The Structure of the LNG import Price in the Northeast Asia: Considering the Price Premium


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1. Introduction

Background

- The Northeast Asia is the heart of LNG trade
  - In 2014, LNG import volume of Japan, Korea, China, and Taiwan accounted for 37.3%, 15.7%, 7.9%, and 5.6% of the world LNG import volume, respectively.

- Several problems in trade environment of LNG are pointed out
  1) Trade of LNG in Asia-Pacific region has rigidity since most of LNG is traded as a long-term contract which contains disadvantageous clauses to importing countries.
  2) There is no competitive regional trading hub in Asia;
     - No appropriate market price
     - Indexing to crude oil price has been a dominant mech.

Source: GIIGNL
1. Introduction

Background

- Price formula for LNG traded in NE Asia is critical to prevent unreasonable price
- Most of the pricing formulas are simple linear function of crude oil price

\[ P_{LNG} = A \times P_{crude} + B \]

- Fundamental changes in formula are limited but it is adjusted quarterly by re-negotiation
  - Thus, there can be a *price premium or discount* on the LNG import price for the NE Asian countries
  - Price premium or discount reflects negotiation power or the condition of supply and demand
- Thus, if we can measure the price premium or discount, it can give insights into NE Asian market with the quantitative index.

Source: GIIGNL
<Research Question>
1. How much premium did Korea and Japan pay?
2. Did the premium level change by events?
3. Are there differences in the premium between Korea and Japan?

Considering two exporting countries, Qatar and Indonesia, we
① Estimated the premium on the LNG import price
② Figured out and compared fluctuations of the premium
③ Gave some policy and strategy implication
2. Methodology and Data

Model specification

• A LNG import price for Korea and Japan in term contracts are usually linked with crude oil prices
• The LNG pricing formula in these contracts can be expressed as a simple linear equation (Equation 1)

<table>
<thead>
<tr>
<th>Equation 1: LNG pricing formula</th>
</tr>
</thead>
</table>

\[ P_{\text{LNG}} = A \times P_{\text{crude}} + B \]

- \( P_{\text{LNG}} \): LNG import price [$/MMBtu]
- \( P_{\text{crude}} \): Crude oil price [$/barrel]
- \( A \): Rate of the crude oil price linkage [barrel/MMBtu]
- \( B \): Constant term [$/MMBtu]
2. Methodology and Data

Model specification

- The constant term $B$ can be interpreted as the term related to
  ① the LNG transportation cost, or
  ② the premium part which is determined and focused by negotiations (Do, 2005)

- Equation 1 can be re-written separating $B$ into transportation cost and premium additively (Equation 2)

Equation 2: LNG pricing formula considering transportation cost and premium

$$P_{LNG} = A \times P_{crude} + C + FR + PR$$
$$B = C + FR + PR$$

- $C$: Constant term [$/MMBtu$]
- $FR$: Freight rate [$/barrel$]
- $PR$: Premium [barrel/MMBtu]
2. Methodology and Data

Model specification

• In Equation 2, the variables can be classified into two parts:
  ① $P_{\text{LNG}}, P_{\text{crude}}, FR$: can be observed in time series
  ② $PR$: cannot be observed but it determines the LNG price

• To estimate this time-varying premium, a state-space model can be used (Equation 3)
  - This state-space model can be estimated by Kalman filter

Equation 3: State–Space model of LNG pricing formula

| Observation Equation: $P_{\text{LNG},t} = A \times P_{\text{crude},t} + C + FR_t + PR_t + \epsilon_t$ |
| State equation: $PR_t = \gamma \times PR_{t-1} + \nu_t$ |
| Constraints: coefficients of $FR_t$ and $PR_t$ are 1 |

$\epsilon_t$: Observation error term  
$\nu_t$: State error term
2. Methodology and Data

Data collection

Table 1. The summary statistics

<table>
<thead>
<tr>
<th></th>
<th>Observation</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LNG import price of Korea</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>from Qatar</td>
<td>106</td>
<td>14.87</td>
<td>3.47</td>
<td>8.04</td>
<td>21.36</td>
</tr>
<tr>
<td>Indonesia</td>
<td>106</td>
<td>12.36</td>
<td>2.98</td>
<td>5.95</td>
<td>21.50</td>
</tr>
<tr>
<td><strong>LNG import price of Japan</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>from Qatar</td>
<td>106</td>
<td>13.53</td>
<td>3.53</td>
<td>7.31</td>
<td>18.87</td>
</tr>
<tr>
<td>Indonesia</td>
<td>106</td>
<td>12.90</td>
<td>4.30</td>
<td>5.88</td>
<td>19.63</td>
</tr>
<tr>
<td>Japanese Crude Cocktail</td>
<td>106</td>
<td>89.77</td>
<td>23.74</td>
<td>43.26</td>
<td>134.36</td>
</tr>
<tr>
<td><strong>LNG freight rate to Korea</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>from Qatar</td>
<td>106</td>
<td>1.45</td>
<td>0.51</td>
<td>0.80</td>
<td>2.53</td>
</tr>
<tr>
<td>Malaysia</td>
<td>106</td>
<td>0.61</td>
<td>0.21</td>
<td>0.34</td>
<td>1.05</td>
</tr>
<tr>
<td><strong>LNG freight rate to Japan</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>from Qatar</td>
<td>106</td>
<td>1.53</td>
<td>0.54</td>
<td>0.83</td>
<td>2.67</td>
</tr>
<tr>
<td>Malaysia</td>
<td>106</td>
<td>0.64</td>
<td>0.21</td>
<td>0.38</td>
<td>1.08</td>
</tr>
</tbody>
</table>

- Monthly data from Sep. 2006 to Jun. 2015
- $P_{LNG}$: 4 country-specific LNG import prices
  - Monthly LNG import price [$/MMBtu]
  - Dividing the value amount of imported LNG by the LNG volume (Korea International Trade Association)
  - Considering the trade routes and country-specific physical properties of LNG
- $P_{crude}$: Japanese Crude Cocktail (JCC) price
  - Monthly JCC price [$/barrel]
  - Crude oil price which is linked with Qatar’s contract
  - Proxy for Indonesia’s contract
- $FR$: 4 country-specific LNG freight rates
  - Monthly freight rates of LNG volume [$/MMBtu]
  - Freight rates from Malaysia is a proxy of that from Indonesia (geographic proximity)
3. Empirical Results

**Crude oil indexation**

- Calculating correlation coefficients between LNG import prices and JCC
- As KEEI(2015) said the LNG prices are linked with the previous JCC price
  - ex) JCC price a month ago ($JCC_{t-1}$)
  - JCC price three months ago ($JCC_{t-3}$)
  - The average of JCC prices during just before three months ($\sum_{i=1}^{3} JCC_{t-i}/3$)

<table>
<thead>
<tr>
<th>to</th>
<th>Korea</th>
<th>Indonesia</th>
<th>Japan</th>
<th>Indonesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>from</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$JCC_{t-1}$</td>
<td>0.839</td>
<td>0.725*</td>
<td>0.875</td>
<td>0.860*</td>
</tr>
<tr>
<td>$JCC_{t-3}$</td>
<td>0.981*</td>
<td>0.497</td>
<td>0.929</td>
<td>0.797</td>
</tr>
<tr>
<td>$\sum_{i=1}^{3} JCC_{t-i}/3$</td>
<td>0.938</td>
<td>0.629</td>
<td>0.930*</td>
<td>0.851</td>
</tr>
</tbody>
</table>

* denotes the largest correlation coefficient
JCC price is a proxy for Indonesian LNG
# 3. Empirical Results

## LNG from Qatar

**Table 3. Estimation Results of the LNG Pricing Formula: LNG from Qatar**

<table>
<thead>
<tr>
<th></th>
<th>Korea</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Standard Error</td>
</tr>
<tr>
<td><strong>Observation Equation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_{\text{crude},t}$</td>
<td>0.124***</td>
<td>0.006</td>
</tr>
<tr>
<td>$C$</td>
<td>2.158***</td>
<td>0.598</td>
</tr>
<tr>
<td>$FR_t$</td>
<td>1.000</td>
<td>-</td>
</tr>
<tr>
<td>$PR_t$</td>
<td>1.000</td>
<td>-</td>
</tr>
<tr>
<td><strong>State Equation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$PR_{t-1}$</td>
<td>0.720***</td>
<td>0.069</td>
</tr>
</tbody>
</table>

***, **, and * denote that it is significant at 1%, 5%, and 10% significance level respectively.

$P_{\text{crude},t}$, $C$, $FR_t$, and $PR_t$ mean the crude oil price, constant, the freight rate, and the premium.

Coefficients of the freight rates and the premium are constrained to be 1.
The premium on the LNG price of Qatar

LNG from Qatar

Premium (U.S. dollar per MMBtu)

-4 -3 -2 -1 0 1 2 3 4


Korea Japan

3. Empirical Results
### 3. Empirical Results

#### LNG from Indonesia

Table 4. Estimation Results of the LNG Pricing Formula: LNG from Indonesia

<table>
<thead>
<tr>
<th>Observation Equation</th>
<th>Korea</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Standard Error</td>
</tr>
<tr>
<td>$P_{\text{crude},t}$</td>
<td>0.070***</td>
<td>0.016</td>
</tr>
<tr>
<td>$C$</td>
<td>5.391***</td>
<td>1.577</td>
</tr>
<tr>
<td>$FR_t$</td>
<td>1.000</td>
<td>-</td>
</tr>
<tr>
<td>$PR_t$</td>
<td>1.000</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>State Equation</th>
<th>Korea</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Standard Error</td>
</tr>
<tr>
<td>$PR_{t-1}$</td>
<td>0.842***</td>
<td>0.063</td>
</tr>
</tbody>
</table>

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$P_{\text{crude},t}$, $C$, $FR_t$, and $PR_t$ mean the crude oil price, constant, the freight rate, and the premium.

Coefficients of the freight rates and the premium are constrained to be 1.
3. Empirical Results

LNG from Indonesia

The premium on the LNG price of Indonesia

Korea  Japan
**4. Discussion for the Premium**

- **The premium on the LNG price of Qatar**
  - Considering 2 events in the Northeast Asia
  - Russia became a LNG supplier: April 2009
    - Russia started exporting LNG to Korea and Japan from Sakhalin-Ⅱ project
    - Qatar and Russia started competing in the Northeast Asian market as well as European market *(Hulbert, 2012)*
  - The Fukushima nuclear disaster: March 2011
    - Tsunami stroke the Fukushima Daiichi nuclear power plant and the core of it melted down and released radioactive material
    - Public acceptability problem of nuclear generation came up and the LNG demand increased
4. Discussion for the Premium

Changes in Premium

Table 5. The average of the measured premium on the LNG Import Prices

<table>
<thead>
<tr>
<th></th>
<th>Qatar</th>
<th>Indonesia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Korea</td>
<td>Japan</td>
</tr>
<tr>
<td>Whole Period</td>
<td>-0.003</td>
<td>0.265</td>
</tr>
<tr>
<td>Period 1</td>
<td>-0.025</td>
<td>-1.201</td>
</tr>
<tr>
<td>Period 2</td>
<td>0.150</td>
<td>0.998</td>
</tr>
<tr>
<td>Period 3</td>
<td>-0.058</td>
<td>0.815</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Statistical Test for Difference in average</th>
<th>b</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>between period 1 and 2</td>
<td>0.175</td>
<td>2.198***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.208</td>
<td>-0.183</td>
</tr>
</tbody>
</table>

Null hypothesis is that there is no difference against alternative hypothesis that there is a difference in the average premium.

***, **, and * denote that it is significant at 1%, 5%, and 10% significance level respectively.
t-statistics are in parenthesis

- Considering 2 events in the Northeast Asia

- Statistical tests for difference in average premium are conducted
  ① After importing Russian LNG
   - Increases: Qatari LNG imported by Japan
   - Decreases: Indonesian LNG imported by Korea
  ② After the Fukushima disaster
   - Increases: Indonesian LNG imported by Korea/Japan
   - Decreases: -
4. Discussion for the Premium

- Statistical tests for difference in average premium are conducted
  ① After importing Russian LNG
  Increases: Qatari LNG imported by Japan
  Decreases: Indonesian LNG imported by Korea

- The appearance of Russia as a new supplier of LNG means increasing in competition of supplier side
  - It gave a negotiation card to Korea and Japan
  - Thus, it is expected that the premium decreases
  - The premium on the Indonesian LNG price decreased
    (only significant for Korean case)

- However, the appearance of new supplier does not always mean that importing countries are beneficial
  - The premium on the Qatari LNG price increased
  - It may be because the LNG contracts are very rigid and the business stealing effects are small
  - Thus, the sales volume of existing exporters in LNG market is guaranteed to some extent
4. Discussion for the Premium

After Fukushima disaster: March 2011 ~

- Statistical tests for difference in average premium are conducted
  ② After the Fukushima disaster
    Increases: Indonesian LNG imported by Korea/Japan
    Decreases: -

- For Indonesia, increases in LNG demand was an opportunity to raise their profit more
  - In addition, Indonesia is relatively close to Korea and Japan and it can supply the LNG rapidly

- For Qatar, increases in LNG demand was an opportunity to compensate their loss
  - Qatar has also exported their LNG to Europe
  - However, there was deep recession in Europe and their LNG demand decreased
  - After the Fukushima disaster, the Middle East exporters turned their LNG volume to Asia, which headed towards Europe at first
Recently, the premium paid by Japan is higher than that paid by Korea.

It may reflect the fact that Japan was directly affected by an aftermath of the Fukushima nuclear disaster.

In addition, it may reflect the structural difference in importing LNG between Korea and Japan:

- Korea has the world’s largest LNG buyer as a single corporation, Korea Gas Corporation (KOGAS).
- However, there are 7 power companies, 8 gas companies, and several industrial importers in Japan.
- The buying power of each company can be relatively weak though Japan imports larger amount of LNG.
5. Policy Implications and Conclusion

Policy Implication

1. When Korea and Japan try to diversify their LNG import routes, they should concentrate on re-negotiation between exporting countries and themselves.
   - Since much of the LNG are traded as a rigid contract in this region, it could be different to usual markets and Korea and Japan should use a negotiation card well.

2. LNG importers should be attention to demand and supply of other region
   - Natural gas markets were considered as separated markets by continents but there is a country which exports its LNG to many regions, like Qatar.
   - Thus, natural gas markets by continents could be connected by some sellers.

3. Korea, Japan, and other countries should establish a close cooperation to enhance their buying and negotiation power on the global LNG market
5. Policy Implications and Conclusion

1. Considering the spot trade of LNG in the Northeast Asia
   - We could not consider the spot volume of LNG because of the statistic limitation

2. Extending the scope of study: Considering other exporting countries
   - Korea and Japan import their LNG not only from Qatar and Indonesia but also Australia, Malaysia, Russia and some other countries
   - We can compare the premium by regions of exporting countries

3. Time series analyses using the estimated premium
   - Some time series analyses, for instance cointegration, causality, or structural break tests, can be done using the estimated premium
   - It can give more insights into the Northeast Asian market
Thank You

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