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Energy market financialization: empirical evidence and implications from East Asian LNG markets

Xunpeng Shi[a,b,c], Yifan Shen[d]*

[a]Australia-China Relations Institute, University of Technology Sydney, Australia. Xunpeng.shi@gmail.com

[b]School of Low Carbon Economics & Center of Hubei Cooperative Innovation for Emissions Trading System, Hubei University of Economics, China

[c]Energy Studies Institute, National University of Singapore, Singapore

[d] Institute of Politics and Economics, Nanjing Audit University, Nanjing, China. Email: shenyifan1989@gmail.com.

Abstract: In the process of transferring from oil indexation to competitive pricing for natural gas, the number of potential gas trading hubs that underpin the competitive prices is a key question, but lack of empirical investigations. This study employs a Structure Vector Auto-regression model (SVAR) and monthly LNG price data of four East Asian importers to examine whether the natural gas markets are integrated among them. The study finds that LNG markets are fragmented and thus there are different market fundamentals in the four examined markets. The results suggest that there should be multiple LNG benchmark trading hubs at the time being so that each hub could reflect different fundamentals. Since gas trading hubs in different markets are not exclusive, governments and gas industry in East Asia should collaborate in hub building because they face common challenges in the process.

Key words: market integration; trading hub; East Asia;

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1 Introduction

Along the increasing trend of financialization of the international energy markets since the 2008 (Ji and Zhang, 2018; Zhang, 2018, 2017), natural gas market is not exceptional. Natural gas market, although fragmented so far, is increasingly integrated due to the move toward gas-on-gas competition pricing that requires gas hubs to facilitate competition (EIA, 2017; IEA, 2013) and financial markets to generate the price signals (Dayong Zhang et al., 2018). Although without controversies, a large part of the literature suggests that gas-on-gas competition prices generated through gas hubs are preferable to oil indexation[1] (EIA, 2017; IEA, 2013; Shi and Variam, 2016). Currently, Oil indexation and hub indexation, the two competing pricing mechanisms, are in the battleground in East Asia and large part of Europe.

East Asia, which had 60% of traded gas indexed to oil price in 2017 (IGU, 2018a), is expected to be the next region, after North American and Europe, that can develop its competitive market prices for gas (either natural gas or LNG) (EIA, 2017; IEA, 2013). The four main East Asian LNG importers, China, Japan, South Korea and Taiwan imported 61% of global LNG import in 2017 (GIIGNL, 2018). A financialized and competitive East Asian local gas benchmark price could reduce market inefficiency, increase transparency, attract investments and avoid geographical and exchange risks from indexed to other regions' gas prices (Shi and Variam, 2016). Currently, China, Japan and Singapore have been actively promoting hub creation and associated market liberalization in bidding for hosting such a competitive gas benchmark price.

While hub pricing is a key step towards financialization in natural gas market and is desirable for the East Asian gas markets, there are a number of issues in debates and of interest to both policy makers and academia, such as how many gas price benchmarks are needed, and which

[1] Oil indexation is the prevailing gas pricing mechanism that link gas price to the price of crude oil. In contrast, hub indexation is an established pricing mechanisms in the North America, UK, and the Netherlands. In this hub indexation, gas price is determined by gas-on-gas competition in hub, with Hurry Hub, NBP and TTF as the salient examples

countries can host a benchmark hub. Some believes a host of benchmark price can give the host advantages during the price formulation and thus there is potential of competition among the hubs (Tong et al., 2014). If only one benchmark hub is needed, Singapore is the most likely host due to reasons such as geographic advantages, hand free governance, oil trading hub experience and other physical infrastructure (IEA, 2013). EIA (2017), however, considers Japan (Tokyo) as the most possible host for a liquid physical hub in Asia. Other academic studies have argued that due to the fragmented gas market, there could be more than one benchmark prices and there is no difference either a China (Shanghai) or a Japan (Tokyo) hub price become the price benchmark for East Asian gas and LNG trading (Shi, 2016a; Shi and Variam, 2017).

Examining whether gas market have been integrated within the East Asian market can share light on the possible number of markets, which will further determine the number of trading hubs that are needed to be stablished. The number of price benchmarks and associated hubs will depend on whether the East Asian gas market are integrated. If the gas market is integrated, only one price hub is needed. On the contrary, if it is fragmented, each market area will need one hub.

To the best of our knowledge, however, there is no empirical studies that analyses gas market integration within the Asia Pacific region. Previous studies on gas market integration, such as Siliverstovs et al. (2005) and Neumann (2009), mainly explores relationship among the North American, European, and Asian gas markets even through these three markets are widely believed to be segmented (IEA, 2013).

This study dedicates to exam how fragmented the East Asian gas market in the past decade with an application of a Structure Vector Auto-regression model (SVAR). In this study, unless explicitly specified, hub is narrowly defined as benchmark hub, a hub that offers benchmark price. See Shi (2017, 2016b) for more discussion on hub category and hub formulation in East Asia. To the best of our knowledge, this is the first paper to test market integration among China, Japan, Korea and Taiwan gas markets. Our empirical findings also contribute to the recent debates on creating benchmark gas trading hub in Asia.

We proceed the paper as below: after the introduction, we introduce our methodology to test market integration in the next Section. Section 3 reports data and the empirical results. The last section concludes the paper.

2 Methodology: a test of market integration between the energy markets

To test integration between the energy markets, we consider a standard bilateral standard SVAR model:

$$A_0 z_t = \alpha + \sum_{i=1}^{N} A_i z_{t-i} + \varepsilon_t, \qquad (1)$$

Where $z_t = (r_1, r_2)$ is the monthly returns in two markets of interest, ε_t denotes the vector of serially and mutually uncorrelated structural innovations. N represents the number of lag term.

We postulate that A_0^{-1} has a recursive structure that the reduced-form errors e_t can be decomposed according to $e_t = A_0^{-1}\varepsilon_t$:

$$e_t \equiv \begin{pmatrix} e_t^{r_1} \\ e_t^{r_2} \end{pmatrix} = \begin{bmatrix} a_{11} & 0 \\ a_{21} & a_{22} \end{bmatrix} \begin{pmatrix} \varepsilon_t^{r_1} \\ \varepsilon_t^{r_2} \end{pmatrix} \qquad (2)$$

To test the market integration between LNG markets, we set r_1 as the LNG return in the explanatory market, and r_2 as the return in the corresponding explained LNG market. Based on this setting, the variance decomposition can correctly reflect all the integrated dynamics between two LNG markets.

In the empirical application below, we adopt a Gibbs sampling algorithm in the Bayesian framework to estimate the SVAR model. Note, however, that we use a flat prior and, therefore, the results reported below are data driven. We use 20,000 iterations discarding the first 10,000 iterations as burn-in. We adopt 6 lags in equations (1) to capture the dynamic effect. Our estimation results are robust to the reasonable changes of number of lags.

Note that when testing the integration between the LNG markets, the contradictory between observed fragmentation and empirical integration could mainly due to oil indexation that price gas and LNG trade in East Asia and Europe. Because of this reason, we conduct the empirical results of market integration between LNG markets in comparison with and without elimination of the oil impacts. The test will be useful despite of oil indexation because since 2010, spot trading which may no longer be indexed to oil price are increasing over time (IGU, 2018b).

3 Data and results

3.1 Data

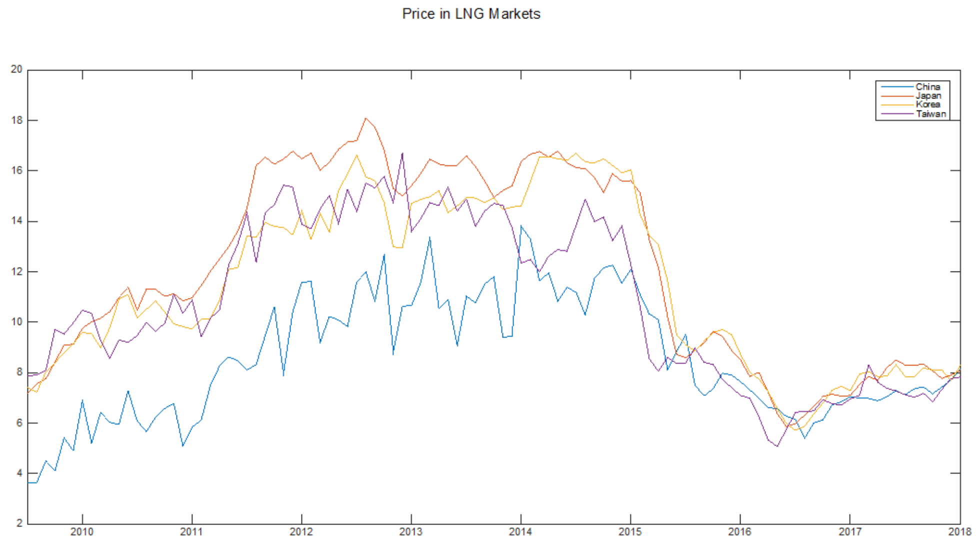
We have LNG price data for major East Asian gas markets, China, Japan, Korea and Taiwan, which, together accounts for 61% of global LNG import in 2017 (GIIGNL, 2018). Our data sets, which are provided by Energy Intelligence Group, span from September 2009 to March 2018. We focus on primary on LNG because all the East Asian countries, with China as an exception, reply on LNG as the form of gas import. LNG prices from India, Singapore, and Thailand could not be tested due to their short history of LNG import. Although imports significant pipeline gas, China's gas prices could not be tested because pipeline gas has fixed suppliers and have made little contribution to the liquidity in the Asia Pacific markets (IGU, 2018b; Shi et al., 2017). The LNG prices are measured by USD per MMBTU, and the returns are calculated as:

$$r_{i,t} \sim \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right) * 100 \qquad (3)$$

Where $r_{i,t}$ stands for the monthly return of the LNG series, and $P_{i,t}$ stands for the monthly prices at time t .

Figure 1 plots the prices and returns of LNG in East Asia. Figure 1 reveals similar price dynamic patterns between Japan and Korea markets in both the short run and the long run. Taiwan market in general tracks these two markets in the long run, but depicting substantial discerptions in the short run. Meanwhile, the considerable price gap between China and other markets indicates its isolated status, particularly in the first half of our sample period.

Figure 1. Price and Return in the LNG Markets



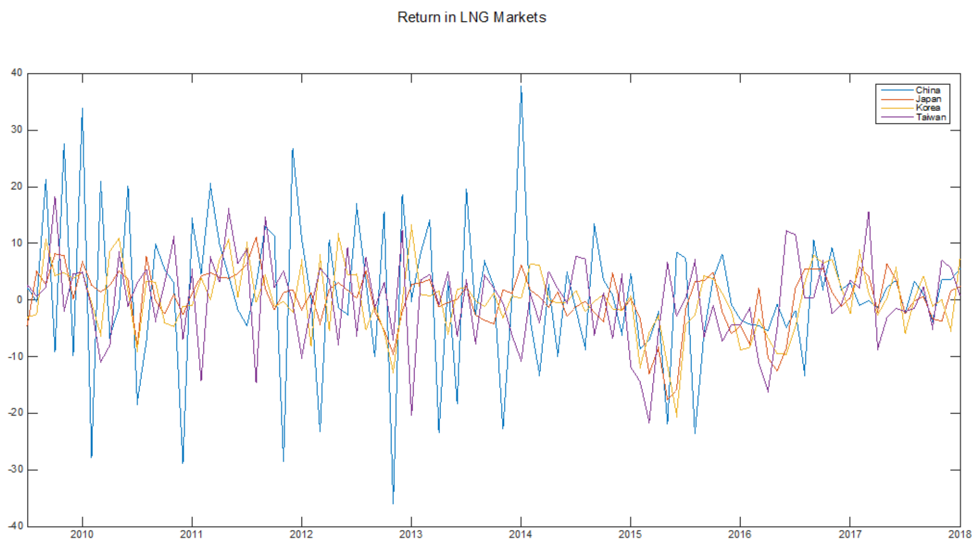


Table 1 Panel A reports the summary statistics of the monthly LNG returns. It first shows that all these markets experienced a positive average return during the sample period. Panel A also shows that gas markets of China and Taiwan are in general featured with greater volatility compared to those of Japan and Korea. We document the standard deviation of 166.947 in China and 57.890 in Taiwan. Table 1 further reports that all the LNG series is left skewed and leptokurtic, confirming the financial property of LNG returns. Altogether, these results show that the benchmark trading hub(s) is (are) needed to hedge the financial risks in the LNG market.

Table 1 Panel B displays the cross-correlations of LNG returns in different economies. The cross-correlation figure reflects the average contemporaneous integration between LNG markets. Note that, although we document the positive relationships across all the return series, the bonds between each market are modest. For example, the China and Taiwan market seem to be more isolated to other markets. The highest correlation figure of these two markets we document is 0.277. This result provides the first evidence that integration among LNG markets is relatively low. The country-specific heterogeneities still dominate the contemporaneous dynamics of LNG prices.

Table 1: Summary Statistics of LNG Returns

Panel A. Descriptive Statistics				
	China	Japan	Korea	Taiwan
Min	-36.121	-17.631	-20.268	-21.581
Max	37.754	11.080	13.287	18.261
Mean	0.826	0.261	0.226	0.137
Std	166.947	25.969	34.894	57.890
Skew	-0.144	-1.038	-0.302	-0.317
Kurt	3.930	4.571	3.597	3.264

Panel B. Cross-correlation				
	China	Japan	Korea	Taiwan
China	1.000	0.277	0.178	0.022
Japan		1.000	0.630	0.200
Korea			1.000	0.083
Taiwan				1.000

3.2 The role of oil price on natural gas prices

Before test the integration across the LNG markets, we tested the relationship between oil and LNG market to verify the role of oil indexation using a standard bilateral Structural VAR model. In this test, we set r_1 as the oil return and r_2 as the return in the corresponding LNG market, so that $z_t = (r_{oil}, r_{LNG})$. Based on this setting, we assume shocks to oil markets cause the changes in the LNG market contemporaneously, but shocks to the LNG market do not have the instant direct impact on the oil market within the same month. This identification is reasonable since it is commonly accepted that the natural gas prices are indexed to crude oil price in East Asia. We use monthly Brent price sourced from Thomas Reuter as the representative oil price.

The results confirm that the LNG market in East Asia is in general integrated to the oil market, but with significant different levels of integration. The oil price can explain approximately 75% movements in Japan, and 55% percent movements in Korea LNG market, 32% in Taiwan market and 22% in the Chinese markets. As the results are not the key of our interest, we only report the details in the Appendix.

3.3 Integration across the LNG markets

To formally test the integration between LNG markets, we estimate the SVAR model for each pair of LNG markets. To concentrate our analysis, we only show the long run variance decomposition results, which corresponds to the 12-month forecasting periods. As discussed earlier, to fully capture all the co-movement components, we adopt a standard recursive identification and assume the country in the first column has the instant impact on another market. If the shocks in one markets explain a large fraction of variations in another, then we can say that this two market shows a great level of integration.

For comparing, we consider the case with and without exclusion the oil price effects. The diagonal entries in Table 2 and 3 are calcualted by the average variations explained by a certain LNG market itself. Table 2 reports the variance decomposition results when eliminating the oil effects, which has been explicitly discussed in the previous section. Table 3 reports the counterpart results without elimination of the oil price effects.

Table 2 and 3 deliver two observations: First, there is not an integrated LNG market in East Asia. For all the four LNG markets, the shocks in itself can explain more than 85% variations. Second, the observed co-movement patterns in LNG markets mainly come from a common driver, the oil shocks. Table 3 show that, maintaining the oil shocks, the co-movements between LNG markets increase significantly.

In sum, the LNG markets in East Asia is in general fragmented at current stage. Each market area will need one hub to reflect the country-specific heterogeneities which dominate the dynamics in LNG prices. This multiple hub implication is consistent that in the previous literature (Shi and Variam, 2017, 2016). Such results suggest that East Asian governments and LNG industry from different countries should collaborate since hub creation needs significant intuitional reforms including market liberalization, and commercials changes including removal or relaxation of destination restrictions, which are all common challenges in the region (EIA, 2017; IEA, 2013).

Table 2: Variance Decompostion:
Ruling Out the Oil Shocks

	China	Japan	Korea	Taiwan
China	85.38%	13.39%	10.23%	19.10%
Japan	17.85%	86.68%	9.39%	8.88%
Korea	13.92%	17.15%	88.87%	13.53%
Taiwan	12.08%	9.43%	13.77%	86.16%

Notes: We report the variance decomposition in the long run, which refer to 20 month forecast horizon. The diagonal term shows the average variations in LNG market explaine by itself. We use the recursive ordering in our VAR model and order the country in the first column the first in the off-diagonal entries of the table.

Table 3: Variance Decompostion:
Including the Oil Shocks

	China	Japan	Korea	Taiwan
China	82.43%	20.58%	15.68%	19.10%
Japan	21.49%	64.09%	49.31%	12.39%
Korea	17.21%	42.49%	67.85%	14.87%
Taiwan	14.00%	44.66%	31.45%	84.55%

Notes: We report the variance decomposition in the long run, which refer to 20 month forecast horizon. The diagonal term shows the average variations in LNG market explaine by itself. We use the recursive ordering in our VAR model and order the country in the first column the first in the off-diagonal entries of the table.

4 Concluding remarks

The increasing financialization of energy market, including natural gas market, creates the academic and policy debates on the degree of integration in East Asian gas market. In this study, we employ a Structure Vector Auto-regression model (SVAR) and monthly LNG price data for four East Asian importers to examine whether natural gas market are integrated in East Asia. The results suggest that LNG markets are fragmented and thus there are different market fundamentals in the four examined markets. These finding suggest that there should be multiple LNG benchmark gas prices and associated trading hubs.

Our study on formulating the LNG trading hub in Asia has important practical implications. First, the benchmark hub price, and further the LNG futures, provides an additional signal and instrument for the firms to hedge energy price risks, mitigating the management costs. Second, prices generated from trading hub and its associated future markets can optimize resource allocation through market competition, which are in general more efficient than conventional oil indexed natural gas prices. Third, different from the hub price in North American or Europe, the benchmark hub price in Asia may more accurately reflect unique the supply and demand conditions in this particular region. Moreover, since the creation of natural gas trading hubs in different markets is not exclusive while institutional and commercial challenges that are foundation for generating competitive hub prices are common challenges for all of them, governments and gas industry in East Asia should collaborate in the process of developing competitive gas prices and gas trading hubs.

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