text{theoretical fuel consumption}) \\ & + (\text{actual run coefficient} \times \Delta\text{theoretical fuel consumption} \\ & + 1/2\ \Delta\ \text{actual run coefficient} \times \Delta\ \text{theoretical fuel consumption})\end{aligned}$$

[31]

So term1 in formula3 shows actual run coefficient change factor and term2 shows theoretical fuel consumption change factor.

Therefore energy consumption change factor is composed of total distance traveled change factor and actual fuel consumption change factor. And total distance traveled change factor is composed of change factor of average distance traveled per car and change factor of number of car ownership. And actual fuel consumption change factor is composed of actual run coefficient change factor and theoretical fuel consumption change factor.

[31] say formula3

ANNEX Ⅱ ：Trial calculation of oil saving potentials

Trial calculation of oil saving is introduced here. Hypotheses in this calculation are set as follows:

hypothesis 1 ：all the cars existed in 2003 will be disused after 2010[32].

hypothesis 2：the cars shipped after 2003 will never be disused until 2010.

hypothesis 3：average distance traveled per car will not change every year.

hypothesis 4：actual driving conditions will not change.

hypothesis 5：the ratio of cars in each car weight class will not change.

hypothesis 6：unless the fuel economy standard is set, fuel economy will not change.

hypothesis 7：fuel economy improvement rate is stable.

Our trial calculation of oil saving is based on these hypotheses.

We compare the energy consumption in X(year) in case that fuel economy is stable after 2003, and the energy consumption in X in case that fuel economy is improved by introducing the fuel economy standards, and we define the difference between them as the total oil saving. Then let us see the way of our trial calculation of oil saving on the basis of oil saving in 2004. Energy consumption in 2004 is illustrated as follows:

Energy consumption in 2004= fuel economy in 2003
×number of cars owned in 2003
×average distance traveled per car in 2003[33]
＋number of shipped cars in 2004
×fuel economy in 2004
×X

Oil saving in 2004 is illustrated as follows:

oil saving in 2004 = fuel consumption in 2003×number of cars owned in 2004×X
－(fuel economy in 2003×number of cars owned in 2003×X
＋number of shipped cars in 2004×fuel economy in 2004×X)

From the hypothesis 1 , we can illustrate

number of cars owned in 2004＝number of cars owned in 2003
＋number of shipped cars in 2004

So,

number of cars owned in 2004

[32] We know there is a concept of "Weibull Distribution", however, we could not get the official data of average survival period of cars in China so we assume the survival rate to be 100% in this trial calculation.

[33] Put it that average distance traveled per car in 2003 is X. From the hypothesis 3 , we put it that average distance traveled per car in 2004 is also X.

＝fuel economy in 2003
×(number of cars owned in 2003＋number of shipped cars in 2004)×X
－(fuel economy in 2003×number of cars owned in 2003×X
＋fuel economy in 2004×number of shipped cars in 2004×X)
= (fuel economy in 2003－fuel economy in 2004)
×number of shipped cars in 2004×X

Then let us see energy consumption in 2005. First, energy consumption in 2005 is illustrated as follows:

energy consumption in 2005
＝fuel economy in 2003×number of cars owned in 2003×X
＋fuel economy in 2004×number of shipped cars in 2004×X
＋fuel economy in 2005×number of shipped cars in 2005×X

oil saving in 2005 is illustrated as follows:

oil savings in 2005
＝fuel economy in 2003×number of shipped cars in 2005×X
－(fuel economy in 2003×number of cars owned in 2003×X
＋fuel economy in 2004×number of shipped cars in 2004×X
＋fuel economy in 2005×number of shipped cars in 2005×X)

From the hypothesis 1 and 2, we can illustrate

number of cars owned in 2005
＝number of cars owned in 2003
＋number of shipped cars in 2004＋number of shipped cars in 2005,

so,

number of cars owned in 2005
= fuel economy in 2003×(number of cars owned in 2003
＋number of shipped cars in 2004＋number of shipped cars in 2005)×X
－(fuel economy in 2003×number of cars owned in 2003×X
＋fuel economy in 2004×number of shipped cars in 2004×X
＋fuel economy in 2005×number of shipped cars in 2005×X)
= (fuel economy in 2003－fuel economy in 2004)
×number of shipped cars in 2004×X
＋(fuel economy in 2003－fuel economy in 2005)
×number of shipped cars in 2005×X

In the same way, oil saving after 2006 is illustrated as follows:

oil saving in 2006＝oil saving in 2004＋oil saving in 2005
＋(fuel economy in 2003－fuel economy in 2006)

×number of shipped cars in 2006×X

oil saving in 2007＝oil saving in 2004＋oil saving in 2005＋oil saving in 2006
＋(fuel economy in 2003－fuel economy in 2007)
×number of shipped cars in 2007×X

oil saving in 2008＝oil saving in 2004＋oil saving in 2005
＋oil saving in 2006＋oil saving in 2007
＋(fuel economy in 2003－fuel economy in 2008)
×number of shipped cars in 2008×X

oil saving in 2009＝oil saving in 2004＋oil saving in 2005
＋oil saving in 2006＋oil saving in 2007＋oil saving in 2008
＋(fuel economy in 2003－fuel economy in 2009)
×number of shipped cars in 2009×X

oil saving in 2010＝oil saving in 2004＋oil saving in 2005＋oil saving in 2006
＋oil saving in 2007＋oil saving in 2008＋oil saving in 2009
＋(fuel economy in 2003－fuel economy in 2010)
×number of shipped cars in 2010×X

Therefore, total oil saving from 2003 to 2010 is illustrated by the formula bellow:

total oil saving＝oil saving in 2004×7＋oil saving in 2005×6＋oil saving in 2006×5 ＋
oil saving in 2007×4＋oil saving in 2008×3
＋oil saving in 2009×2＋oil saving in 2010

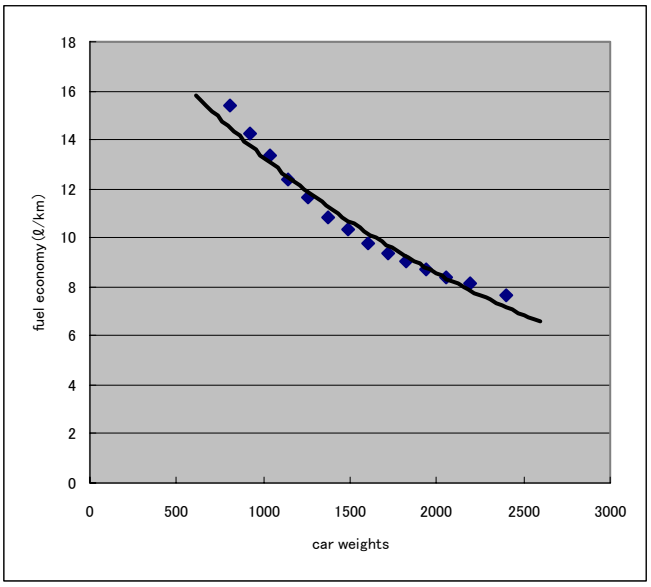
Next, we explain the way of our trial calculation of fuel economy change and that of change in the number of future cars owned.

At first, we tell about the way of trial calculation of fuel economy change. Let us see trial calculation of fuel economy in 2010. It is assumed that in 2010 all the cars will complete the fuel economy standards of 2008. So we made a hypothesis that fuel economy in 2010 equals that in 2008. Then let us see trial calculation of fuel economy in 2003. The aim is to make the fuel economy in 2010 better than that in 2003 by 15%. It means fuel in 2003 economy is worse than that in 2010 by 15%. Accordingly we define that fuel economy in 2003 is worse by 15% than fuel economy standard in 2008 which equals fuel economy in 2010[34]. Then we will tell about how to decide the fuel economy standard in 2008. We put the fuel economy standard in 2008 into the chart1. We draw an approximate curve and make the formula, and put the value of 750～2500 into the formula y = 20.696e-0.0004x and calculate the average fuel economy. The answer is

[34] We put the fuel economy in 2008 and drew the approximate curve. And we put the figure from 750, 751, 752… to 2500 into the calculated formula of approximate curve y = 20.696e-0.0004x. Then we divide the total of them by 1751 and got the fuel economy standard. Why we did so is due to the hypothesis5 “the ratio of cars in each car weight class will not change”

11.02646. This multiplied by 0.85[35] is 9.372488, which is fuel economy in 2003. From the hypothesis7, fuel economy improvement rate is stable[36] so fuel economy change is projected in chart2.

【Chart 1 】
Fuel economy standard in 2008 in China



【Chart2】
Fuel economy change prospects

year	fuel economy (km/l)
2003	9.372488
2004	9.608769
2005	9.845051
2006	10.08133
2007	10.31761
2008	10.55389
2009	10.79018
2010	11.02646

Next, we will tell about the change in the number of cars owned. We made a trial calculation of vehicle coverage on the basis of the hypothesis below. We made a comparison between GDP per capita[37] and vehicle coverage in Korea, Japan and China as chart3 shows. As this chart shows, Korea's move has followed Japan's move. We made the approximate curve longer and made a future change prospect. And it shows future vehicle coverage in China will follow that in Japan and Korea. We put the projected future GDP per capita[38] into this approximate curve formula y = 1E-08x2.1781, and got the vehicle coverage. This vehicle coverage multiplied by population prospects[39] means the number of cars owned[40]. As a result, we got the trial calculation of

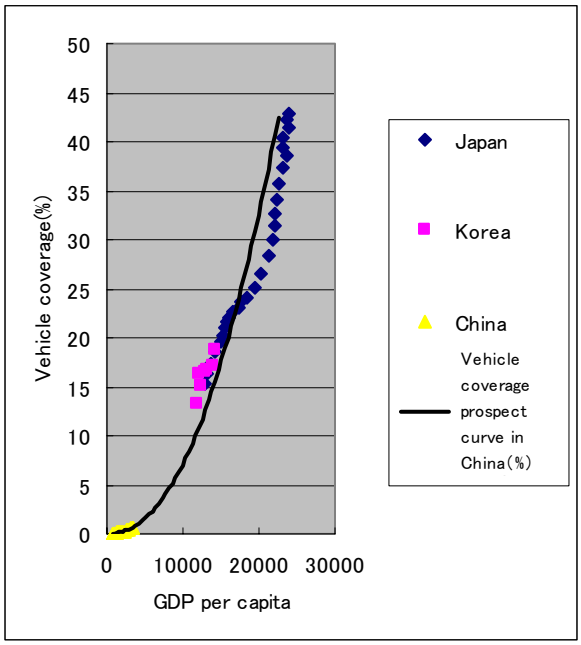
[35] Because of fuel economy improvement by 15%.
[36] Annual fuel economy improvement value＝(fuel economy in 2010－fuel economy in 2003)÷7＝0.236281. So, fuel economy in X(year)＝fuel economy in 2003＋ (X－2003)×0.236281
[37] We use GDP per capita in PPP (purchasing power parity). It is because we suppose nominal or real GDP does not consider the exchange fluctuation and they cannot show consumers' purchasing power.
[38] The prospects of GDP growth rate is supposed to be 7% which is the aim in the Tenth five-year program.
[39] We used the future population prospect by UNEP（http://www.unep.org/）.
[40] The way of our trial calculation of future number of cars owned is popular because the way is used by "the Institute of Energy Economics, Japan" or other think tanks in Japan.

change in the number of cars owned. From the hypothesis 1 and 2, the number of shipped cars is illustrated as the formula below:

number of shipped cars＝number of cars owned in (X＋1)year
－number of cars owned in X year

From this formula, chart4 is figured.

【Chart3】GDP per capita and vehicle coverage



【Chart4】 Number of cars owned and number of shipped cars

year	number of cars owned	number of shipped cars
2003	10910475	
2004	12725203	1814729
2005	14841152	2115949
2006	17308226	2467073
2007	20184581	2876355
2008	23537993	3353412
2009	27447438	3909446
2010	32004949	4557511

If put the above data into the above formula, oil saving in each year and total oil savings are indicated as chart5.

【Chart5】 Oil savings

year	oil savings
2004	4761.22X
2005	15597.78X
2006	34105.79X
2007	62218.17X
2008	102269.6X
2009	157073.6X
2010	230013.3X
total	606039.6X

Accordingly, total oil savings by fuel economy standards amounts 606039.6X. If put the average distance traveled per car in Japan, it amounts 58119195550. It is 4242701.275 t [41].

[41] Oil 1ℓ=0.73kg=0.000073t
by Petroleum Association of Japan (http://www.paj.gr.jp/html/statis/kansan.html)

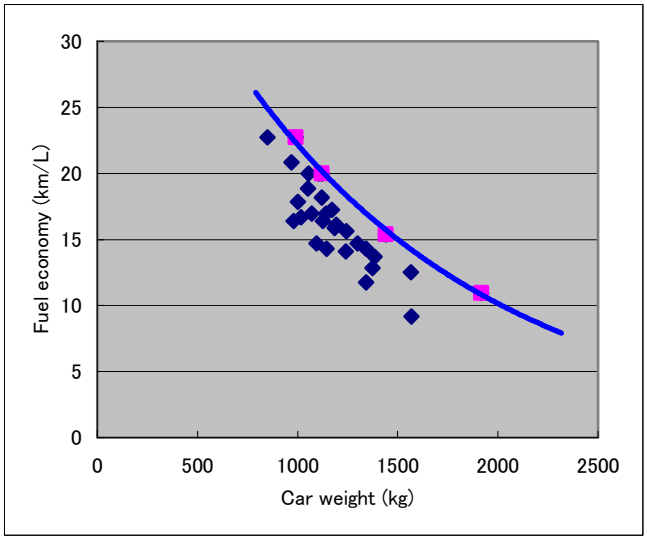
ANNEXⅢ : Trial calculation of oil saving by introducing top runner approach in China

We will explain the way of our trial calculation of oil saving by introducing top runner approach here.

The period we will analyze is from 2003 to 2010 as in the former calculation. This is for analyzing the difference of the amount of oil saving between top runner standard and Chinese current standard.

The way of trial calculation of oil saving is same as in the former calculation. But there is one difference in the setting of fuel economy standard in 2010. We got the approximate curve from the Chinese best fuel economy in each weight class now and the fuel economy standard in 2010 is indicated from that. The formula of the approximate curve is y = 48.445e-0.0008x. From this formula, we can calculate the average fuel economy[42] and it amounts 14.30905km/ℓ. Then from hypothesis7 “fuel economy improvement rate is stable”, fuel economy change is illustrated as follows in chart2.

【Chart 1 】Car weight and fuel economy



【Chart2】Fuel economy change

year	Fuel economy change
2003	9.372488
2004	10.07771
2005	10.78294
2006	11.48816
2007	12.19338
2008	12.89861
2009	13.60383
2010	14.30905

Then, with this fuel economy in 2010, oil saving is calculated as follows in chart3.

[42] We use the same way of calculating fuel economy as in the former calculation.

【Chart3】Amount of oil saving

year	Oil saving (total)
2004	13549.45X
2005	43079.9X
2006	91555.67X
2007	162554.3X
2008	260364.9X
2009	390105.9X
2010	557865.2X
total	1519075X

Therefore, the oil saving by introducing top runner approach in China amounts 1519075Xℓ. Average distance traveled per car[43] in Japan is put to this on trial, it amounts 145679337170ℓ. It equals 10634592t[44].

[43] We put the average distance traveled per car (9590km) as in the former calculation.
[44] Oil 1ℓ=0.73kg=0.00073t
by Petroleum Association of Japan (http://www.paj.gr.jp/html/statis/kansan.html)

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