

## Structure of Pass-Through of Oil Price and Exchange Rate to Gasoline Price in Japan

— Effect of Depreciation of the Yen on the Rise of Gasoline Price —

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### Summary

*Gasoline price has been surging. The retail price of gasoline recorded JPY155.2/L, the highest since April 2012, on 18 February 2013. The increase since mid-November 2012, when the current surge started, reached JPY10/L. The soaring oil price drove the surge of gasoline price. Oil price in dollar, however, has been stable—although at a high level of around \$107/bbl—for the last three months. It is the rapid depreciation of the yen that raises the oil price in the currency.*

*Oil price accounts for the largest portion in the cost structure of gasoline retail price along with the excise “gasoline tax” of JPY53.8/L. Therefore, oil price and the structure of pass-through of oil price to gasoline price affect gasoline price greatly.*

*We analysed the pass-through structure of oil price in dollar factor and exchange rate factor to gasoline price by decomposing changes in oil price in yen into the two factors. The pass-through rates of oil price in dollar factor were 59% and 61% when the factor increased and decreased, respectively. Although the pass-through rates were well below complete pass-through, the pass-through was symmetric. The pass-through rate of the exchange rate factor was 108%, more than the complete pass-through when the yen depreciated—the factor contributed to an increase in gasoline price. On the other hand, the rate was only 79% when the yen appreciated—the factor contributed to the decrease—showing asymmetry in the pass-through.*

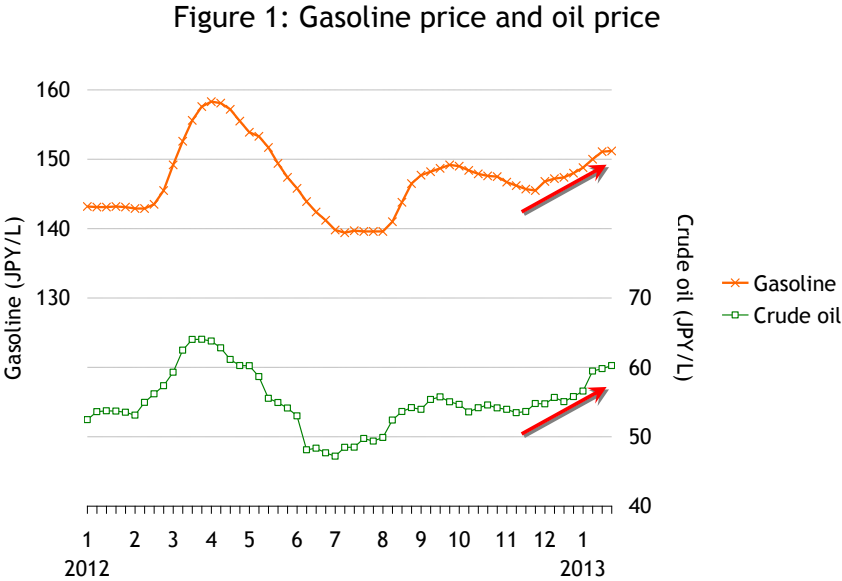
*Changes in exchange rates contributed to the rise of gasoline price including taxes by more than JPY7/L in the last three months (19 November 2012 – 4 February 2013). The depreciation of the yen by JPY1/\$ leads to rise of gasoline price by JPY0.79/L when the oil price in dollar is \$110/bbl. The pass-through rate of oil price in yen to gasoline price, which is estimated directly, can be regarded as an implicit weighted average of the pass-through rates of the two factors above. They were estimated at 72% and 60% when the oil price rose and fell, respectively.*

*The low pass-through rates reflect the difficulty in gasoline business—especially in the retail sector—and the asymmetry comes from efforts in securing business continuity in a harsh business environment. Social recognition linking gasoline price closely with oil price in dollar, which is widely reported, may affect the fact that pass-through of oil price in dollar factor is symmetric while that of the exchange rate factor is asymmetric.*

Keywords: Gasoline price, oil price, exchange rate and pass-through

**Rising gasoline price**

Gasoline price has been surging during the last three months (Figure 1). The retail price of regular gasoline (national average, at gasoline stations and paid in cash) rose for 11 weeks in a row and recorded JPY155.2/L, the highest since April 2012, on 18 February 2013 (Agency for Natural Resources and Energy). The increase since mid-November 2012, when the current surge started, reached JPY10/L. The soaring oil price drove the surge of gasoline price.



Notes: Gasoline price is that of regular gasoline, at gasoline stations and paid in cash. Oil price is that of Middle Eastern, front month and close at the Tokyo market.

Sources: Agency for Natural Resources and Energy, Tokyo Commodity Exchange

Oil price (at the Tokyo market, Middle Eastern) in dollars, however, has been stable—though in a high level of around \$107/bbl—for the last three months. It is the depreciation of the yen devaluated from around JPY80/\$ to level of JPY93/\$ – JPY94/\$ that raised oil price in yen (Figure 2).

Views and expectations for further monetary easing by the incoming cabinet which spread after the Prime Minister Yoshihiko Noda (at that time) expressed his intension to dissolve the House of Representatives, and actual actions by the new Abe Administration—“Abenomics”— fuelled the rapid depreciation of the yen. The rise of oil price in yen is inevitable under the devaluated currency as oil is priced in dollars in the international market and Japan depends on imports for almost all of its oil supply. Changes in oil price in dollar affected the rises and falls of oil price in yen greatly in the first half of FY2012. In

contrasting, the contribution of the recent depreciation of the yen to the rise of oil price in yen is particularly significant (Figure 3).

Figure 2: Oil price in dollar and yen-dollar exchange rates

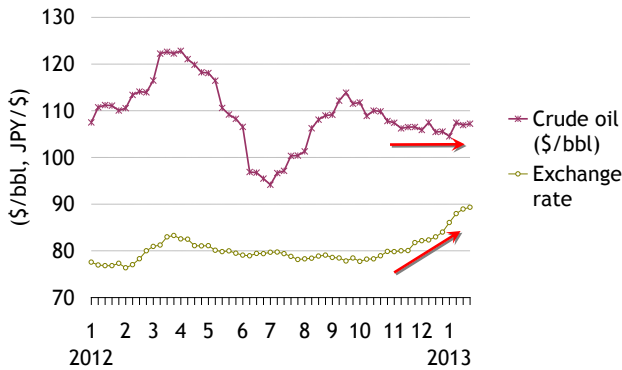
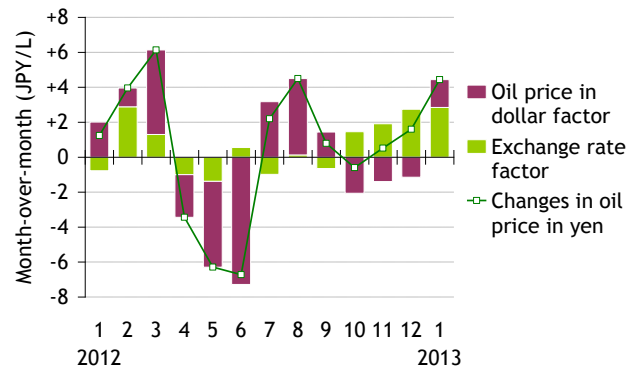


Figure 3: Decomposition of changes in oil price in yen



Source: Compiled from data by Tokyo Commodity Exchange

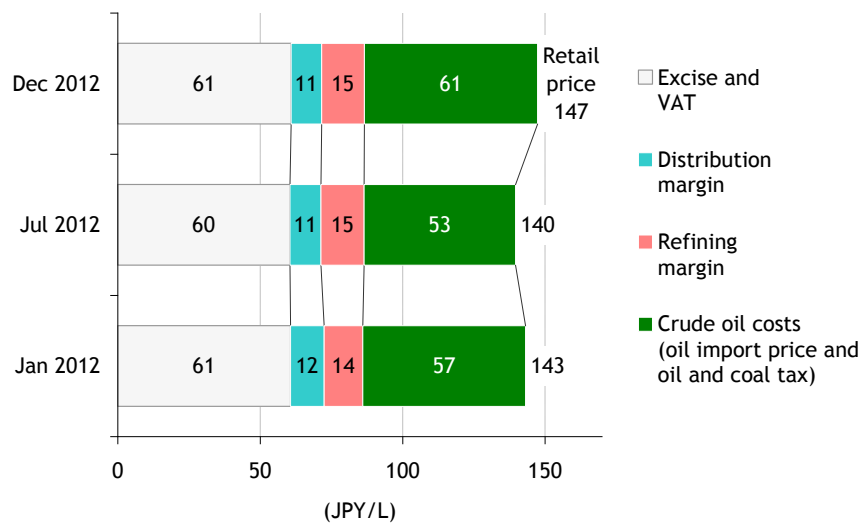
Note: Aggregated into monthly from daily decomposition results

Source: Compiled from data by Tokyo Commodity Exchange

### Oil price affecting gasoline price greatly

Crude oil cost (or oil price) accounts for the largest portion in cost structure of gasoline retail price along with the excise “gasoline tax” (Figure 4). The oil cost constituted JPY61/L of the gasoline price of JPY147/L in December 2012. Therefore, oil price affects the gasoline price greatly.

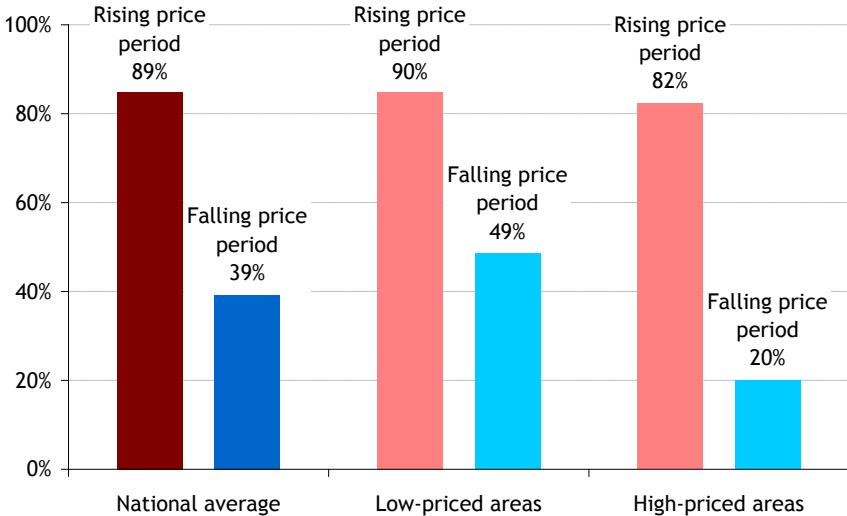
Figure 4: Cost structure of gasoline retail price (including taxes)



Note: Oil and coal tax was JPY2.04/L before September 2012 and is JPY2.29/L in and after October 2012. National gasoline tax and local gasoline tax are JPY48.6/L and JPY5.2/L, respectively.

How oil price is passed-through to gasoline price is also a big factor influencing gasoline price. According to Yanagisawa (2012), the pass-through of oil import price to gasoline price was not complete for the period from January 2009, when the market-linked system started penetrating, to September 2011. While the pass-through rate<sup>1</sup> of oil import price when the price was rising was 89%, the rate was only 39% when the price was falling showing asymmetry (Figure 5).

Figure 5: Pass-through rates of oil import price to gasoline price (January 2009 - September 2011)



Note: Estimation based on monthly data

Source: Yanagisawa, “Structure for Pass-Through of Oil Price to Gasoline Price in Japan”

**Pass-through structure of yen-dollar exchange rate and oil price in dollar to gasoline price**

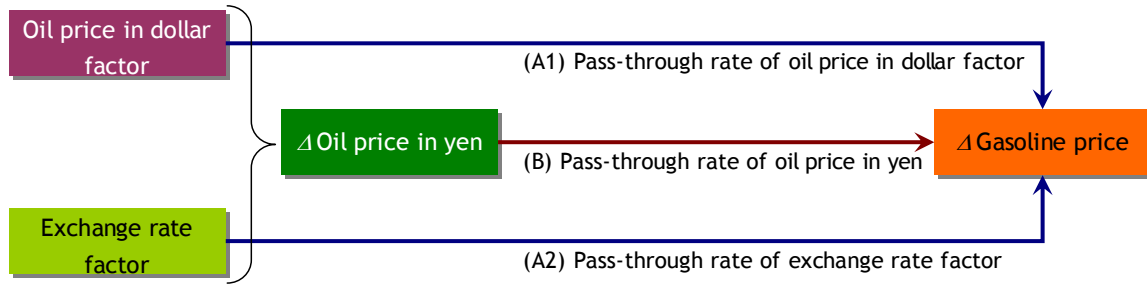
How do the yen-dollar exchange rates affect gasoline price today while the depreciation of the yen leads to rise in oil price? It is unsurprising to presume that changes in exchange rates are passed-through to gasoline price via oil price in yen. It, however, is not evident whether the pass-through is complete or not, nor is symmetric or not.

No orthodox model allows us to analyse the pass-through structure of oil price in dollar (\$/bbl) to gasoline price (JPY/L), or that of yen-dollar exchange rate (JPY/\$) to gasoline price since their dimensions and units are different. We therefore analysed the pass-through structure of oil price in dollar factor and exchange rate factor to gasoline retail price excluding taxes utilising the results of decomposition analysis (Figure 3). Particularly, we

<sup>1</sup> In this case, ratio of change in gasoline price to change in oil import price. Pass-through rate of 89% means that gasoline price rose by JPY0.89/L corresponding to rise of oil import price by JPY1/L.

estimated the two pass-through rates of oil price in dollar factor [(A1) in Figure 6] and of exchange rate factor [(A2) in Figure 6] to gasoline price instead of oil price in yen to gasoline price [(B) in Figure 6].

Figure 6: Pass-through structure of oil price in dollar factor and exchange rate factor to gasoline price



Considering the possibility of asymmetric pass-through, we used an estimation model like Equation (1):

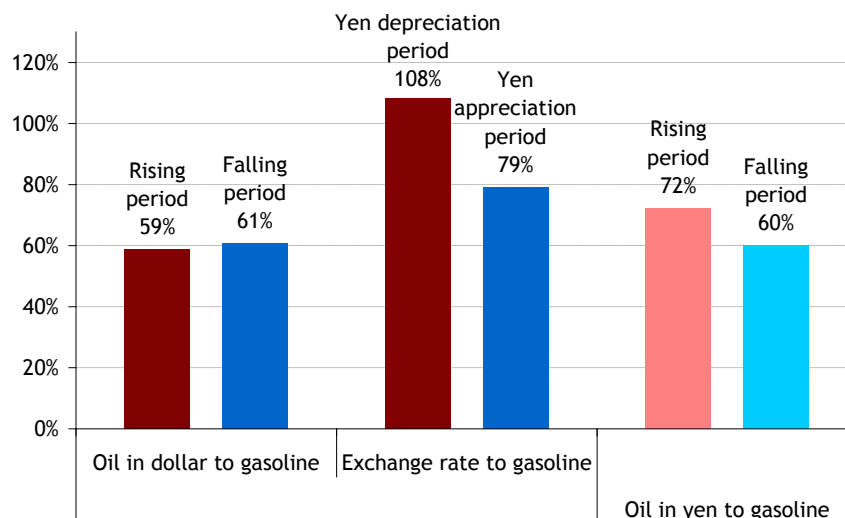
$$\begin{aligned}
 \Delta \text{Gasoline price} = & \beta_d^+ \max(\text{Oil price in dollar factor}, 0) \\
 & + \beta_d^- \min(\text{Oil price in dollar factor}, 0) \\
 & + \beta_e^+ \max(\text{Exchange factor}, 0) \\
 & + \beta_e^- \min(\text{Exchange factor}, 0) \\
 & + \gamma_s \Delta \text{Gasoline shipment} + \gamma_e ECT + u
 \end{aligned} \tag{1}$$

where  $ECT$  is an error correction term and  $u$  is the residual.  $\beta_d^+$  and  $\beta_d^-$  express the pass-through rates of the oil price in dollar factor to gasoline price when the factor increases and decreases, respectively. Similarly,  $\beta_e^+$  and  $\beta_e^-$  express the pass-through rates of the exchange rate factor to gasoline price when the yen depreciates—the factor contributes to increases—, and appreciates—the factor contributes to decreases—, respectively. Considering the market-linked system, which is the mainstream for setting the gasoline wholesale price, independent variables were lagged properly. To analyse the recent situation, weekly data was used with the estimation period from 5 January 2012 to 4 February 2013.

The pass-through rates of oil price in dollar factor were estimated at 59% and 61% when the factor increased and decreased, respectively (Figure 7). Although the pass-through rates were well below complete pass-through rate of 100%, the pass-through was symmetric.

The pass-through rate of the exchange rate factor was 108%, more than the complete pass-through when the yen depreciated—the factor contributed to increase. On the other hand, the rate was only 79% when the yen appreciated—the factor contributed to decrease—showing asymmetry in the pass-through.

Figure 7: Pass-through rates of oil price and exchange rate to gasoline price



Note: Estimation based on weekly data from 5 January 2012 to 4 February 2013. Depreciation of the yen contributes to rise in gasoline price.

For reference, we conducted an analysis of direct pass-through structure of oil price in yen to gasoline price with Equation (2), not decomposing oil price in yen. The pass-through rate obtained by this method can be regarded as implicit weighted average of the pass-through rates of oil price in dollar factor and exchange rate factor in the estimation period.

$$\Delta \text{Gasoline price} = \beta_y^+ \max(\Delta \text{Oil price in yen}, 0) + \beta_y^- \min(\Delta \text{Oil price in yen}, 0) + \gamma_s \Delta \text{Gasoline shipment} + \gamma_e \text{ECT} + u \quad (2)$$

The pass-through rates of oil price in yen were estimated at 72% and 60% when the oil price rose and fell, respectively. Although the magnitude has shrunk compared with that in the period of January 2009 to September 2011<sup>2</sup>, the pass-through of oil price to gasoline price was still asymmetric.

Circumstances surrounding the gasoline business are harsh. Its retail sector, which is struck by further less margin after the revision of the market-linked system—rises in brand royalties in fact—, faces difficulty most especially. The sector can not pass-through completely the rise in wholesale price to retail price due to stiff competition. Therefore, the sector tries to secure its business base by suppressing the pass-through rate or shifting the pass-through timing when wholesale price falls. In other words, the low pass-through rates reflect the difficulty in gasoline business and the asymmetry comes from efforts in securing business continuity under the harsh business environment.

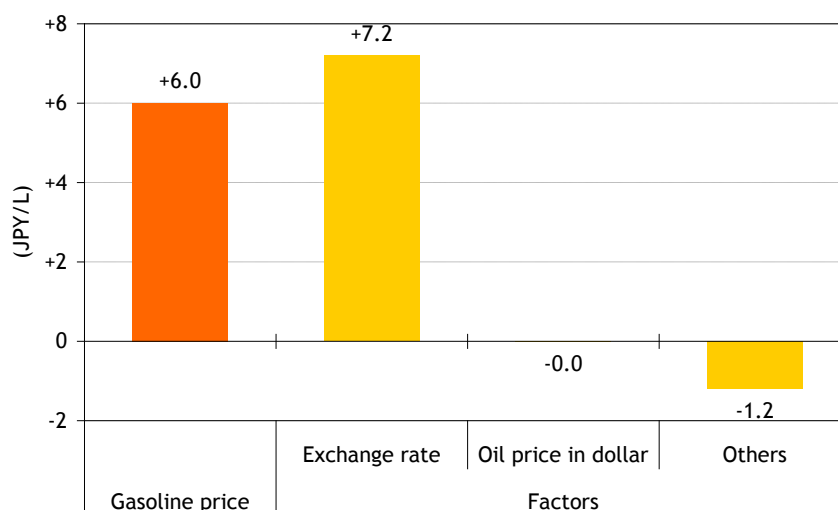
<sup>2</sup> Strict comparison is not possible since conditions of the estimation are different; differences in oil price (importing price vs. futures price), in data frequency (monthly vs. weekly) and in other independent variables.

It may be a bit surprising that the pass-through of oil price in dollar factor was symmetric while we found asymmetry in the pass-through of the exchange rate factor despite the fact that all domestic transactions are settled in yen. Social recognition linking gasoline price closely with oil price in dollar, which is widely reported, may affect the phenomenon.

### Rise of gasoline price brought about by depreciation of the yen

The yen has devaluated by JPY10 against the dollar while oil price in dollar has been stable at around \$107/bbl in the last three months (19 November 2012 – 4 February 2013). According to the obtained pass-through rates, the changes in exchange rates are estimated to have contributed to the rise of gasoline price including taxes by more than JPY7/L in the period (Figure 8).

Figure 8: Contribution to change in gasoline price including taxes  
(19 November 2012 - 4 February 2013)



Depreciation of the yen raises the gasoline price beyond the extent of the devaluation of the currency since the pass-through rate of exchange rate factor in the case of depreciation of the currency is 108% exceeding a complete pass-through. For example, depreciation of the yen by JPY1/\$ leads to rise of gasoline price (including taxes) by JPY0.79/L when oil price in dollar is \$110/bbl. On the other hand, the appreciation of the yen by JPY1/\$ leads to a fall in gasoline price by JPY0.58/L. If the pass-through were complete and symmetric, change in the exchange rate by JPY1/\$ would result in change in gasoline price by JPY0.73/L.

Oil price in dollar is cheap and yen is still strong compared with those in August 2008 when gasoline price hit the historical highest, JPY185/L. Oil price in dollar, however, is rising since February 2013 with the successive depreciation of the yen. Gasoline price will soar further if this trend continues.

## Reference

A. Yanagisawa (2012), "Structure for Pass-Through of Oil Price to Gasoline Price in Japan", *IEEJ Energy Journal*, Vol. 7, No. 3

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