

## Structure for Pass-Through of Oil Price to Gasoline Price in Japan

Akira Yanagisawa\*

### Executive Summary

There is a high level of interest in gasoline price changes since gasoline is a necessary commodity *e.g.* in rural areas people greatly depend on automobiles. Japan currently adopts a market-linked pricing system for the wholesale price of gasoline from primary distributors to their agencies. Transparency is secured by revising the wholesale price referring to the domestic market prices such as futures and spot prices.

However, the domestic market prices referred by the market-linked pricing system are also influenced by oil price, as well as the supply of and demand for gasoline. Even after introduction of the system, there is still a strong relationship between the gasoline retail price and the oil price. This paper conducts a quantitative analysis of how the oil price, a fundamental external factor, is passed-through to the gasoline retail price.

The pass-through rate of the oil price to the retail price was 89% in the period of rising oil price, while 39%, less than half, in the period of falling oil price, indicating an asymmetry. The fierce competition in the gasoline business does not allow the retail price to be increased beyond the rise in the oil price, yet the fall in oil price is compressed when it is reflected in the retail price. Considering the weight of the oil price, the difference in the pass-through rates in the period of rising and falling price is not small. Low pass-through rate and asymmetry originate in both the pass-through from the oil price to the wholesale price and that from the wholesale price to the retail price. The asymmetry contributes to improving the harsh management foundation of both primary distributors and agencies. Inversely, it can be understood that the efforts to secure profits are expressed in this asymmetry.

The regional variance in the pass-through stems from the variance in the pass-through rate from the wholesale price to the retail price. In the high-priced areas and areas where gas stations are scarce, the pass-through rates are low, and a downward rigidity of price is particularly observed. However, in the low-priced areas changes in wholesale price are relatively well reflected. This results in regional variance of retail price to widen in the period of falling oil price.

### 1. Introduction

In October 2008, (then) Nippon Oil Corporation and Idemitsu Kosan Co., Ltd., changed the wholesale price to the market-linked pricing system. This marked the transfer to a method of determining the wholesale price, referring to domestic market prices such as futures and spot prices, every week. With the rapid rise of oil price until mid-2008, the inherent problems of the crude oil cost-linked system, a system for revising the wholesale price each month in accordance with the changes in oil price adopted until then, could no longer be overlooked, triggering its introduction. The primary distributors showed their intent to secure transparency of the wholesale price by reflecting the market prices and agile revision of price.

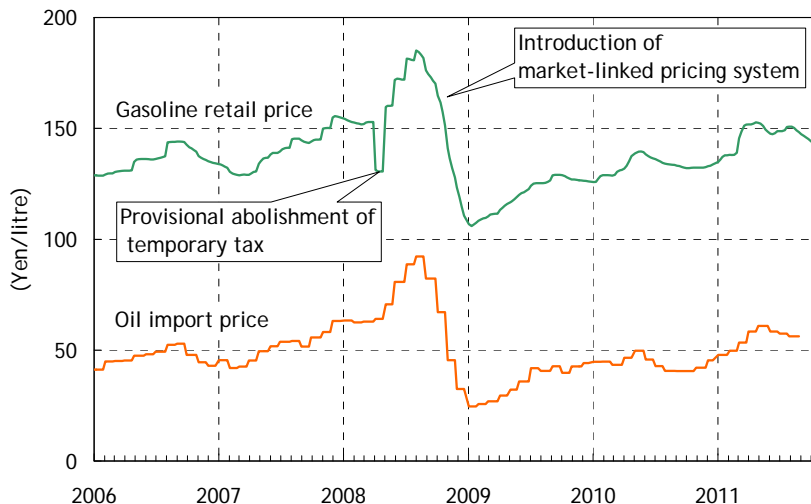
With Showa Shell Sekiyu K.K. transferring over to the market-linked pricing system in July 2009, the system was adopted for the wholesale price in almost all of Japan. However, the domestic market prices referred to in the market-linked pricing system are influenced by both the demand and supply situation of gasoline and the oil

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\*Senior Economist, Energy Demand, Supply and Forecast Analysis Group, Energy Data and Modelling Center (EDMC), The Institute of Energy Economics, Japan

price. As a result, even after the introduction of the market-linked pricing system, and even after the partial review of the system made in the first half of FY 2010, there is still a strong relationship between the gasoline retail price and the oil import price (Fig. 1-1).

Fig. 1-1. Gasoline retail price and oil import price



Note: Retail gasoline price: regular gasoline, shop price, including consumption tax, nationwide, survey conducted on Monday; Oil import price: CIF, monthly average

Source: Gasoline: “General Retail Price Survey,” The Oil Information Centre, The Institute of Energy Economics, Japan (IEEJ); Oil: “EDMC Energy Trend,” The Energy Data and Modelling Centre, IEEJ

In the medium-to-long term, if the crude oil cost is not passed-through in an appropriate manner, there will be a risk of the system to supply gasoline becoming unsustainable. Under these situations, the fluctuations in gasoline retail price are often observed and explained in connection with oil prices. Major newspapers have reported the following:

*Mainichi Shimbun*: “...The range of fall has decreased reflecting the bottoming out of international oil prices...”<sup>1</sup>

*Yomiuri Shimbun*: “...The cause of the fall in price is considered to be the stagnant domestic demand and the fall in overseas oil prices...”<sup>2</sup>

*Asahi Shimbun*: “...Because oil prices fell with future uncertainties in European finance and the US economy...”<sup>3</sup>

*Nihon Keizai Shimbun*: “...It marked its lowest figure in the past seven months with the sudden fall in international oil prices at the end of September...”<sup>4</sup>

There is a high level of interest in price fluctuation since gasoline is a necessary commodity *e.g.* in rural areas people greatly depend on automobiles. In this situation, some consumers complain that while the price rises

<sup>1</sup> “Gasoline prices fall for 11 consecutive weeks,” *Mainichi Shimbun*, 27 Oct. 2011

<sup>2</sup> “Gasoline prices fall for 10 consecutive weeks,” *Yomiuri Shimbun*, 20 Oct. 2011

<sup>3</sup> “Gasoline prices fall again” *Asahi Shimbun*, 6 Oct. 2011.

<sup>4</sup> “Price fall in gasoline prices widens,” *Nihon Keizai Shimbun*, 6 Oct. 2011.

quickly when oil price goes up, it does not come down as fast when it falls. On the other hand, the gas stations are distressed by the fact that it is difficult to pass-through the increase in purchase cost to the retail price.

This paper therefore focuses on the relationship between the gasoline price and the oil price, a fundamental external factor for the gasoline price, in Japan. In other words, a quantitative analysis is conducted on how the oil import price is passed-through to the gasoline retail price after introduction of the market-linked pricing system.

## 2. Pass-through of Oil Import Price to Gasoline Retail Price

An orthodox method of observing a quantitative relationship between the oil import price<sup>5</sup> and gasoline retail price<sup>6</sup> is regression analysis of the latter by the former. However, the possibility of both prices being non-stationary is inferred. This being the case, the regression between the price levels provides spurious correlation and could prevent accurate analysis. To avoid this, differences from the previous month for both series are taken to make them stationary and a regression analysis is performed between the series of differences, *i.e.*, as pass-through relationship. Other independent variables – the amount of domestic gasoline sales<sup>7</sup> and amount of gasoline stock at the beginning of the period<sup>8</sup> that indicate the supply and demand balance situation in the upper stream of distribution, as well as the amount of gasoline purchased per household<sup>9</sup> which are taken as the proxy variable for retail market conditions. Consideration is also given to the possibility that pass-through is asymmetric (the degree of pass-through differs depending on periods of rising and falling price). The model used is as follows:

$$\begin{aligned} \Delta \text{Retail price}_t = & \sum_{i=0}^1 \beta_i^+ \max(\Delta \text{Oil price}_{t-i}, 0) + \sum_{i=0}^1 \beta_i^- \min(\Delta \text{Oil price}_{t-i}, 0) \\ & + \gamma_w \Delta \text{Amount of domestic sales}_t \\ & + \gamma_s \Delta \text{Amount of stock at the beginning of the period}_t \\ & + \gamma_r \Delta_{12} \text{Amount of gasoline purchased per household}_{t-1} + \gamma_e \text{ECT}_{t-1} + u_t \end{aligned} \quad (1)$$

where  $\Delta$  is the change from the previous month,  $\Delta_{12}$  is the year-on-year change, ECT is the error correction term (deviations from medium- to long-term equilibrium values) and  $u$  is the residuals.  $\beta^+$  and  $\beta^-$  indicate the pass-through rates to the gasoline price when the oil price rises or falls, respectively.

The regression period was determined to be from January 2009, when the market-linked pricing system was beginning to permeate, to September 2011.

As a result, the pass-through rate of the oil price to the retail price was estimated at 89%<sup>10</sup>, less than full

<sup>5</sup> “EDMC Energy Trend,” The Energy Data and Modelling Center, IEEJ. CIF, yen denominated, monthly average; hereinafter “oil price.”

<sup>6</sup> “General Retail Price Survey,” The Oil Information Center, IEEJ. Regular gasoline, shop price, excluding gasoline tax and consumption tax, nationwide, monthly average of Monday surveys; hereinafter “retail price.”

<sup>7</sup> “Resources and Energy Statistics,” METI. The amount of domestic sales volume is the amount sold to the wholesale and retail business by petroleum product manufacturers and importers. Seen from the downstream of distribution, this equals the sum of the amount sold to the final consumer and stock changes in distribution.

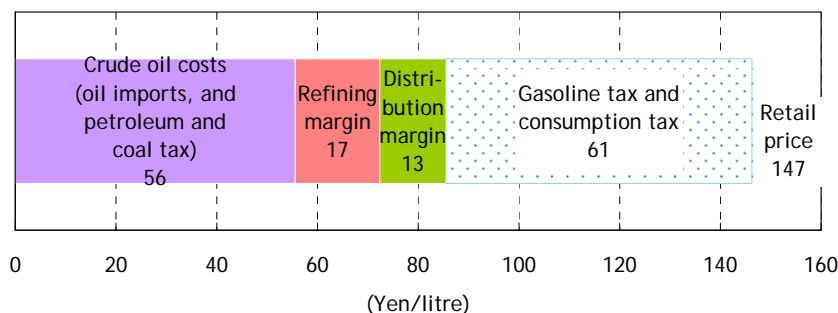
<sup>8</sup> “Resources and Energy Statistics,” METI

<sup>9</sup> “Family Income and Expenditure Survey,” households with two or more members, Statistics Bureau, Ministry of Internal Affairs and Communications

<sup>10</sup> In this model, changes in gasoline retail price are explained by changes of oil price in the relevant month and the previous month. This being the case, the period of rising price is when oil prices increased for two consecutive months. The same applies to the period of falling price.

pass-through (100% pass-through rate) in the period of rising oil price<sup>11</sup> and 39% in the period of falling oil price; much less than in the period of rising price<sup>12</sup>. This indicates that pass-through is asymmetric. The severe situation of the gasoline business does not allow the retail price to rise above the rise in oil price. However, when the oil price falls, the amount of fall is reduced in the retail price. Considering the weight of the crude oil cost in the retail price (Fig. 2-1), the difference in pass-through rates in the periods of rising and falling price is not small.

Fig. 2-1. Cost structure of gasoline retail price (including tax)  
(September 2011, average)



Note: Petroleum and Coal Tax is 2.04 yen/litre, gasoline excise is 48.6 yen, local gasoline excise is 5.2 yen

The cause of the high pass-through rate in the period of rising price is believed to come from the fact that business continuity is difficult unless retail prices are increased following the increase in crude oil costs. On the other hand, the cause of retail prices not decreasing in line with the fall in oil price is believed that forces work to secure profits and maintain management strength as much as possible. This is because gasoline is a necessary commodity, meaning decrease in the total amount of sales is limited even if the fall in price being reduced (gasoline demand is inelastic to price)<sup>13</sup>.

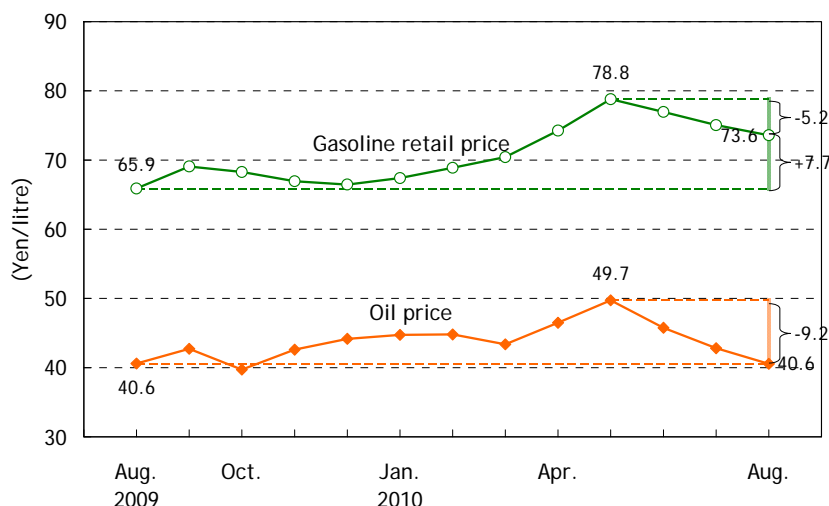
The situation that took place for a period of a little over a year from August 2009 can be introduced as a typical example of the asymmetry of pass-through (Fig. 2-2). The oil price, which was 41 yen/litre in August 2009, gradually rose with the increase in international oil prices supported by expectations for economic recovery. In May 2010, it reached 50 yen, but with rising concerns of the European financial crisis, it returned to 41 yen in August 2010. Though gasoline indicated a similar trend, a review of the details finds differences. While oil price fell to the level of the previous year in August 2010, gasoline remained at 74 yen/litre and did not return to its year-on-year level (66 yen/litre), exceeding it by about 8 yen. While the oil price, which peaked in May 2009, fell almost 9 yen, the fall in the gasoline price was just above 5 yen.

<sup>11</sup> In standard price theory, demand will decrease by price increase. Then the equilibrium price will not increase as much as the increase in oil price, meaning that a full pass-through will not occur. However, gasoline demand is inelastic against price, especially in the short-term, and the effect on retail price by supply and demand adjustment is considered to be minor.

<sup>12</sup> Actual change in retail price will also reflect the inventory factor, etc. described above.

<sup>13</sup> However, competition among gas stations is fierce.

Fig. 2-2. Retail price and oil price (August 2009 - August 2010, monthly average)



Source: Gasoline: Calculated from “General Retail Price Survey,” The Oil Information Centre, IEEJ; Oil: “EDMC Energy Trend,” The Energy Data and Modelling Center, IEEJ

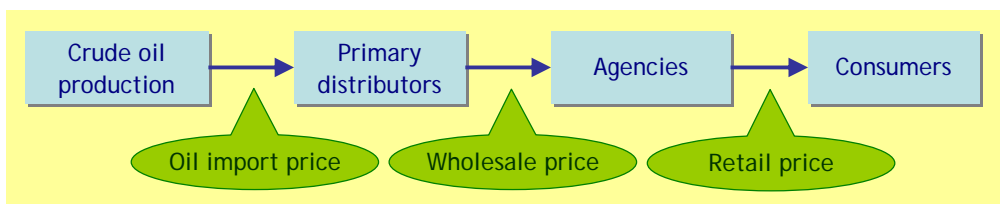
### 3. Decomposition of Pass-through of Oil Price to Retail Price

#### 3-1. Subject of Analysis

So then from where do the low pass-through rate and asymmetry in the pass-through of the oil price to the retail price come?

Of the various distribution routes of gasoline, that with the largest handling is the one that starts with the primary distributors, going through the agencies and on to the final consumer. Though direct sales by the primary distributors are on the increase, almost 60% of the entire sales amount is still sold through the agencies. The pass-through of the oil price to the retail price is analysed by measuring the pass-through rate of oil price to the gasoline wholesale price, and the pass-through rate of the gasoline wholesale price on the retail price.

Fig. 3-1. Prices subject to analysis and relevant gasoline distribution route



#### 3-2. Pass-through of Oil Price to Gasoline Wholesale Price

The model for analysing the pass-through of the oil price to the gasoline wholesale price<sup>14</sup> is similar to the one used to analyse the pass-through of the oil price to the retail price, which was mentioned above. However, only

<sup>14</sup> “Wholesale Price Survey,” The Oil Information Center, IEEJ. Without tax; hereinafter “wholesale price”

the amounts of domestic sales and stock at the beginning of the period that indicate the supply and demand situation in the upper stream of distribution are used as independent variables, apart from the oil price. Specifically, the formula is as per formula (2).

$$\begin{aligned} \Delta \text{Wholesale price}_t = & \sum_{l=0}^1 \beta_l^+ \max(\Delta \text{Oil price}_{t-l}, 0) + \sum_{l=0}^1 \beta_l^- \min(\Delta \text{Oil price}_{t-l}, 0) \\ & + \gamma_w \Delta \text{Amount of domestic sales}_t \\ & + \gamma_s \Delta \text{Amount of stock at the beginning of the period}_t + u_t \end{aligned} \quad (2)$$

The explanatory power of the oil price on the wholesale price is not that high since the major reference index of the wholesale price is the domestic market prices in the market-linked pricing system. However, it has been estimated that, on average, 77% of rise and 69% of fall in the oil price has been passed-through to the wholesale price. In other words, in the pass-through of the oil price to the wholesale price, there is lower pass-through with slight asymmetry.

### 3-3. Pass-through of Wholesale Price to Retail Price

In the model to analyse the pass-through of the wholesale price to the retail price, the amount of gasoline purchased per household is used to indicate the retail market situation as an independent variable other than the wholesale price. Specifically, its formula is as follows:

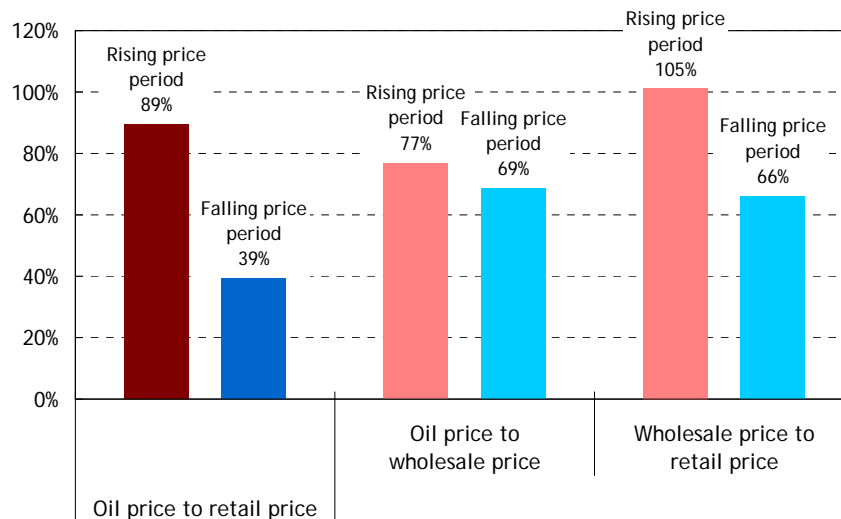
$$\begin{aligned} \Delta \text{Retail price}_t = & \sum_{l=0}^1 \beta_l^+ \max(\Delta \text{Wholesale price}_{t-l}, 0) + \sum_{l=0}^1 \beta_l^- \min(\Delta \text{Wholesale price}_{t-l}, 0) \\ & + \gamma_r \Delta_{12} \text{Amount of gasoline purchased per household}_{t-1} + \gamma_e \text{ECT}_{t-1} + u_t \end{aligned} \quad (3)$$

The explanatory power of the wholesale price on the retail price is substantially higher than that of the oil price on the wholesale price. The pass-through rate in the period of rising wholesale price is 105%, exceeding full pass-through. On the other hand, the pass-through rate in the period of falling price is only 66%; significantly lower. This indicates that asymmetry can also be seen in the pass-through of the wholesale price to the retail price.

### 3-4. Decomposition of Pass-through of Oil Price to Retail Price

From the above, the low pass-through rate and asymmetry of pass-through of the oil price to the retail price is estimated caused in both stages *i.e.* the pass-through of the oil price to the wholesale price and from the wholesale price to the retail price. Exceptionally the pass-through rate in the period of rising price from the wholesale price to the retail price is high.

Fig. 3-2. Decomposition of pass-through of oil price to retail price



Regarding contribution to asymmetry, the pass-through of the wholesale price to the retail price is greater. On the other hand, a somewhat large asymmetry exists in the pass-through of the domestic market prices referenced in the market-linked pricing system to the wholesale price (see Box).

Box: Oil Price and Domestic Market Prices, Domestic Market Prices and Wholesale Price

Given the structure of the market-linked pricing system, price pass-through from the oil price to the wholesale price can be considered in two stages: (1) the pass-through of the oil price to the domestic market prices<sup>15</sup> and (2) the pass-through of the domestic market prices to the wholesale price. Here, the futures price<sup>16</sup> was used as a proxy variable for the domestic market prices and analysed.

(1) Oil price and domestic market prices

The changes in domestic market prices are explained through the changes of oil price, amounts of domestic sales and stock at the beginning of the period. The estimated pass-through rate was 63% in the period of rising price and 63% in the period of falling price. Though there is no asymmetry, the pass-through rate is not high.

(2) Domestic market prices and wholesale price

The changes in the wholesale price are explained through the changes of the domestic market prices and stock at the beginning of the period. The pass-through rate in the period of rising wholesale price was 80% In the period of falling price it was only 60% of the rising price period, at 47%. Asymmetry is observed in the pass-through.

From this, it can be estimated that the asymmetry in pass-through from the oil price to the wholesale price is generated at the stage of pass-through from the domestic market prices to the wholesale price.

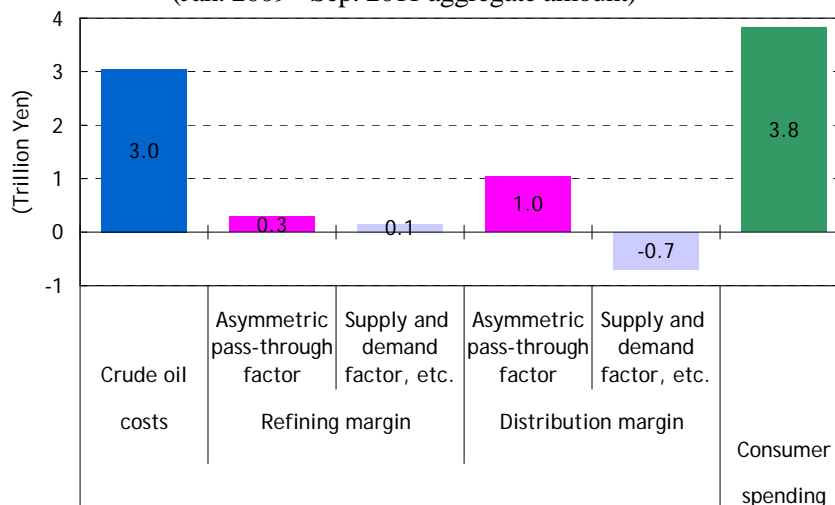
These asymmetries influence, for example, the structure for bearing the crude oil costs. The crude oil costs on

<sup>15</sup> Strictly speaking, the term “pass-through” does not apply.

<sup>16</sup> Tokyo Commodity Exchange, Inc., front month, settlement, monthly average

gasoline have increased by an aggregate 3 trillion yen<sup>17</sup> between the periods from January 2009, when oil prices bottomed out until September 2011 (Fig. 3-3).

Fig. 3-3. Increase in gasoline expenditure by consumers and its breakdown  
(Jan. 2009 - Sep. 2011 aggregate amount)



Note: Calculated at 4.8 million kL/month

If pass-through of the oil price to the gasoline price is full (pass-through rate = 100%), the final consumer will bear the full increase of the crude oil cost of 3 trillion yen. However, though the pass-through rate is lower than 100%, with the asymmetry (and other factors such as the supply and demand situation of gasoline) the increase in final consumer spending is approximately 3.8 trillion yen, exceeding the crude oil cost increase. The asymmetry in pass-through is expected to contribute to a 1.3 trillion yen rise in consumer spending by both the pass-through of the oil price to the wholesale price and that of the wholesale price to the retail price combined<sup>18</sup>. This is much greater even after the setoff of the effects of the fall in prices for market stagnation in the retail market (approximately 0.7 trillion yen).

#### 4. Pass-through Situation by Region

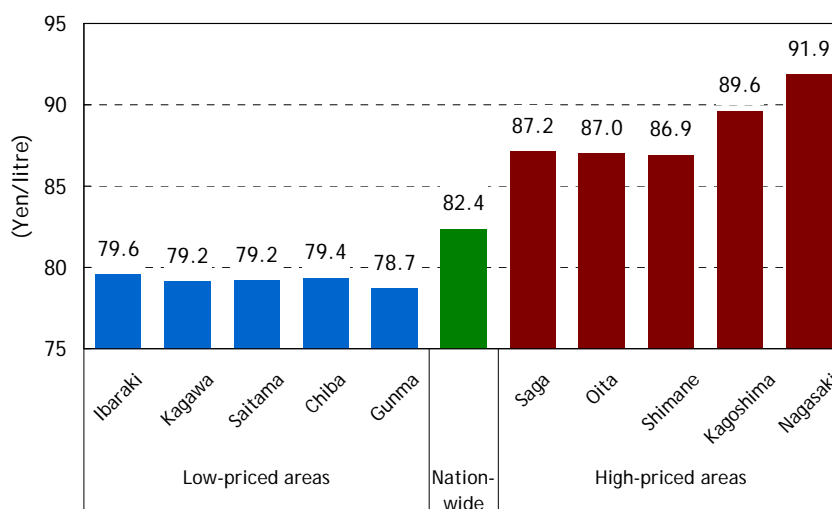
Reflecting the local situation, the retail prices vary significantly from region to region. For the prefectures in the Kanto region, with fierce competition among gas stations it is sold at 3-4 yen/litre cheaper than in other parts of the country. On the other hand, in places like Nagasaki and Kagoshima, with many separated islands where transportation costs are high, the selling price is 7-9 yen higher than in the rest of the country.

<sup>17</sup> In comparison to the case where the oil price has continued to remain at the January 2009 level.

<sup>18</sup> Compare with the case in which the pass-through rates in the period of rising and falling price are identical (average for both periods) and the pass-through is symmetric.



Fig. 4-1. Retail price (October 2011 average)



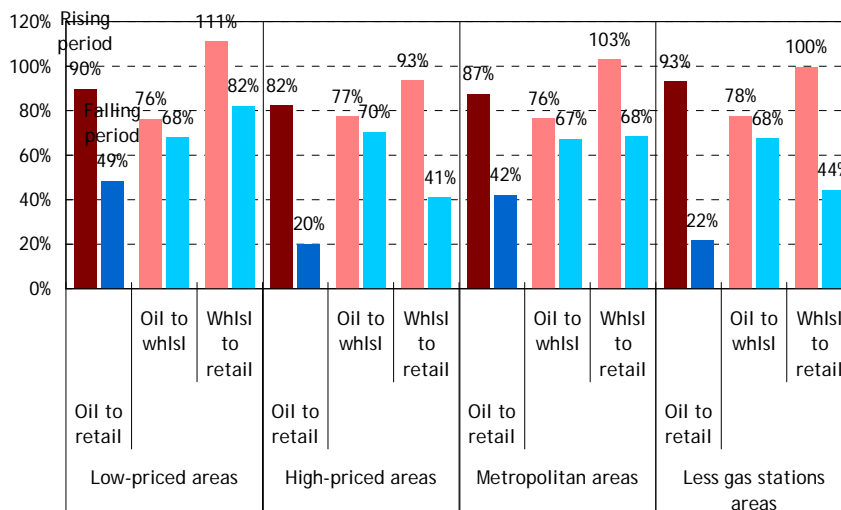
Source: Calculated from “General Retail Price Survey,” The Oil Information Centre, IEEJ

There could also be locality existing in the pass-through of the oil price to the retail prices, in addition to the price level. We therefore conducted an analysis on the five lowest priced prefectures in average between January 2009 and September 2011 (Ibaraki, Kagawa, Saitama, Chiba and Gunma) along with the high-priced areas (Nagasaki, Kagoshima, Shimane, Oita and Saga). We also added the urban metropolitan areas where the amount of sales per gas station was larger (Tokyo, Kanagawa, Aichi, Osaka and Fukuoka)<sup>19</sup> and the less gas stations areas (Hokkaido, Shimane, Tottori, Kochi and Yamaguchi<sup>20</sup>) with fewer gas stations per length of national routes and prefectural routes to the subjects of analysis. Fig. 4.2 shows the results of estimation of the pass-through rate.

<sup>19</sup> The average amounts of sales per gas station in these five prefectures are more than double the average in other prefectures.

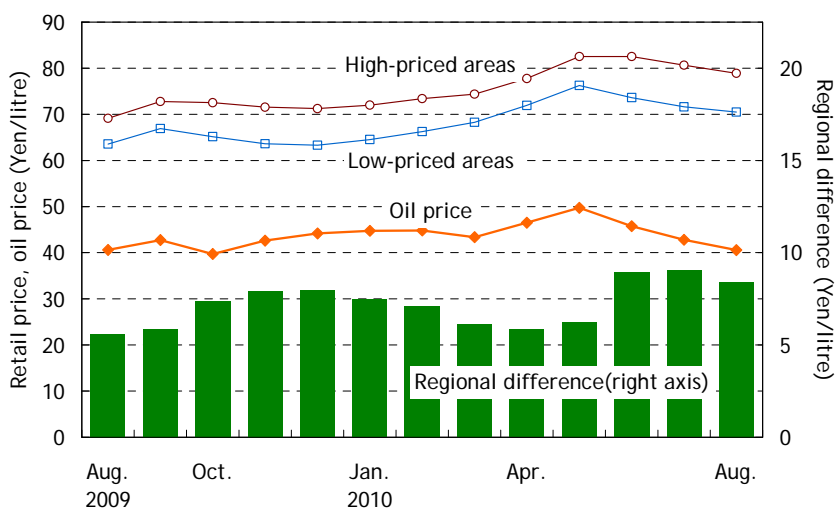
<sup>20</sup> Earthquake-damaged Iwate (fifth) was removed and substituted by sixth-ranked Yamaguchi.

Fig. 4-2. Decomposition of pass-through of oil price to retail price (by region)



Though the pass-through rate of the oil price to the retail price in the period of rising price was a little lower in the high-priced areas, overall the rates were within the same level for all the areas. In comparison, a large regional difference was seen from the pass-through rates in the period of falling price. While the metropolitan areas were around the national average, at 42%, and there was a slightly higher rate of 49% in the low-priced areas, the figures were only around the 20% level in both the high-priced and the less gas stations areas. This being the case, it is expected that the price gap between the low-priced and high-priced areas will become more significant in the period of falling oil price. Looking at the retail prices between August 2009 and August 2010, the retail price in high-priced areas was slow to fall in the period of falling price and the increasing trend in the price gap with the low-priced areas can be observed (Fig. 4-3). Inversely, the gap narrowed during the period of rising price because the pass-through rate in the low-priced areas was relatively higher.

Fig. 4-3. Regional differences in retail prices and oil price (Aug. 2009 - Aug. 2010, monthly average)



Source: Gasoline: Calculated from “General Retail Price Survey,” The Oil Information Centre, IEEJ; Oil: “EDMC Energy Trend,” The Energy Data and Modelling Centre, IEEJ

In the pass-through rates by stages of distribution, that of the oil price to the wholesale price was upward of 75% for all regions in the period of rising price and around 70% in the period of falling price. On the other hand, the pass-through rates from the wholesale price to the retail price indicated a large regional difference, especially in the period of falling price. The regional difference in the pass-through rate of the oil price to the retail price can be said caused by the difference in the pass-through rates of the wholesale price to the retail price.

It is interesting to note that the pass-through rate of the wholesale price to the retail price in the high-priced areas (93%) in the increase period is lower than that for the low-priced areas (111%). The high retail prices in the high-priced areas are not the result of a large price increase and small price decrease, but rather are characterised more in their asymmetric nature coupled with price rigidity. This is believed to be the result of the gas stations being small in size on average<sup>21</sup> with little margin in management. Inversely, in the low-priced areas, with fierce competition among the gas stations the pass-through rate might be thought to be low in the period of rising price, but the pass-through surpasses the full pass-through rate actually. Factors such as a low-margin, high-turnover business model in which the increase in purchase cost must be securely passed-through to the retail price for the business to succeed, the existence of price leaders, represented by “hyper” gas stations<sup>22</sup> could be considered to have a strong influence on the price increase. In the low-priced areas, the pass-through rate in the period of falling price is also relatively high (but not exceeding the pass-through rate in the period of rising price), and it can be said that this fact reflects the changes in the wholesale price more than for other areas.

The less gas stations areas show the same tendencies as in the high-priced areas. In other words, the pass-through rate is low in the period of falling price with large asymmetry. The scarcity of competing gas stations could also be the backdrop of downward rigidity in price. The pass-through rate in metropolitan areas is almost the same as the national average and no special regional differences can be noticed compared to the three other areas.

## 5. Summary

The pass-through of the oil price to the gasoline retail price does not reach full pass-through, reflecting the severe conditions of the gasoline business, and asymmetry can be observed. This means that while the pass-through rate in the period of rising oil price is 90%, it is less than half at only 40%, in the period of falling price. The gap of pass-through rates between the period of rising price and falling price reaches 50 percentage points. Considering the share of crude oil cost in the retail price cost structure, this gap is not small. The low pass-through rates and asymmetry of pass-through are understood to come from both stages in the pass-through of the oil price to the wholesale price (pass-through of the domestic market prices to the wholesale price for asymmetry, to be more exact) and in the pass-through of the wholesale price to the retail price.

The regional difference in pass-through is caused by the difference in pass-through rate of the wholesale price to the retail price. The pass-through rate in the low-priced areas is higher than the national average for periods of both rising and falling price, reflecting better the fluctuation of the wholesale price relatively. Conversely, in the high-priced areas and the less gas stations areas, the pass-through rate is low and downward price rigidity is particularly observed. As a result, the regional difference in retail prices tends to expand in the period of falling oil price. With improvements in the fuel economy and the fall in automobile ownership, gasoline demand is expected to transition on a declining trend. As the shake-up of failing gas stations continues along with this trend,

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<sup>21</sup> The average amount of sales per gas station in high-priced areas is not only smaller than the national average, but even smaller than the non-metropolitan region average.

<sup>22</sup> Large-scale sales structure co-established in shopping malls, etc.

there is possibility of an increase in areas where more travel will be required to refuel and at the same time, the regional gap in prices will widen.

The relationship between the domestic market prices and the wholesale price, and the wholesale price and the retail price, is judged quite clear. In this sense, the securing of transparency, one of the objectives of the introduction of the market-linked pricing system, can be said to be somewhat achieved. However, consumers may feel unconvinced by the fact that now becomes clear, that retail price rises, but do not falls, easily.

The environment surrounding the gasoline business is severe and half the petroleum sales operators are facing losses, and the average operating profit margin is lower than the average for wholesale and retail business, at only 0.6%<sup>23</sup> (FY 2009). Under such a situation, the asymmetry in pass-through may be said to be contributing to the improvement in the management foundation for both primary distributors and agencies. Inversely, it can also be understood that efforts to secure profits are indicated in the form of asymmetry.

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Contact: report@tky.ieej.or.jp

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<sup>23</sup> "Petroleum Products Sales Business Management Survey Report," National Petroleum Association