Reconsidering Oil Prices Based on Supply and Demand Factors

– Breakdown of Surging Oil Price into Supply/Demand and Non-Supply/Demand Factors –

Akira Yanagisawa*

Summary

Oil prices have continued rising. Particularly, their trend since early 2011 is similar to that in 2008 when the benchmark West Texas Intermediate crude oil futures price hit a record high of $145/bbl. Price levels above $110/bbl and the rapid price hike of $30/bbl in only two and a half months are feared to trigger inflation and drag down economic recovery.

The levels of oil prices based on actual supply and demand are controversial. Based on the past quantitative analyses, the author suspects that non-supply/demand factors have made no small contributions to oil price hikes since 2004. In the latest attempt, the author conducted a model analysis to reconsider oil prices, using an approach that is different from the past ones.

According to an analysis using a very orthodox, simple model, the oil price based on supply/demand factors stood at about $80/bbl at the peak in mid-June 2008 and at about $60/bbl at the end of April 2011. Non-supply/demand factors' contribution to the oil price began to expand again in the second half of 2009, reaching $45/bbl during the latest upsurge.

The benchmark crude oil futures price rose by $30/bbl over the six months since it deviated from a boxed range around $75/bbl. Non-supply/demand factors' contribution to the rise is at $19/bbl, far larger than $11/bbl for supply/demand factors. Non-supply/demand factors have accounted for an even greater share of the rapid rise from mid-February.

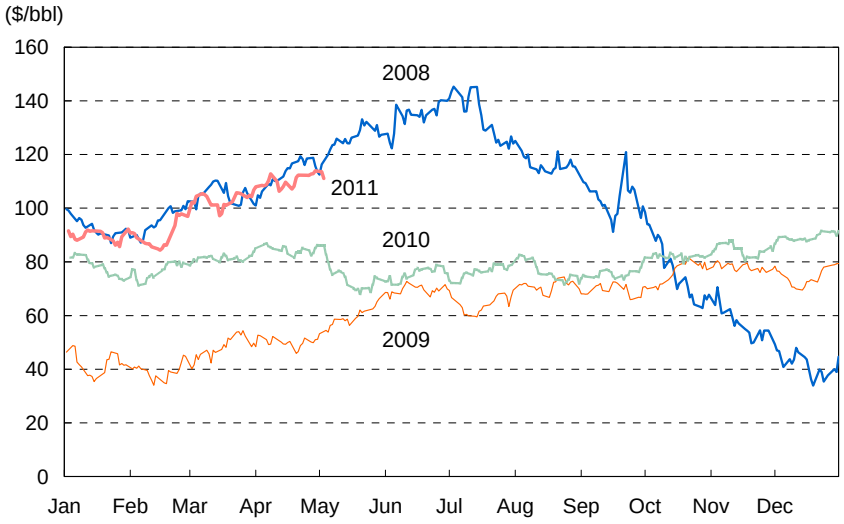
1. Introduction

Oil prices have continued rising. The trend of the benchmark West Texas Intermediate crude oil futures price (the front-month contract's daily settlement price) since early 2011 is similar to that in 2008 when it hit a record high of $145/bbl (Fig. 1-1). Price levels above $110/bbl and the rapid price hike of $30/bbl in only two and a half months are feared to trigger inflation and drag down economic recovery.

Even in that situation, the Organization of Petroleum Exporting Countries, or OPEC, has been negative about increasing output, claiming that OPEC supply has been sufficient. The cartel also notes that the present price includes a risk premium of $15-20/bbl. The amount of the risk premium is suspected as a gap between the market price and what OPEC claim is the appropriate level of $90/bbl.

* Leader, Energy Demand, Supply and Forecast Analysis Group, The Energy Data and Modelling Center, The Institute of Energy Economics, Japan

Fig. 1-1 WTI Futures Price



Sources : U.S. Department of Energy, NYMEX

The levels of oil prices based on actual supply and demand are controversial. The financial industry among industries and the United States among countries have seemingly viewed oil price hikes over the recent years as reflecting supply/demand changes. In contrast, the oil industry and OPEC have tended to attribute the hikes to the impact of speculative money and the like.

Based on his past quantitative analyses, the author suspects that oil price hikes since 2004 have been attributable in no small part to non-supply/demand factors. In the latest attempt, the author conducted a model analysis to reconsider oil prices, using an approach that is different from the past ones.

2. Past Analyses

First, the author would like to outline his past oil price analyses. Yanagisawa (2008a, 2008b and 2011) developed vector autoregressive, or VAR, models indicating the relationship between oil supply/demand in the world or the United States and oil prices on a quarterly basis and estimated fundamental oil prices based solely on the oil supply-demand balance. As a result, the estimated fundamental price has ranged from $40/bbl to $60/bbl since 2007. Meanwhile, Yanagisawa (2009 and 2010) considered the Granger causality between oil price and factors other than actual oil supply/demand conditions. Findings indicate that non-supply/demand factors have exerted influences on oil price generally or at times.

Based on these and other analyses, the author suspects that oil price hikes since 2004, including the ongoing hike, have been attributable in no small part to non-supply/demand factors.

3. Estimating Supply/Demand-based Oil Price

This time, the author considers oil price explained by supply/demand factors independently from the past analyses. But he pursues a simple, straight quantitative model as in the past analyses. This is because he gives priority to an easy-to-understand model and considers that larger and more complex models do not necessarily guarantee more accurate analyses.

The constructed model is a single equation of oil price. It is very orthodox and simple, with parameters fixed for the period subject to the analysis. But this model uses weekly data that are far more frequent than the quarterly data used for the past analyses. Independent variables are the gross input to atmospheric crude oil distillation units (hereafter crude oil input to refineries) in the United States, U.S. crude oil inventories[1] (excluding Cushing inventories, at the end of the previous week), crude oil inventories (at the end of the previous week) in Cushing where WTI is delivered, the expected inflation rate (break-even inflation rate[2]), the dolla's effective nominal exchange rate, the Dow Jones industrial average, the ratio of managed money's net longs to total open interest for WTI futures, and the ratio of swap dealer' net longs to the open interest[3]. Of these variables, crude oil input to refineries and crude oil inventories are actual oil supply/demand indicators. All variables other than the expected inflation rate are rates of (log) changes from a year earlier. Estimation is made for the longest period where data are available, between 22 June 2007 and 29 April 2011.

The constructed model is as follows. As autocorrelation was identified in the residuals, this is taken into account for estimation. Standard errors are in parentheses under coefficients.

$$\begin{aligned}\text{Oil price} = {} & \underset{(0.0804)}{0.02806} + \underset{(0.144)}{0.2613} \times \text{Crude oil input to refineries} \\ & - \underset{(0.312)}{0.9483} \times \text{U.S. crude oil inventories} - \underset{(0.0694)}{0.2159} \times \text{Cushing crude oil inventories} \\ & + \underset{(2.22)}{3.613} \times \text{Expected inflation rate} - \underset{(0.543)}{2.500} \times \text{Exchange rate} + \underset{(0.165)}{0.2790} \times \text{Stock prices} \\ & + \underset{(0.284)}{1.063} \times \text{Managed money} + \underset{(0.288)}{0.7724} \times \text{Swap dealers} \\ & R^2\text{: } 0.986,\ \rho = 0.943\end{aligned}$$

The oil price explained by oil supply and demand is computed by substituting historical values into variables indicating oil supply and demand and excluding influences of other variables. Supply/demand-based price averaged about $60/bbl in the period for estimation. The peak stood at about $80/bbl[4] in mid-June 2008. The latest price was about $60/bbl in late April 2011. In contrast, non-supply/demand factors' contribution to the oil price has been expanding again since the second half of 2009, reaching $45/bbl[5] (Fig. 3-1).

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1 While WTI is a global benchmark crude oil, weekly global data are difficult to attain. Therefore, U.S. oil supply and demand data are used here.

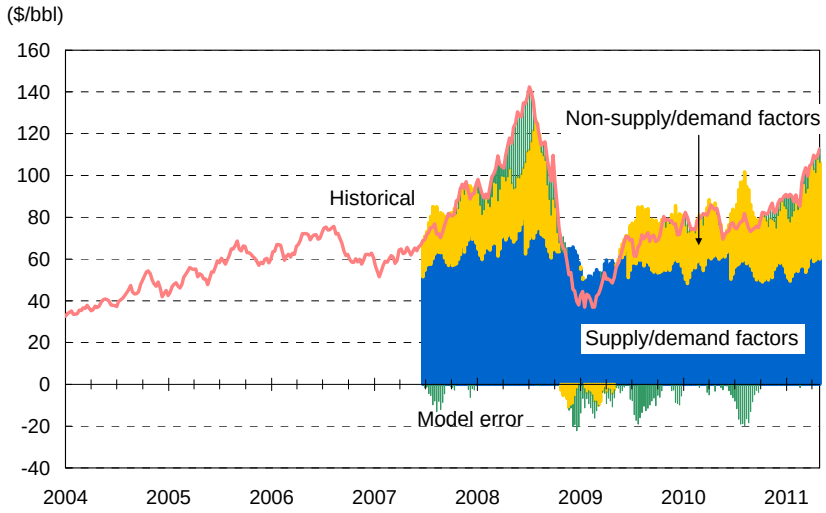
2 The break-even inflation rate is computed from the five-year U.S. Treasury yield and the five-year inflation-indexed Treasury yield.

3 See appendix.

4 The all-time high was recorded on the market three weeks later.

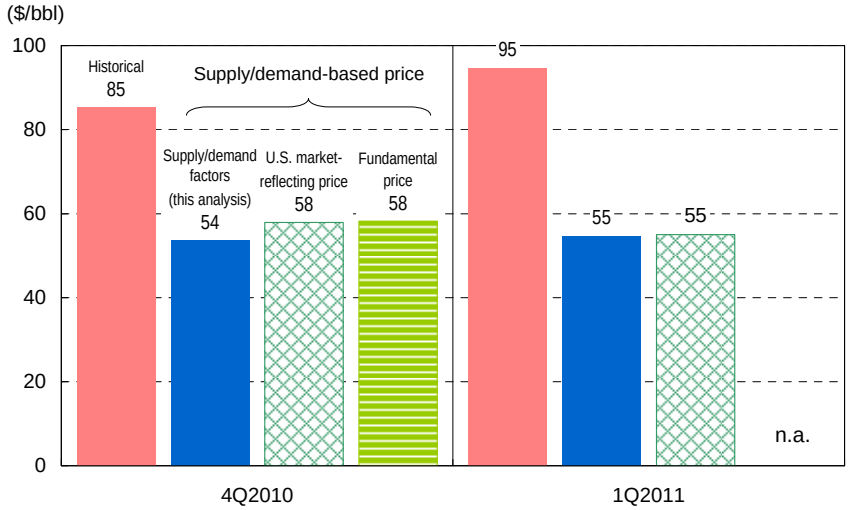
5 Due to model errors, the sum of supply/demand and non-supply/demand factors is not identical to the historical value.

Fig. 3-1 Breakdown of WTI Price



The estimation results indicate almost the same trend as seen in the author's earlier analyses, although some differences are seen for some periods. Fig. 3-2 compares estimation results for the fourth quarter of 2010 and the first quarter of 2011.

Fig. 3-2 Historical WTI Futures Price and Supply/Demand-based Price (4th quarter of 2010, 1st quarter of 2011)



Note : The U.S. market-reflecting price is based on U.S. oil supply and demand and the U.S. economic situation. The fundamental price is based on global oil supply and demand. The two prices, though named differently, are both based on oil supply and demand.
Source : Yanagisawa (2011) for the U.S. market-reflecting price and the fundamental price

4. Factor-by-factor Breakdown of Oil Price Fluctuations

Implications of parameters in the model equation are explained in Table 4-1.

As degrees of changes in these factors are not same, these parameters themselves do not necessarily indicate actual contributions to oil price fluctuations. But they can indicate the oil

price's sensitivity to these parameters.

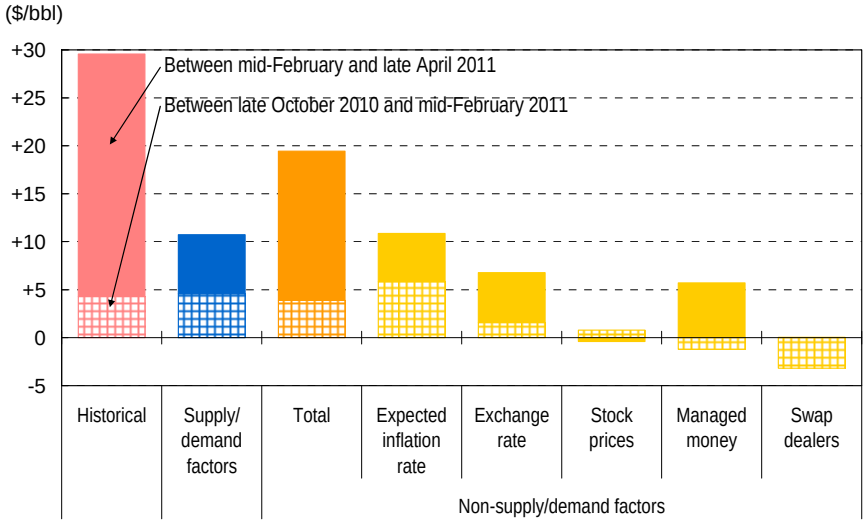
Table 4-1 Implications of Model Parameters

	Factor	Memo. : Average in estimation period	Change in factors	Relevant oil price change
Supply/demand factors	Crude oil input to refineries	14,627 kb/d	+1%	+0.3%
	U.S. crude oil inventories (excluding Cushing)	307,522 kbbl	+1%	-0.9%
	Cushing crude oil inventories	27,651 kbbl	+1%	-0.2%
Non-supply/ demand factors	Expected inflation rate	1.60%	+0.1% point	+0.4%
	Dollar's effective exchange rate	101.94 (Jan 1980 =100)	+1% (Dollar's appreciation)	-2.5%
	Stock prices	$10,874	+1%	+0.3%
	Ratio of managed money's net longs to open interest	7.16%	+1% point	+1.1%
	Ratio of swap dealers' net longs to open interest	7.36%	+1% point	+0.8%

Note : Oil price in the estimation period averaged $82.15/bbl.

In a manner to promote understanding, the author measured each factor's contribution to oil price hikes since the autumn of 2010. The benchmark oil price rose by $30/bbl in some six months after deviating from a boxed range around $75/bbl. Particularly, a rapid hike since mid-February has been surprising. The author divided the six months into the first 3½ months (between late October 2010 and mid-February 2011) and the remaining 2½ months (between mid-February 2011 and late April 2011) and computed each factor's contribution to oil price changes in the two periods, as given in Fig. 4-1 below.

Fig. 4-1 Factor-by-factor Breakdown of Oil Price Fluctuations (between late October 2010 and late April 2011)



Note : Due to model errors and the crossover term, these factors' contributions do not add up to the historical fluctuation.

While both supply/demand and non-supply/demand factors contributed to the oil price hike, non-supply/demand factors' contributions at $19/bbl are far greater than supply/demand factors' at $11/bbl. Non-supply/demand factors' contributions to the rapid oil price hike since mid-February increased even further.

Among non-supply/demand factors, a rise in the expected inflation rate under Quantitative Easing 2 and other policies made a great contribution to the oil price hikes throughout the estimation period. In and after mid-February, speculative money's flow into the crude oil futures market (managed money's contribution) was the largest factor behind the rapid oil price hike. The dollar's depreciation also worked to boost the oil price.

5. Conclusion

Even this analysis using a modelling approach that is different from the past ones has led to the conclusion that non-supply/demand factors have made considerable contributions to the present oil prices.

The WTI price is now rising in a manner to follow the Brent oil price hike induced by such factors as the destabilisation of the Middle East. The situation has turned around from a period toward the autumn of 2010 when oil prices remained stable (though at high levels). Non-supply/demand factors have made far greater contributions to the turnaround than supply/demand factors.

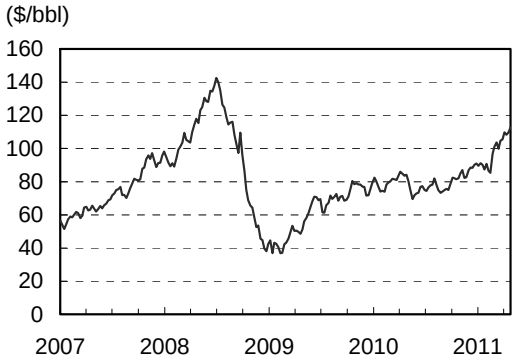
Fears of inflation under the oil price hikes and its adverse effects on the economy have gradually grown in developed countries as well as developing countries where energy efficiencies are still low. OPEC has been cautious of increasing output, claiming that crude oil supply has been sufficient. Given that non-supply/demand factors have exerted greater influences on oil prices than supply/demand factors, however, excessive oil supply, rather than sufficient supply, may be required to stabilise rising oil prices. Nevertheless, OPEC hopes to maintain oil prices at the maximum levels falling short of causing a decline in demand and cannot be expected to expand oil supply to excessive levels. Meanwhile, the demand side has no choice but to build a flexible energy system that would save oil consumption and shift to other energy sources flexibly.

Direct responses to non-supply/demand factors should also be considered. But none may try to hold down the dollar's exchange rate or the expected inflation rate for the sole purpose of stabilising oil prices. The crude oil futures market is expected to play a key role in hedging risks and finding appropriate prices under appropriate liquidity levels. Given that the present oil price hike is expected to cause risks to the world economy and be interpreted as inappropriate, some regulatory actions on the futures market may be viewed as bringing about advantages that could be greater than relevant disadvantages.

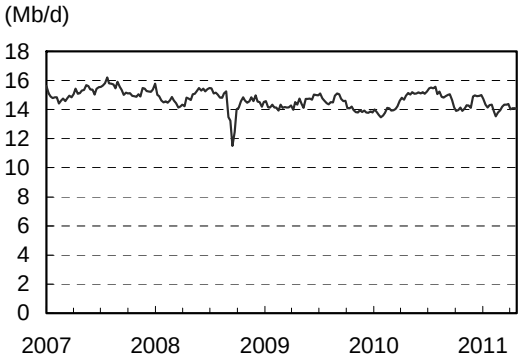
Various actions are required to hold down oil price spikes, including an easier actual supply/demand balance, the reduction of fears about future supply shortages, the elimination of excessive monetary easing' adverse effects, and institutional reforms to lead the futures market to maintain appropriate functions.

Appendix : Trends of Indicators

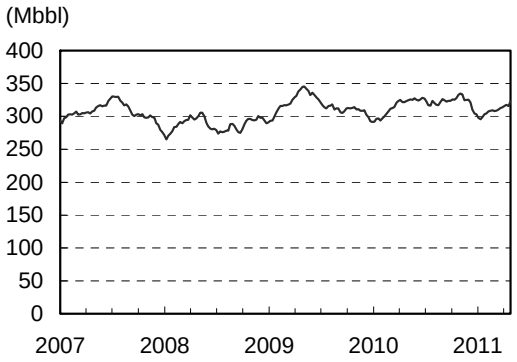
Oil price



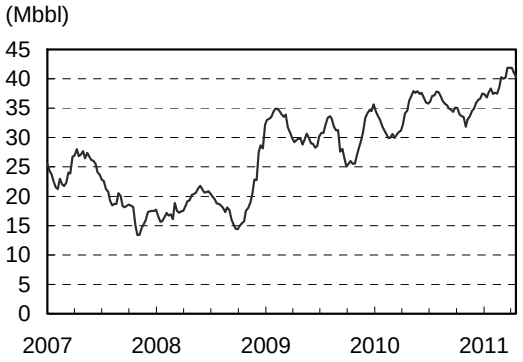
Crude oil input to refineries in U.S.



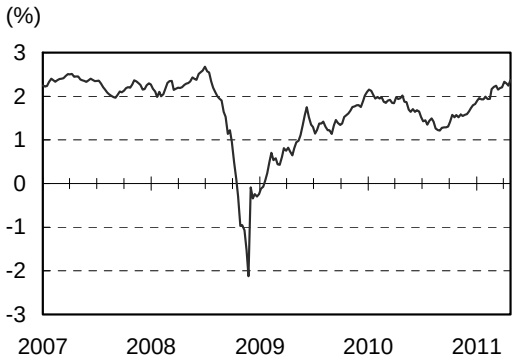
U.S. crude oil inventories
(excluding Cushing inventories)



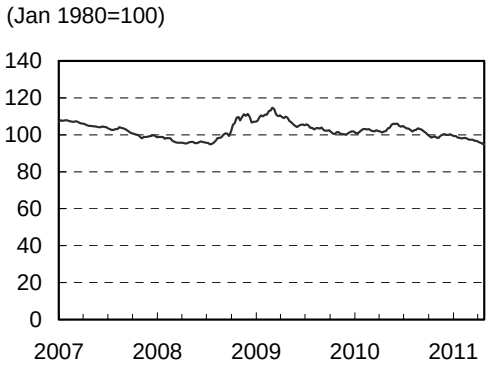
Cushing crude oil inventories



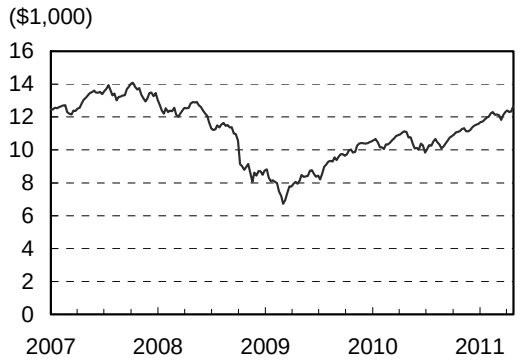
Expected inflation rate



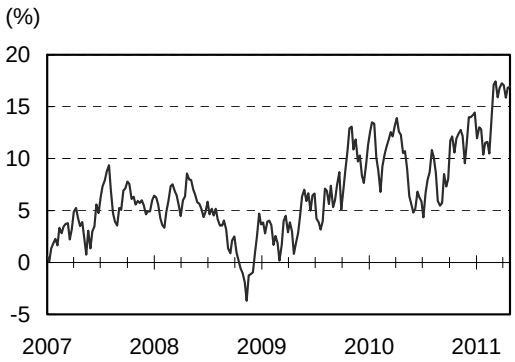
Dollar’s effective nominal exchange rate



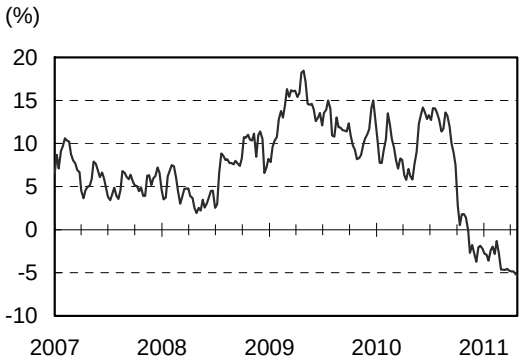
Dow Jones industrial average



Ratio of managed money's net longs to open interest



Ratio of swap dealers' net longs to open interest



Sources : U.S. DOE and NYMEX for oil price, U.S. DOE for crude oil input to refineries and crude oil inventories, FRB data for expected inflation rate, FRB for dollar's effective nominal exchange rate, NESE for Dow Jones industrial average, CFTC data for net ratios of managed money's and swap dealers' net longs to open interest.

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Contact: report@tky.ieej.or.jp