

Energy price indices in Japanese CPI

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Abstract

In Japan, energy resources, such as crude oil, coals and natural gas, are mostly supplied by imports. The Japanese CPI and living consumption of Japanese households have been influenced by fluctuations in imported energy prices directly or indirectly. The energy price index in the CPI, that is useful for measuring direct impact of energy prices, is composed of “Electricity and gas” index and “Petroleum products (heating fuel and automobile fuel)” index. It is very important to estimate these price indices precisely and effectively.

On the “Electricity and gas”, there are institutional changes for supply to household consumers, from the conventional regional monopoly supply system to liberalized markets gradually. Regarding the “Petroleum products”, regional differences in weights and prices are large. Those are caused by difference of public transportation supply (for automobile fuel) or that of climate (for heating fuel). In those indices, it is necessary to accumulate precise prices and weights by region continuously. In addition, it is necessary to cover supply system changes caused by intensifying supply competition and labor saving of services (from full service to self-service), on the background of gasoline demand reduction caused by improvement in fuel efficiency and spread of energy saving cars like hybrid vehicles.

In this paper, we introduce issues on these economic environmental changes / institutional changes in Japan and how we handle the tabulation of the energy price indices in the CPI. We also introduce considerations for the impact of resource energy import prices to the CPI, the relation between energy price index and Japanese some “Core indices”, and the problem of drift in chain indices brought by energy price fluctuations.

1. Introduction

In Japan, energy resources, such as crude oil, coals and natural gas, are mostly supplied by imports. The Japanese CPI and living consumption of Japanese households have been influenced by fluctuations in imported energy prices directly or indirectly. The energy price index in the CPI, that is useful for measuring direct impact of energy prices, is composed of “Electricity and gas” index and “Petroleum products (heating fuel and automobile fuel)” index. It is very important to estimate these price indices precisely and effectively.

In this paper, we introduce issues on economic environmental changes / institutional changes in Japan and how we handle the tabulation of the energy price indices in the CPI. We also introduce considerations for the impact of resource energy import prices to the CPI, the relation between energy price index and Japanese some “Core indices”, and the problem of drift in chain indices brought by energy price fluctuations.

2. Coverage of the “Energy” index

In the OECD and many countries, the coverage of “Energy” is defined as COICOP 04.5 (Electricity, gas and other fuel) and 07.2.2 (Fuel and lubricants for personal transport equipment). The coverage of Japan's “Energy” index is similar to these. Among the 585 survey items that constitute the current whole CPI of Japan, the “Energy” index is composed of 5 survey items. Among them, one item is examined at 04.5.1 (Electricity) of COICOP, two items at 04.5.2 (Gas), one item at 04.5.3 (Liquid fuels), and one item at 07.2.2. Among the 04.5.4 (Solid fuels) and 04.5.5 (Heat energy), there are no items subject to the current price survey.

The CPI weight of “Energy” is 7.84% as a whole. Among them, the 04.5 weight is 5.78% (3.56% for 04.5.1, 1.81% for 04.5.2, 0.41% for 04.5.3) and the 07.2.2 weight is 2.06%. The expenditures of 04.5.4 and 04.5.5 are included in the weight of the 04.5.3.

In Japan's CPI, the survey items and weights are revised every five years. The transition of the energy components is as described below. (In the meantime, the coverage of the weight is almost the same since 1980s.) The energy index was retroactively updated in 2006 to time series data until 1970. In the 1970 base index and the 1975 base index, “Charcoal (04.5.4)” was investigated in addition to the current survey items. From the 1970 base index to the 1980 base index, the “Coal and wood briquettes (04.5.4)” was also investigated. From the 1970 base index to the 1985 base index, “Coal (04.5.4)” was investigated. Both of these have not been subject to price survey now due to the reduction of the weight. Also, from the 1995 base index to the 2000 base index, we are conducting a price survey of “Premium gasoline” separately in addition to “gasoline (regular gasoline)” which is currently being investigated. Before the 1965 base index, we have been investigating “Wood fuel (04.5.4)” as an item that can enter energy.

Items that are not currently conducting price survey but may be subject to energy include premium

gasoline, diesel oil, cartridge type gas cylinder, solid fuels and the like. Of these, premium gasoline and diesel oil are taken up in the section 6.

The cartridge type gas cylinder occupied the weight of about 0.006% as of 1999, but after that, we did not compile weights targeted to this item. Strictly speaking, on the COICOP classification, cartridge type gas cylinder for leisure use is classified as the 09.2.2 and does not enter energy index. The target of energy index is limited to those for household cooking use. However, in Japan, it is considered that the same cartridge type gas cylinder is often used for both cooking and leisure, so it is practically difficult to separate them. On the other hand, with regard to the solid fuels, it can be confirmed that “Coal” accounted for about 0.0003% as of 1994.

As of 2015, the weight corresponding to “Others of light heat” for the “Family Income and Expenditure Survey”, which is consisted of cartridge type gas cylinder (part of the COICOP 04.5.3), solid fuels (04.5.4) and heat energy (04.5.5), is 0.01%, but it is included in all the 04.5.3 for Japanese CPI aggregation in convenience.

Table 1 Surveyed items and weights for “Energy” index

Base year	Weights (% share to total CPI)									
	Total Energy	COICOP 04.5.1	COICOP 04.5.2		COICOP 04.5.3	COICOP 04.5.4			COICOP 07.2.2	
		Electricity	Piped Gas	LPG	Kerosene	(a)	(b)	(c)	Gasoline (Regular)	Gasoline (Premium)
1970	4.88	1.83	0.73	0.54	0.42	0.15	0.09	0.12	1.00	-
1975	5.61	1.78	0.87	0.83	0.49	0.03	0.03	0.02	1.56	-
1980	7.26	2.28	1.05	0.97	0.78	0.02	0.02	-	2.14	-
1985	7.62	2.69	1.17	0.88	0.72	0.02	-	-	2.16	-
1990	6.21	2.40	0.93	0.72	0.40	-	-	-	1.76	-
1995	6.43	2.67	0.88	0.79	0.38	-	-	-	1.38	0.35
2000	6.83	2.94	0.88	0.84	0.39	-	-	-	1.42	0.35
2005	7.40	2.92	0.93	0.78	0.53	-	-	-	2.24	-
2010	7.72	3.17	0.96	0.81	0.50	-	-	-	2.29	-
2015	7.84	3.56	1.16	0.65	0.41	-	-	-	2.06	-

(a):Coal (b): Coal and wood briquettes (c): Charcoal

3. Electricity

The target of CPI's "Electricity" is the charge related to low voltage supply for household use. Until March 2016, this market was supposed to be supplied by a specific electric power company for each area. The companies that supply electricity to households were limited to 10 companies throughout Japan. In addition, regulations requiring approval by the government were also applied for price setting. In April 2016, electricity retailing was fully liberalized. As a result of liberalization, business companies other than the ten monopolistic companies began to enter the electricity supply business for households, and the choice of the price plan also expanded than before. On the other hand, the traditional tariff system by ten monopolies also continue. Nevertheless, as of March 2017, the vast majority of households still continue contracts with the conventional rate system (hereinafter referred to as "regulated fee"). Therefore, in calculating current CPI, only the regulated fee is covered.

The regulated fee is the sum of the "Basic charge" corresponding to the capacity on contracts, the "Electric energy charge" corresponding to the electric energy consumed, and the "Renewable energy power promotion surcharge". A value added tax, "Consumption tax", is also imposed for this total. Among them, consumers are charged a constant fee for monthly fee for "Basic charge". On the other hand, the "Electric energy charge" is charged to the consumer by multiplying the determined "Consumed unit price" by the amount of electricity consumed for one month.

In the case of regulated charges, the "Consumed unit price" sets expensive for heavy users, but it sets lower price for light users. Therefore, it is necessary to confirm price fluctuations of both heavy users and light users. On calculating the "Electricity" price index of the CPI, we check the prices of the five model cases and tabulate by the weighted arithmetic mean of these model case prices. The model cases and weights are set by the distribution of electricity consumption of households obtained from the "Family Income and Expenditure Survey".

What are some factors that cause price fluctuations for the regulated fees? In principle, the authorization by the government is required when the electric power companies revise prices of the Basic charge and the Consumed unit price. At that time, the government is judged by a method called "Appropriated costs accumulation method". In this method, the government confirms whether the fee is set as that the revenue of the electricity charges are equal to the sum of total cost plus the profits which is expected to be necessary for stably supplying electricity. It is also confirmed that the maximum efficiency of management has been improved. This method was adapted in 1933. But the electric power companies only required notification of fee revision to the government without approval on the case of fee deduction since 2000. Price cuts were conducted several times between 2000 and 2008. This is thought to be due to efforts to improve the efficiency of the electric power company. On the other hand, price increases are being implemented several times from 2012 to 2015. It seems passing on to consumers the increase in expenses due to the change in power generation composition from nuclear power generation to thermal power generation.

Table 2 History of electricity charging system for households

1933	Adaptation of the “Appropriated costs accumulation method” for regulated fee system
1974	Adaptation of incremental charging for regulated fee (Revising fees in 1974, 1976, 1978, 1980, 1981, 1986, 1987, 1988, 1989, 1993, 1994, 1995)
1996	Adaptation of the “Fuel cost adjustment system” (Revising basic charges in 1996, 1998)
2000	Electric power companies only required notification of fee revision to the government without approval on the case of fee deduction (Basic charges deduction in 2000, 2002, 2004, 2005, 2006, 2008) (Basic charges increase in 2012, 2013, 2014, 2015)
2016	Liberalized fully for electricity retailing to households

Source: Agency for Natural Resources and Energy (2011) [5] and other sources

For the Basic charge and the Electric energy charge of the regulated fee, the cost of the “Appropriated costs accumulation method” includes “Petroleum coal tax”, “Power development promotion tax”, “Expense required for processing and disposal of spent fuel generated in connection with the use of past nuclear power generation”, etc. When the electric power companies pass these tax rates and so on to consumers, they only required notification of fee revision to the government. With regard to the Petroleum coal tax, “Special taxation on measures against global warming” was implemented to strengthen measures to counter global warming, including the introduction of renewable energy and energy conservation measures in 2012. The tax rate was raised three times on October 2012, April 2014 and April 2016. The pass-through to consumers is delayed several months later than these dates by the electric power companies.

Table 3 “Petroleum coal tax” rate for crude oil and petrol products
(including “Special taxation on measures against global warming”)

Jun. 1978	3.5%
Sep. 1984	4.7%
Aug. 1988	2040 yen/kl
Oct. 2012	2290 yen/kl
Apr. 2014	2540 yen/kl
Apr. 2016	2800 yen/kl

The “Fuel cost adjustment system” was adopted in January 1996 to promptly reflect changes in the

economic situation (change in fuel price and currency exchange rate) that does not reach companies' management efforts, in order to stabilize the business of the electric power companies. Specifically, it is a system that automatically adjusts the Consumed unit price etc. based on the import price of fuels. For example, the electricity price for June is adjusted based on the fuel import price in January to March in the same year, and the electricity price in July is adjusted based on the fuel import price in February to April. From January 1996 to March 2009, it has made adjustments by quarterly basis. And it has adjusted monthly basis since April 2009. The monthly fluctuation of the current "Electricity" price index often reflects fluctuations in electricity prices based on the Fuel cost adjustment system. This means that fluctuations in import prices of crude oil, coal and LNG will be reflected in electricity prices with a time lag of about 4 months. When Japanese electric power companies import LNG, it is said that they are doing long-term contracts linked with crude oil prices. But even before crude oil prices are reflected in LNG prices, time lags of several months has occurred. In addition, the fuel cost adjustment system is based on the premise that the fuel composition on power generation is constant. When the power generation expenses change due to a change in the fuel composition, it is not automatically adjusted by the Fuel cost adjustment system. So if necessary, electric power companies respond by revising the fee with approval as mentioned above.

The "Renewable energy power promotion surcharge" is a system whereby electric power companies buy electricity generated by renewable energy (solar power generation, wind power generation, hydroelectric power generation, biomass power generation and geothermal power generation) at a fixed price (fixed price purchase of renewable energy system) to be borne by consumers. This system aims at stable supply of energy and reduction of environmental burden etc. The unit price of the surcharge is reviewed each year, and the unit price after the review is applied from May payment in every year. The "Renewable energy power promotion surcharge" system was established in 2012, and the charge per unit cost at this time was 0.22 yen / kWh. It was raised every year since then, it is 2.64 yen / kWh since May 2017. It is said that reflecting the fact that introduction of solar power generation and wind power generation advances with the preferential treatment of purchase price advancing, and the cost of buying electricity companies rising.

Table 4 Rate of "Renewable energy power promotion surcharge"

May 2012	0.22 yen/kWh
May 2013	0.35 yen/kWh
May 2014	0.75 yen/kWh
May 2015	1.58 yen/kWh
May 2016	2.25 yen/kWh

The "Consumption tax" is a value-added tax in Japan which is the most taxable coverage. Regarding

the electricity bill, a predetermined tax rate is imposed on the sum of “Basic charge”, “Electric energy charge” and “Renewable energy power promotion surcharge” that we have seen. The consumption tax was created in April 1989 with a tax rate of 3%, then the tax rate was revised to 5% in April 1997 and 8% in April 2014. As of this writing, it is scheduled that the tax rate will be revised to 10% in October 2019. At present, the reduced tax rate system is not set at all. But in October 2019, a reduced tax rate will be introduced to food and some goods/services. When revisions of the tax rate, some transitional measures are taken. There are various transitional measures. Regarding the electricity bill, if the electricity is continuously supplied before the tax rate revision, the tax rate before the revision is applied for the consumption bill by the meter reading immediately after the revision of the tax rate. For example, when revising the tax rate on April 1, 2014, the old tax rate is applied to consumption from March 25, 2014 to April 24, 2014 in case of households whose bill certified at 24th on every month. In response to this, the aggregate of CPI in Japan is calculated by adopting the price deemed that the uniform old tax rate will apply until April 2014.

Table 5 “Consumer tax” rate

Apr. 1989	3%
Apr. 1997	5%
Apr. 2014	8%

Note: “Electricity tax” (tax rate = 5%) or “Gas tax” (tax rate = 2%) were imposed to electricity bill or piped/propane gas before Mar. 1989. Those indirect taxes were abolition at that time.

The above is the outline of the regulated fee. On April 2016, electricity retailing was fully liberalized. As a result, the number of companies that supply electricity to ordinary households has increased from 10 companies to about 400 companies. From new entrants (new electric power), various rate plans that are not bound by the regulated fee are being provided. However, the market share of the new electric power is still only 5% even one year after liberalization [6]. The reason why the market share of the new electric power has scarcely expanded is thought to be due to the fact that the price of the plan provided by the new power is only about 5% cheaper than the regulated charge. According to a net survey conducted by a research company [7], it is about 7% of households to consider switching to new electric power at 5% discount rate. On the other hand, 62% of households are planning to consider switching at 20% discount. In this way, it can be said that the merit of the price of the new power is small with respect to the switching cost at present. Looking at this change situation, it is considered that the method using “Adaptation the cheapest price plan in each model case as the price index” in calculating price indices such as mobile phone index is not suitable for the electricity price index. Also, assuming that there is no difference in quality between the rate plans provided by new electric powers and the regulated fees, if a representative plan of new electric powers are incorporated into the index with the market share of the new electric powers as a weights, the electricity price index

is $5\% \times -5\% = -0.25\%$ in the past year (the contribution to the CPI total index is -0.009).

Also, even under regulated fees, there were discount plans such as discounted electricity used at midnight. Such plans have survived by renaming it even after liberalization in April 2016. According to the “Family Income and Expenditure Survey”, the amount share of such plans are only about 3%. This share has been around 2 to 3% in recent years, and there is no tendency to expand particularly. For this reason, the effect on the year-on-year change is minor even if the above calculation is made. Also, these plans have obvious differences against normal regulated charges in terms of provide. Adjustment may be necessary for the difference (quality difference) in this provision condition, but if such adjustment is made, the influence on the price index will be further reduced.

4. Piped gas

In Japan, gas supply business for households is roughly divided into piped gas supplying mainly LNG by conduit and propane gas supplying LPG by installing containers.

The “Piped gas” price index of CPI is the charge related to small supply for household use. Until March 2017, piped gas was supplied from specific gas companies in each area. Some areas do not have piped gas supply. In such areas, only propane gas is supplied.

The company that supplies piped gas (general gas provider) was about 200 companies in Japan as a whole. Note that this number includes not only for household use. There was also a regulation that required government approval for price setting. In April 2017, retail of piped gas is fully liberalized. As a result of liberalization, some operating companies (registered gas retailers) other than 200 monopoly entered into the piped gas supply business for households.

Of the approximately 200 piped gas companies nationwide, 64 companies that supply piped gas to the surveyed municipalities are subject to price survey. However, due to the specimen design of the CPI, the surveyed prices of large cities are census type one. Approximately one-third of the weight of the piped gas is surveyed all provider, and the remaining two thirds are sample surveys. The latter is in the form of investigating gas companies that are supplying to the extracted municipalities. Most of the 200 companies are small or medium enterprises, but major distributor provide to metropolitan areas. Especially, the largest four companies have huge weights of piped gas, which has a big influence for fluctuations of price index of whole nation.

Although piped gas market is liberalized in April 2017, gas business has higher entry barriers than electricity business, so a few companies enter the liberalized gas market. As of March 23, 2017, there are 37 new entry companies including non-household use.

The regulated fee is the sum of the “Basic charge” which divided into several categories according to the usage amount for one month and the “Unit charge” which imposed according to the usage amount, and the “Consumption Tax” which is imposed sum of the above. The “Basic charge” and the “Unit charge” include the “Petroleum coal tax”, which is the same price fluctuation as the electricity

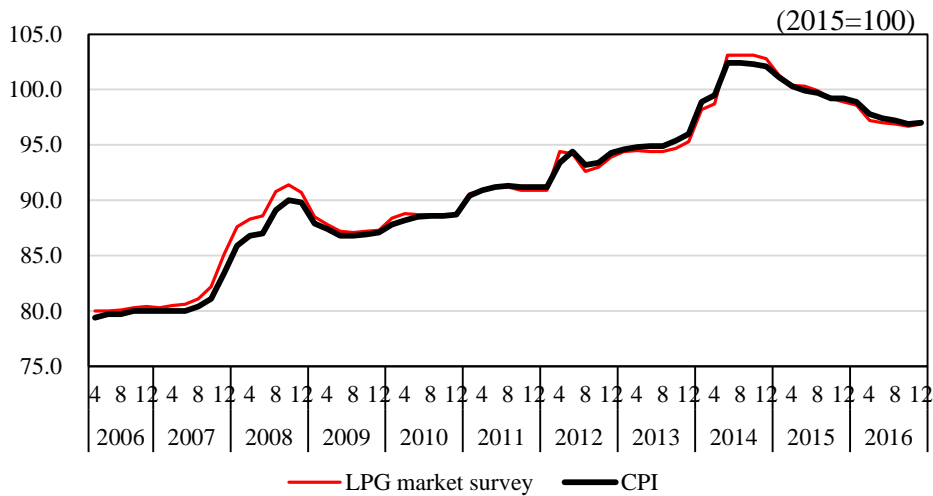
bill. Also, there is a “Raw material cost adjustment system” as a system similar to the “Fuel cost adjustment system” for electricity bills. Like the “Electricity” price index, monthly fluctuations in the current “Piped gas” price index often reflect gas price fluctuations based on the Raw material cost adjustment system. The raw materials of piped gas are composed of LNG and LPG, but most of it is LNG. For this reason, fluctuations in the import price of LNG will spread to the fluctuation in the “Piped gas” price index a few months behind. However, a few piped gas providers have a large proportion of LPG in raw materials, and price variations slightly different from other piped gas providers.

5. Propane gas

Approximately 21000 companies selling LPG throughout the country. Note that this number includes companies targeting business use other than for household use. On the other hand, in the price survey of the CPI, three establishments are surveyed in each survey municipalities whose population is over 150000, whereas one is surveyed in each survey municipality whose population is less than 150000, then 329 establishments are surveyed over nationwide. Although there are many business operators, the suppliers of LPG are limited to several companies that are the original producers of petroleum products. No government regulation is imposed on setting prices by each provider. Because there is no system that gas price is automatically adjusted by fuel cost fluctuations, price index movement of “Propane gas” is slower than that of “Piped gas”. Incidentally, LPG's expenses include “Petroleum coal tax”.

Regarding the price survey of propane gas, two public price surveys are conducted. One is for calculating CPI (“Retail Price Survey”: the government imposes duty of reporting to the surveyed providers), and another is “LPG Market Survey”. “Final Survey” of the “LPG Market survey” conduct once every two months, and they are conducting surveys at approximately 3000 establishments nationwide (survey is designed by 268 regional blocks, at least 30 establishments are allocated to each prefecture). Using the published results of 9 regional blocks average prices in this survey, we can see that there is almost no difference in movement when comparing the results tabulated using the CPI districts weights to the national “Propane Gas” price index of the official CPI.

Fig.1 “Propane gas” price indices calculated by “LPG market survey” and CPI



6. Gasoline

In Japan, gasoline is sold mostly at gasoline stations franchised by seven major original petroleum sales companies. Approximately 34 thousand stations are located throughout the country (as of March 2015). As taxation measures related to gasoline, “Petroleum coal tax” for crude oil as raw material, “Volatile oil tax” (including “Local volatile oil tax”) is imposed on gasoline after refining from crude oil. And the Consumption tax is imposed on the selling price including indirect taxes mentioned above. According to the estimation by the Petroleum Association of Japan [9], out of the 112.5 yen selling price per petrol of gasoline, the Volatile oil tax was 53.8 yen, the Petroleum coal tax was 2.54 yen, the Consumption tax was 8.3 yen, and the pure price of gasoline is 47.9 yen as of the end of February 2016. The import dependency of crude oil is 99.7% in Japan, that is, we depend almost all crude oil on imports. For this reason, as we will see later, the influence of the import price (yen denominated) on gasoline prices is quite large. Generally said there are large regional differences in price levels based on the difference in transportation costs from refineries. Note that mitigation for the Volatile oil taxes have been adopted in Okinawa, southern remote islands in Japan.

In the price survey of CPI, four stations are surveyed in each survey municipalities whose population is over 150000, two are surveyed for 50000 to 150000 population survey municipalities, whereas one is surveyed for less than 50000 population survey municipalities, then 576 stations are surveyed over nationwide.

The weight of the Gasoline in the CPI is 2.06% on a national average. However, regional difference in weight is large due to differences in the degree of development for public transportation system. In the major cities, the weight is only 1.27% (especially 0.65% in Osaka city and 0.67% in Tokyo metropolitan area), whereas it is 3.07% for small municipalities (less than 50000 population).

Table 6 2015-Base weights for “Gasoline”

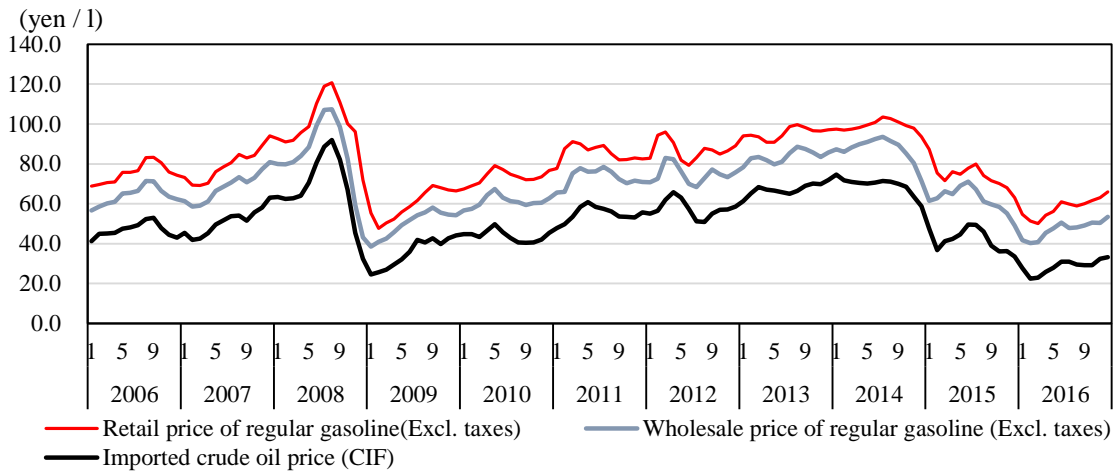
City classes	Weights (% share to total CPI in each city class)
National average	2.06
Major cities < 21 major cities >	1.27
(Tokyo metropolitan area)	(0.67)
(Osaka city)	(0.65)
Middle cities	2.06
< Cities with a population of 150000 - 999999 >	
Small cities A	2.43
< Cities with a population of 50000 - 149999 >	
Small cities B, towns and villages	3.07
< Cities with a population of less than 50000 >	

In the aggregation of the CPI, survey municipal “Gasoline” price indices are accumulated by survey municipal “Gasoline” weights, and then, “nationwide gasoline price index” is created. As a result, prices and weights that vary widely from region to region are accumulated precisely, and nationwide index is tabulated.

What are some factors that cause gasoline price fluctuations? The Volatile oil tax has been constant at 53.8 yen per liter since June 1979 basically. However, it became 28.7 yen per liter since the additional tax rate temporarily expired during one month of April 2008. This effect also appeared in the “Gasoline” price index.

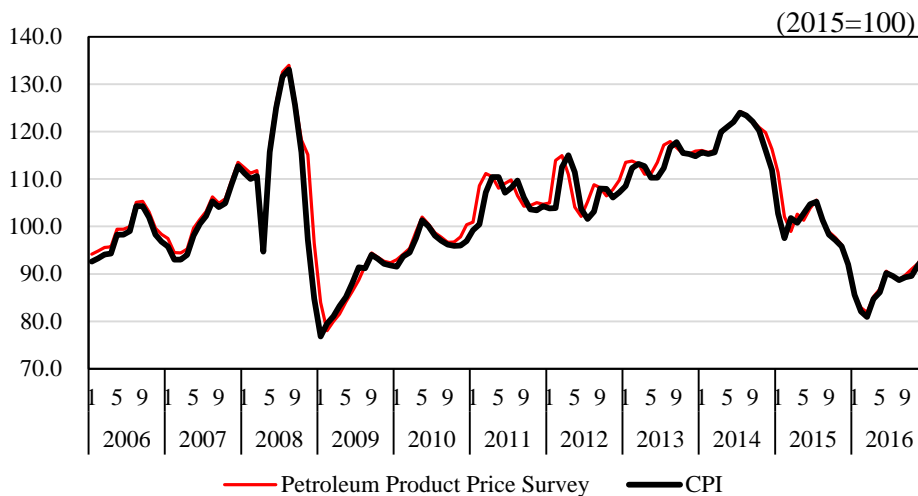
For gasoline price, there is no legal restriction on pricing. On the other hand, retail prices seem to be linked to crude oil import prices because we are procuring most of crude oil from overseas. Looking at the retail price at the gas station (deducting the Volatile oil tax and the Consumption tax), the wholesale price from the original petroleum company to the affiliated gas station (deducting the Volatile oil tax and the Consumption tax) and the crude oil import price (CIF, yen denominated), clear relationship is observed. According to Ueda and Yamashita (2015), the correlation between the international crude oil market price (Dubai, yen denominated) and the “Petroleum product” price index (consisting mostly of “Gasoline”) of the CPI is existed by some time lag. The maximum relation number is observed on one month.

Fig.2 Retail gasoline price, wholesale gasoline price and imported crude oil price excluding taxes



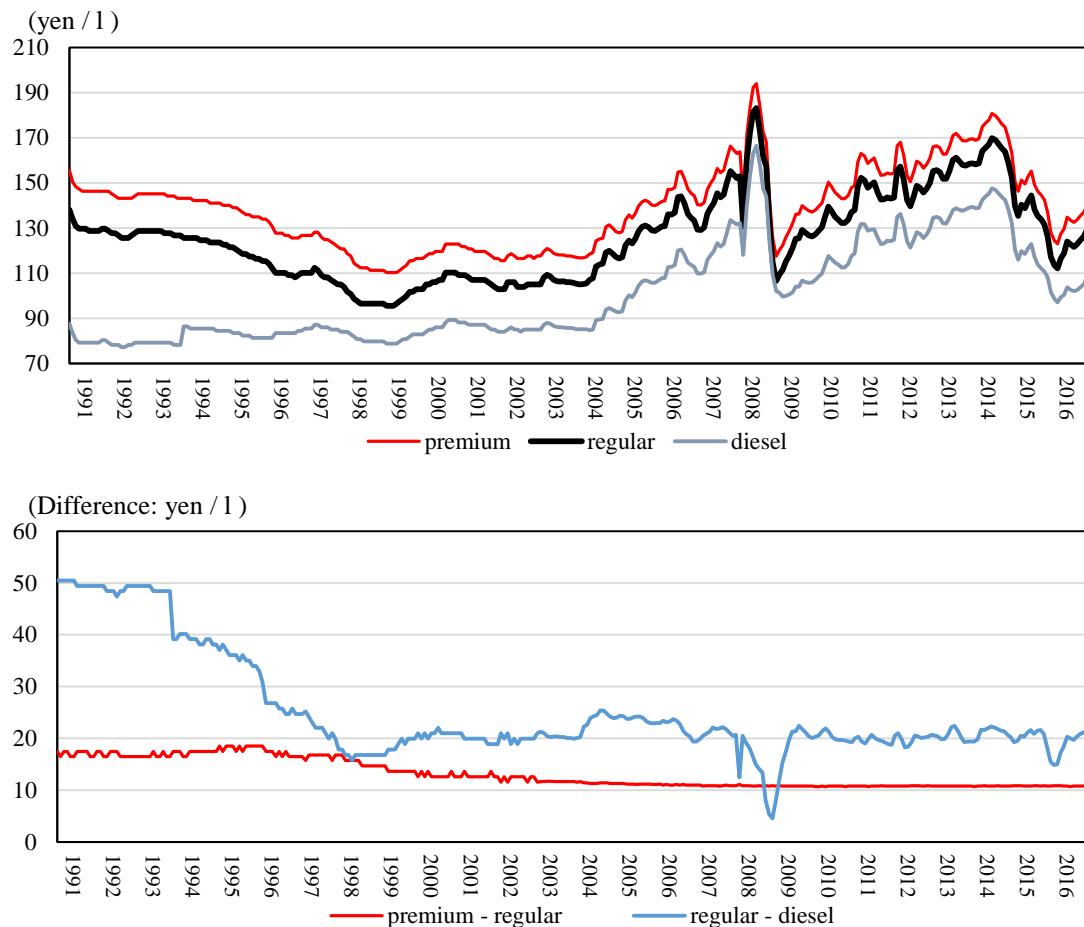
Regarding the price survey of regular gasoline, two governmental price surveys are conducted. One is for calculating the CPI (the Retail Price Survey), and another is “Petroleum Product Price Survey” conducted by the Oil Information Center (An administrative statistics of the Agency for Natural Resources and Energy; survey and tabulation are entrusted to the Oil Information Center). The latter survey covers about 2000 stations (at least 30 stations are allocated to each prefecture) and conduct on every Monday throughout the country. By comparing the results tabulated using the CPI stratification weights and the publicized results of 9 regional blocks in this survey and the results of “Gasoline (regular gasoline)” price index of official CPI, there is almost no difference in movements. Among the “Retail Price Survey” and the “Petroleum Product Price Survey”, the former is a Wednesday to Friday survey, whereas the latter is a Monday survey. While the former deals with a full service stations only, the latter is also different in that it investigates both full services and self-services.

Fig. 3 “Gasoline” price indices calculated by “Petroleum Product Price Survey” and CPI



Household expenditures for the COICOP 07.2.2 (Fuel and lubricants for personal transport equipment) include expenditures on premium gasoline and diesel fuel in addition to regular gasoline that we have seen so far. In the “Petroleum Product Price Survey”, these prices are also investigated like regular gasoline. According to this statistics, the price difference between premium gasoline and regular gasoline is 17 yen in 1991. After that the difference has shrunk over the year 2003. After 2003, it has been constant at around 12 yen difference. In the CPI compiling, both regular gasoline and premium gasoline prices are surveyed up to the 2000-base indices, but from 2005 and onwards, whole gasoline price movement has been represented by that of regular gasoline, since the viewpoint of efficiency of the survey. In addition, the price of diesel fuel has remained below the regular gasoline by roughly 20 yen in 2000 and beyond. Although the price difference during this period is not constant, it can be regarded as being constant in the medium term. Also, according to the new car sales amounts in 2016, the share of diesel cars is 5% of the total cars for passenger [12]. This small share makes us considered that the error due to not inclusive of the price of diesel fuel as the CPI is small.

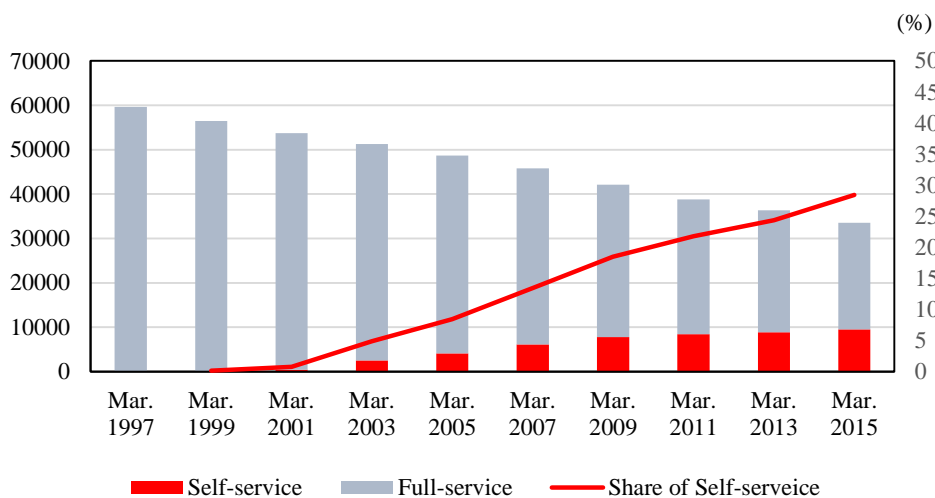
Fig. 4 Retail prices of premium gasoline, regular gasoline and diesel fuel



Source: Petroleum Product Price Survey (Agency for Natural Resources and Energy)

In previous Japan, it was obliged that staffs of gas stations refuel gasoline. In this case, many gas stations provide window wiping and garbage disposal service without imposing additional fee, and the driver does not need to get off the car while refueling (full service). However, since 1998, drivers have been able to refuel gasoline by themselves. In this case, the clerks do not wipe windows or dump. Also, the drivers have to go out of the car while refuel even when it is too hot and humid in the midsummer, or even in the middle of a winter snowstorm (self-service). After the lifting of the self-service gas station in 1998, share of the self-service stations to total number of gas stations has gradually expanded to 30% on March 2015. Among full service and self-service, it is considered that there is a difference in the provision conditions at the time of gasoline sale, that is, the quality difference (although it may be slight). Self-service stations are considered to be able to save labor costs related to sales activities, then self-service is said to be able to make price somewhat cheaper. The retail price of gasoline is greatly affected by the location of gasoline stations (distance from refinery (transportation cost), roadside traffic volume (demand), etc.). It is difficult to eliminate the difference due to difference of location and strictly compare the pure price differences between self-service and full service, but in general, it is said that there is a price difference of around a few yen.

Fig. 5 Numbers of gas stations and share of self-service stations in Japan



Source: Petroleum Association of Japan

In the current CPI of Japan, the price survey target is limited to full service stations. Assuming that self-service and full service gasoline have “no quality difference”, it is possible to think that the average price of gasoline will be lower as the use of self-service stations increases. Supposing that self-service gasoline is 4 yen less than full service. The share of self-service expands from 0% to 30% in 17 years from 1998 to 2015 (based on the number of establishments, not on a sales basis). Under this situation, we can calculate that the average retail price of gasoline among whole gas stations has

been lowered by $4 \text{ yen} * 30\% = 1.2 \text{ yen}$. Since the retail price of recent gasoline is about 110 yen, it is calculated that it was pushed down about 1% in 17 years. From the viewpoint of the year-on-year rate, that is, declining rate for one year, it can be considered that the impact is minor one.

Gasoline has a large price difference due to the location of the gas stations. For this reason, some consumers need to find a cheaper gas station, and there are movements to provide retail price information for each gas station at the private information website. Although I think that it may be possible to try to collect price information from such Internet sites, the price update frequency is somewhat low, and it is a situation that it can't bear the monthly price survey at the time of this writing.

7. Kerosene

Kerosene is sold at gasoline stations franchised by seven major original petroleum sales as well as over-the-counter and delivery of fuel retailers, home centers, co-op and others. Regarding the suppliers for households, selling share of gas stations is 57%, whereas fuel retailers, home centers, and cooperatives etc. have 43% shares, although it is the old survey result conducted in 2006.

As taxation related to kerosene, "Petroleum coal tax" is imposed on crude oil as raw material, and "Consumption tax" is imposed on selling price for kerosene after refining from crude oil. Also, the price level of kerosene has a large regional difference as well as gasoline.

In the price survey of CPI, three or more stations/shops are surveyed in each survey municipalities whose population is over 150000, whereas one is surveyed for less than 150000 population survey municipalities, then 338 stations are surveyed over nationwide. The survey establishments are stations/stores with the largest amount of kerosene sold in each survey area, and there is no provision concerning establishment type (gas station, home center etc.). In addition, the sales form is stipulated as over-the-counter sales, and delivery is not included.

The weight of the Kerosene in the CPI is 0.41% on a national average. However, the weight difference by region is large due to differences in climate. In Hokkaido, the northernmost district of Japan, the weight is as large as 2.21%, for example.

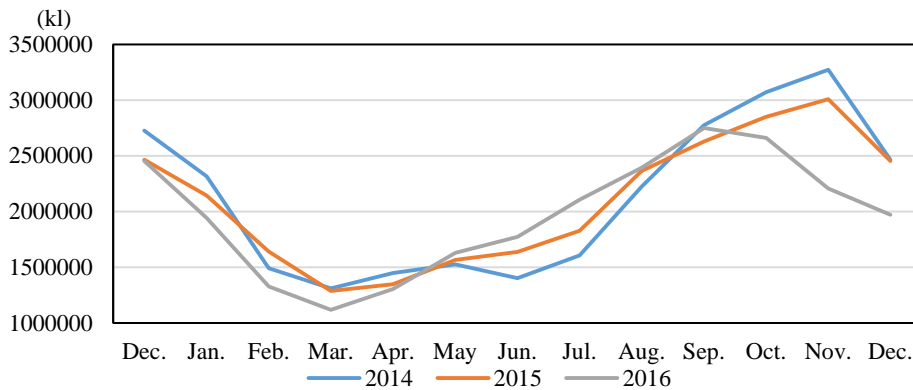
Table 7 2015-Base weights for “Kerosene”

Districts	Weights (% share to total CPI in each district)
National average	0.41
Hokkaido < The northernmost district of Japan > (Sapporo city)	2.21 (2.15)
Tohoku < The secondary northernmost district of Japan > (Aomori city)	1.33 (2.53)
Kanto (Tokyo metropolitan area)	0.24 (0.05)
Hokuriku	0.73
Tokai	0.31
Kinki (Osaka city)	0.16 (0.06)
Chugoku	0.35
Shikoku	0.30
Kyushu	0.30
Okinawa	0.27

In the aggregation of the CPI, survey municipal “Kerosene” price indices are accumulated by survey municipal “Kerosene” weights, and then, “nationwide kerosene price index” is created. As a result, prices and weights that vary widely from region to region are accumulated precisely, and nationwide index is tabulated.

What are some factors that cause kerosene price fluctuations? In terms of taxation, only the “Petroleum coal tax” and the “Consumption tax” are imposed to kerosene (or those material: crude oil), and the movements of these taxes are as seen in the above sections. Regarding at the relationship with the import price of crude oil, it seems that there is no strong relationship like “Gasoline” price index (Indices of gasoline and crude oil are represented in Figs. 2, 3, whereas kerosene is represented in Fig. 7). It is inferred that pass-through of import cost fluctuations to kerosene retail prices is mainly taking place from the late autumn to early spring, which is demand-rich period. There are few purchases in summer, and the retail price of kerosene hardly moves. The product inventory of kerosene in petroleum origin sales companies has strong seasonality (Fig. 6). It is accumulated sequentially from April to November every year, and it decreases from December to March in many cases.

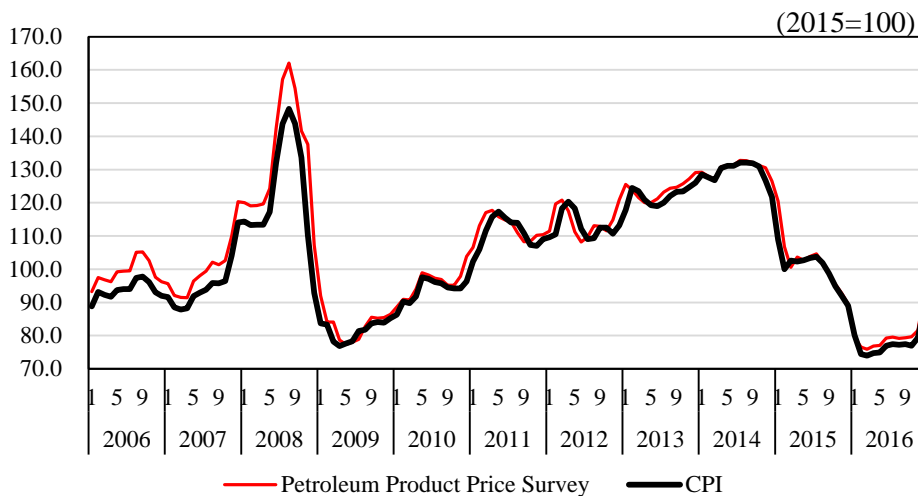
Fig. 6 Product inventory of kerosene in refiners, manufacturers and importers



Source: Current Survey of Petroleum Products Supply and Demand
(Agency for Natural Resources and Energy)

In the “Petroleum product price survey”, results of price survey can be used separately for “gas station” and “home center etc.”, “over-the-counter sales” and “delivery”. On the other hand, the “Kerosene” price index of CPI does not include “delivery”. According to the survey results of 2006 [14], households purchase kerosene by “over-the-counter sales” rather than “delivery” in many areas. But in Hokkaido etc., where the amounts of kerosene consumed are large, households purchase by “delivery” (household is refueled directly to the tank at home) mainly. We can tabulate trial results using the CPI regional weights with selling type (over-the-counter/delivery) proportion by region tabulated in 2006 survey and price data by regional/selling type surveyed by “Petroleum Product Price Survey”. By comparing this trial results and the results of “Kerosene” price index of official CPI, there is almost no difference in movements since 2009.

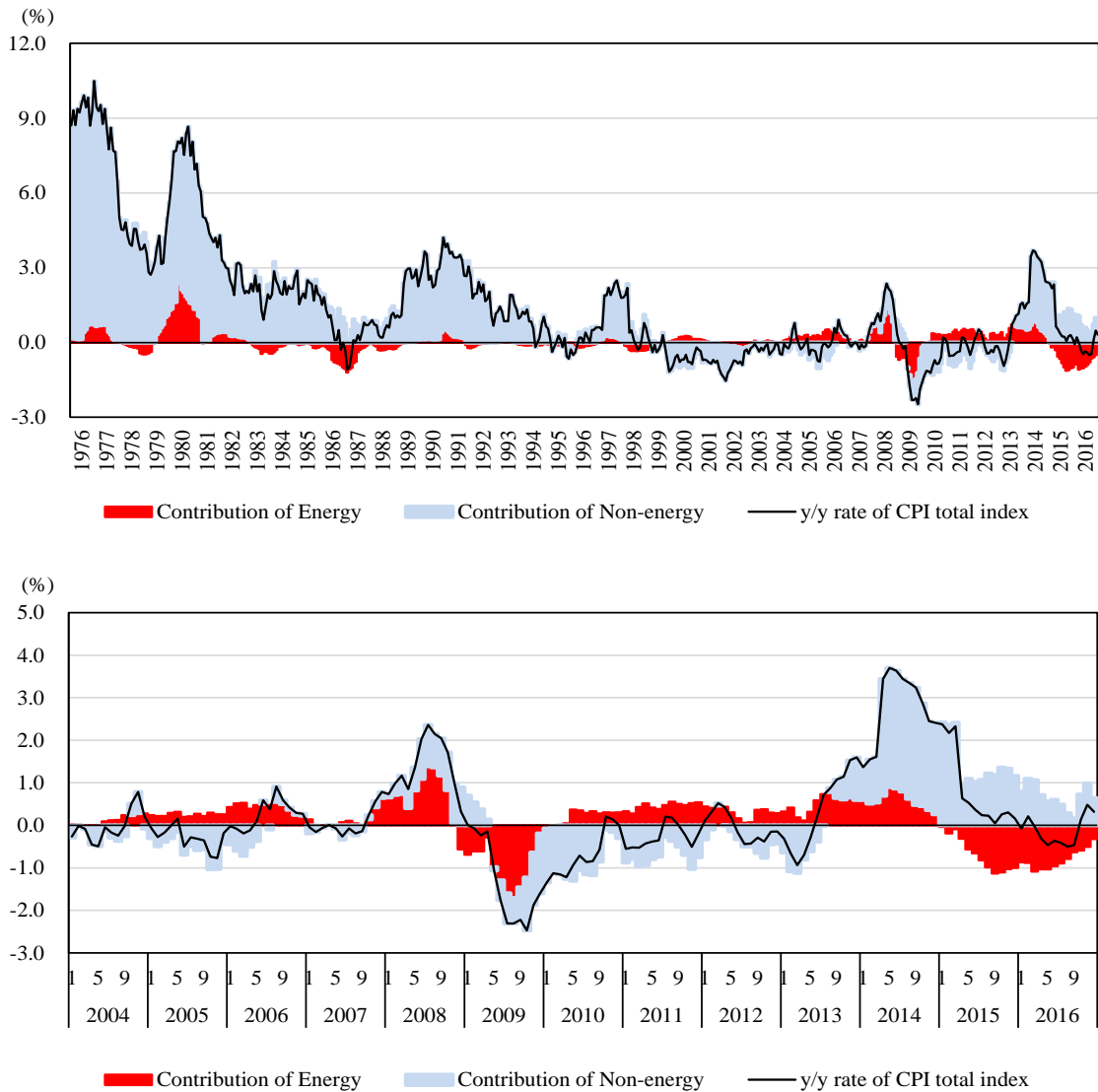
Fig. 7 “Kerosene” price indices calculated by “Petroleum Product Price Survey” and CPI



8. Energy price index and CPI

Fig. 8 shows contribution decomposition of CPI total index as two categories, “Energy” and “Non-energy”. The weight of “Energy” is 7.84% on the 2015-base index series, 6.83% on the 2000-base index series and 7.26% on the 1980-base index series, those are consistently less than 10%. Nevertheless, the absolute value of the contribution of “Energy” is often about the same as “Non-energy” since 2000s. The items that compose “Energy” are strongly influenced by the import price of crude oil and LNG as we have seen. For Japanese consumers’ lives, it is important that energy is supplied stably and cheaply. Although we have looked at from the perspective of consumers who are subject to CPI here, it is equally important for production activities, and securing stable energy is an important policy issue for the Japanese government.

Fig. 8 Contribution decomposition of Energy to y/y rate of CPI total index



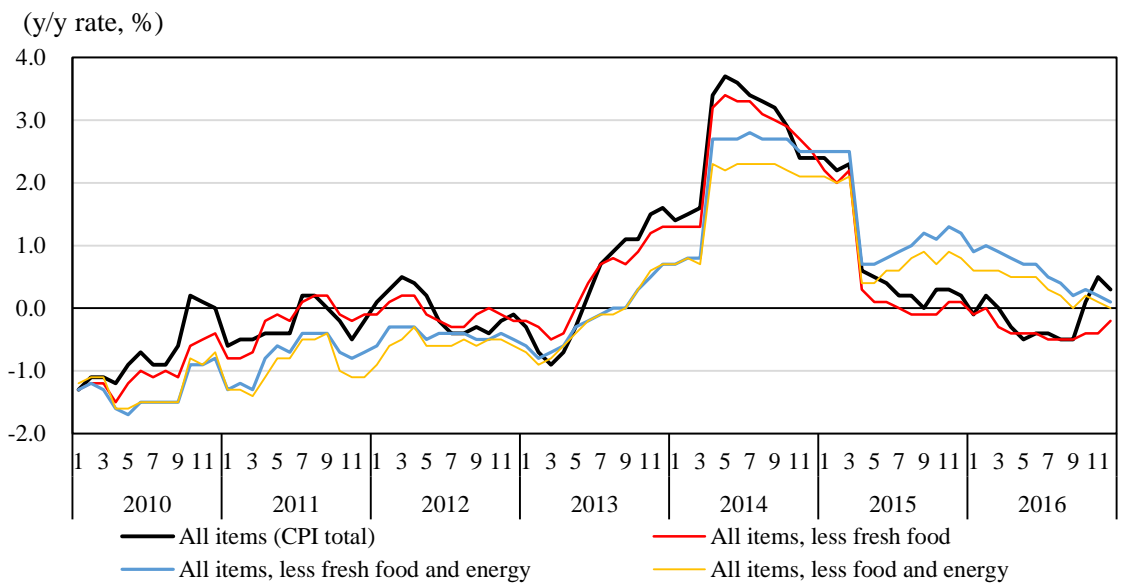
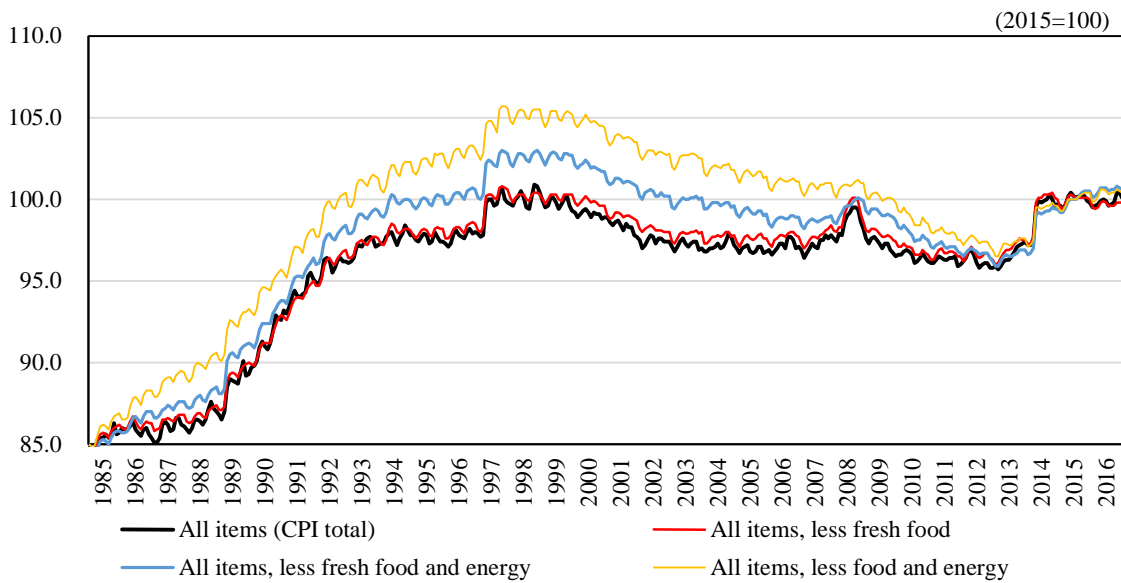
9. Positioning of energy price index as core indicators

What is referred to as “core indicator” in CPI of Japan is the “excluding fresh food” index. This series was started in 1962. Although the “excluding fresh food” index seldom deviates from CPI total index, the effect of short-term price fluctuation of fresh food is eliminated and it is considered useful for observe trend of the CPI total index. (Fresh foods are sometimes subject to short-term but very large price fluctuations due to weather factors and may also contribute significantly to the CPI total index.) This indicator excludes only “Fresh food”, whereas “Energy” has been included.

On the other hand, as we have seen, the price fluctuation of “Energy” is strongly influenced by overseas market conditions (crude oil market, foreign currency exchange market etc.) from the background such as dependence on importing almost all of petroleum. Therefore, since around 2005, indices excluding “Food” as well as “Energy” etc. are also being used together. The Statistics Bureau of Japan (A Governmental bureau in the Ministry of Internal Affairs and Communications) started to publish “excluding food and energy” index, which is also used in OECD analysis. The Cabinet Office (government agencies in charge of economic policy) created indices “excluding fresh foods, energy, institutional factors (items that are not directly related to domestic supply and demand factors), etc.” from 2006 to 2016 [15]. In addition, the Bank of Japan (central bank of Japan) created “excluding fresh food and energy” from 2015 to 2016 [16].

Since January 2017, the Statistics Bureau of Japan decided to calculate “excluding fresh food and energy” index. Currently, the Statistics Bureau of Japan releases three series indices, the “CPI total” index, the “excluding fresh food” index, and the “excluding fresh food and energy” index, as headlines. In the “Monthly Economic Report”, the Cabinet Office made a judgment on consumer price trend centered on “excluding fresh food and energy” [17]. The Bank of Japan set “excluding fresh food” as a main indicator to measure achievement of the price stability target, while focusing also on indicators such as “excluding fresh food and energy”, monetary policy is being formulated. Also, the Statistics Bureau of Japan continues to publish “excluding food and energy”. However, at present, this indicator is not regarded as one of the headlines.

Fig. 9 Core indices on Japanese CPI



10. Influence on drift in chain index

In Japanese CPI, chain index is published as a reference series. Regarding the chain index, it is said that there is a drift problem. In Japanese chained-CPI, fresh foods have short-term large fluctuations in prices, then they have often become a factor of drift, although their scales are relatively small. Also, energy price sometimes moves up and down, which can be a factor of drift. The “Energy” price index rose sharply in 2008, and then, plummeted in 2009. For 2009, the contribution of the “Energy” chain index (-0.78) has a smaller contribution than the 2005-base fixed index (-0.95). It can be interpreted that a large-scale drift has occurred [18].

After that, the “Energy” price index gradually rose to 2014, and it fell sharply from 2015 to 2016. With respect to 2016, while the “Energy” weight of the link index is 7.84% and the year-on-year rate of “Energy” price index is -10.3%, whereas the “Energy” weight of the 2010-base fixed index is 7.72% and year-on-year rate of “Energy” price index is -10.1%. In other words, the chain index has a greater “Energy” weight than the fixed base index, and the price fall is also large. However, the contribution degree of the “Energy” in the chain index (-0.82) has a smaller negative contribution than in the fixed reference type index (-0.86), and there is a possibility that small scale drift may have occurred.

11. Summary

In Japan, energy resources, such as crude oil, coals and natural gas, are mostly supplied by imports. The Japanese CPI and living consumption of Japanese households have been influenced by fluctuations in imported energy prices directly or indirectly. The energy price index in the CPI, that is useful for measuring direct impact of energy prices, is composed of “electricity and gas” index and “petroleum products (heating fuel and automobile fuel)” index. It is very important to estimate these price indices precisely and effectively.

Among the 585 survey items that constitute the current whole CPI of Japan, the energy index is composed of 5 survey items. The monthly fluctuation of the current “electricity” or “gas” price indices often reflects fluctuations based on the fuel cost adjustment system. This means that fluctuations in import prices of crude oil, coal and LNG will be reflected in electricity or gas price indices with a time lag of a few months. The vast majority of households still continue contracts based on regulated fee system for electricity and gas. Therefore, in calculating current CPI, only the regulated fee is covered.

Retail prices of gasoline include volatile oil tax. Retail gasoline price excluding tax correlate to crude oil import price strongly. “Gasoline” price index doesn’t include price of premium gasoline, diesel oil and selling price at self-service station, but it doesn’t brought large bias for the CPI.

In Japanese CPI, “excluding fresh food” index or “excluding fresh food and energy” index often treated as core indices. For chain indices released as reference index, sharp rise and decline of energy price index brought some drift for chained-CPI in 2009.

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