Analysis of Japan's LNG Import Spot Price: what are the implications to domestic gas pricing in Indonesia?

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Abstract

Gas export to Japan has become an important source of revenue for Indonesia since the 1970s. Traditionally, the gas was priced with linkage to the oil price. However, changes in the market during the early 2010s has put pressure to this traditional pricing mechanism. Using the Vector Auto-regression (VAR) approach, this research aims to understand whether the spot LNG import pricing in Japan is moving away from JCC linkage or not, and the extent of the change if there is any.

LNG price analyzed in this research is the Japanese spot cargo import price, published by the Japanese Ministry of Economy, Trade and Industry from March 2014 to November 2017. The Japanese LNG spot price was regressed against US Henry Hub (HH) and UK NBP gas hub prices, Japan Customs-Cleared (JCC) crude oil price, and Japan imported coal price in the same period.

The historical decomposition of the VAR model suggests that the spot LNG price in Japan were increasingly affected by US Henry Hub and UK NBP gas prices, while the effect of JCC crude oil price is weaker, and Japanese imported coal having no significant effect towards Japanese spot LNG price. The impact of mature gas hub prices is also dynamic: HH is showing stronger effect in the mid 2016, then it changed to the domination of NBP in mid 2017.

The result further indicates the increasing connectivity of gas price around the world, with US and UK price affecting Japanese gas price through spot LNG trade. Due to the demand condition in Japan and East Asian market in general, the continuation of US/European gas hub price effect is likely to happen until early 2020s, as the slight deficit in this region might be fulfilled by spot LNG import. Under the new domestic gas pricing regulation in Indonesia, the continuation of NBP impact towards gas pricing in Japan might reduce the price to the level at which fulfilling the increasing domestic gas demand is more efficient than exporting LNG.

Keywords— LNG, Japan, Indonesia, Price, Gas Industry

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1 Introduction

The commercialization of natural gas in Indonesia began in the 1970s, with the discovery of the Badak gas field in East Kalimantan, and the Arun gas field in North Sumatra. At that time, Indonesia is at the earlier stage of gas infrastructure development, so monetizing it via export to Japan was seen as a better option. The construction of LNG plants in those regions immediately followed, and the first shipments of LNG from Badak and Arun to Japan were sent in 1977. Since then, LNG has become one of the most important exports for the Indonesian economy, and Japan has continued as the main destination of Indonesian LNG.

Recently, the US shale gas revolution has reversed the industry expectation that the US would need to import natural gas as LNG, which prevailed in the 2000s, and has created an LNG export capacity for the United States. A significant quantity of new supply has become available for the world market. However, the Fukushima nuclear plant disaster in 2011 and sustained high oil prices in 2013-2014 kept oil-linked LNG contract prices high in Japan, and purchases of additional LNG cargoes by Japanese power generators as part of the replacement for lost nuclear generation pushed LNG spot prices even higher, tightening what would otherwise have been an abundance of LNG supply in the world market at that time.

Unlike oil, gas is difficult to store and transport across different geographic location. Because of that, gas price differs according to the location. Historically, gas prices have generally been higher in Japan than in the US or Europe, and the high gas price in the Japanese market has created the "Asian Premium". This presents a price arbitrage opportunity for exporters, while Japanese utilities and gas consumers have experienced severe financial losses following the unavailability of the nuclear fleet following Fukushima. A question follows from these changes: is the pricing of Japanese LNG is in transformation from mainly oil-linked pricing to another mechanism that better reflects the gas supply and demand condition?

In general, this project aims to update the understanding on LNG price formation in recent years in Japan: one of the largest LNG import markets in the world. Hopefully, it will be beneficial for energy policy making, corporate strategy and decision making in Indonesia: one of the biggest LNG exporters in the world.

Specifically, using the Vector Auto-regression (VAR) approach, this research aims to understand whether the spot LNG import pricing in Japan is moving away from JCC linkage or not, and the extent of the change if there is any. Furthermore, the relationship of LNG price and coal price as competing fuel will also be analyzed. The stronger effect of mature gas hub price in spot LNG pricing is expected, while JCC and coal is expected to have weaker effect; however, the extent of this relationship can be further decomposed by using VAR model. The projected future demand in major export destination will also be discussed, as it could impact the market condition and price formation in the upcoming years. After that, the implication of changing LNG pricing in Japan towards Indonesian domestic gas pricing policy will be discussed.

2 Literature Review

2.1 Overview of Indonesiafls Gas Production and Export

Oil and gas revenue continues to play a big role in Indonesia's economy. In the 2018 State Budget (APBN), oil and gas revenue is projected to contribute to around 29.2% of the state's non-tax revenue (Ministry of Finance, 2017). Due to declining oil production from the mature fields, the role of gas in achieving the state's revenue target has been increased in recent years. With 1,200 Mboepd of projected lifting, gas accounts for the majority of oil and gas lifting target in the latest State Budget (Figure 2.1).

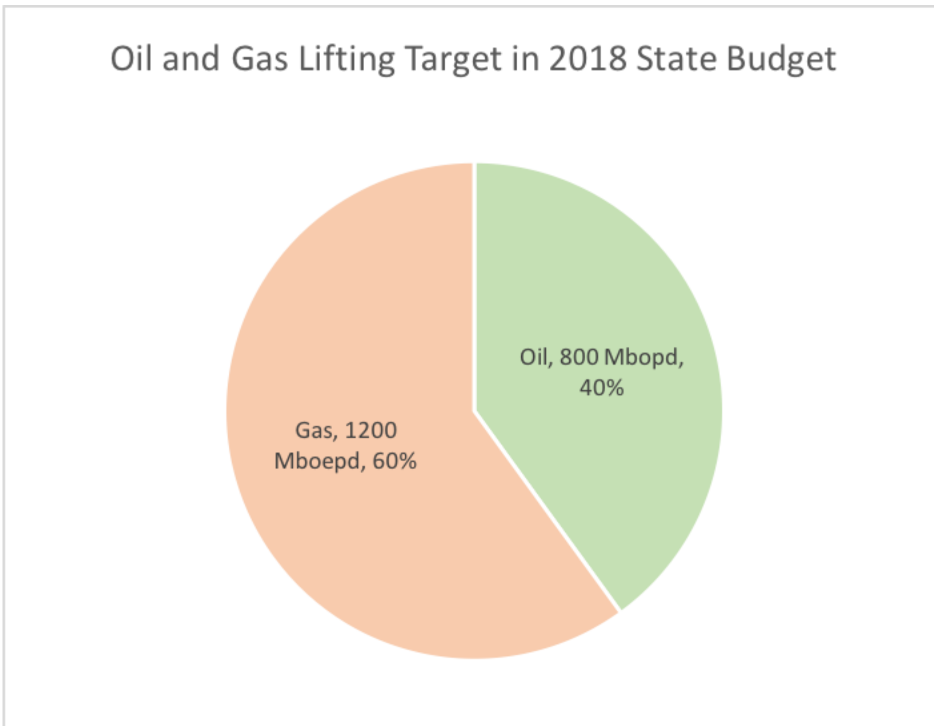

Figure 2.1: Oil and gas lifting target in 2018 State Budget. Data from Ministry of Finance (2017)

In terms of the supply, currently Indonesian gas production is at the plateau stage (Figure 2.2). As seen in the figure, the pattern of growth-plateau-decline has been observed in Indonesia's oil production, which made gas decline scenario in the near future plausible. The length of the national production plateau for gas is not currently clear, but if it turns out to be similar to oil (about 20 years), then the decline phase would begin sometime between 2020 and 2025.

Meanwhile, the domestic gas demand has been growing at a CAGR of 9% between 2003-2015 (SKK Migas, 2016). Furthermore, the National Energy Policy (Kebijakan Energi Nasional/KEN) has mandated that 88 mtoe of the energy mix in 2025 be supplied by gas (Government of Republic of Indonesia, 2014), compared with around 38

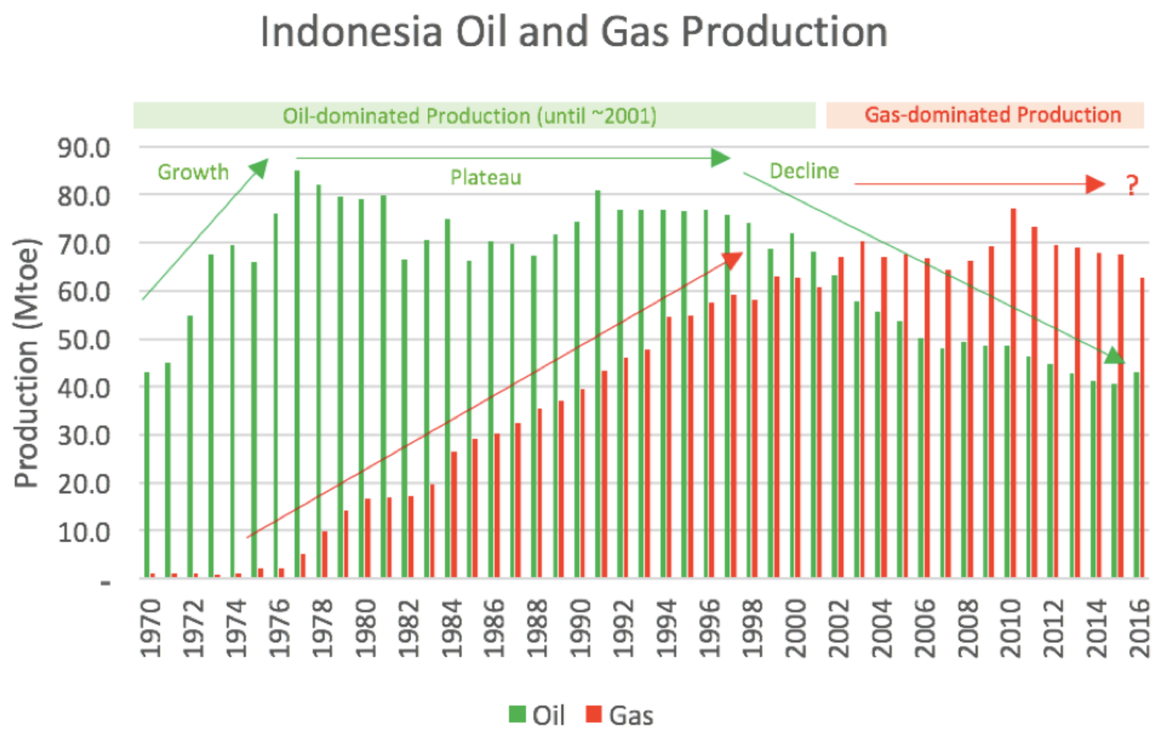

Figure 2.2: Indonesia's oil and gas production profile. Data from BP (2017)

mtoe in 2015. Although currently a net exporter, some researchers and government agencies have suggested that Indonesia might need to import gas starting from early 2020s (Purwanto et al., 2016; SKK Migas, 2016). Due to this possible production decline in the near future amidst growing domestic demand, the optimization of natural gas utilization is critical.

Although the fraction is declining in recent years, LNG exports still account for a significant proportion of Indonesian gas. Figure 2.3 shows that, in 2017, 29% of the produced gas in Indonesia was utilized for LNG export. Together with the pipe export, 42.21% of Indonesia's gas production goes into the international market. Ever since the first shipment in 1977, Japan has been the main export destination for Indonesian LNG. In 2016, Indonesia exported 6.78 MTPA of LNG to Japan, which constitutes around 41% of its total LNG export (Figure 2.4). Due to the long-term nature of LNG export contracts to Japan, this trend is expected to continue in the next few years.

On the other hand, the recent decrease of LNG prices has been accompanied by an increase in the number of LNG importing and exporting countries. Seven new countries have started to import LNG between 2015-2017, and two countries resumed their export in the same period (IGU, 2017). This has created new alternatives and market opportunities for exporting countries such as Indonesia. Understanding the Japan LNG market dynamics would be beneficial for government energy policy making and gas industry stakeholders strategic planning process.

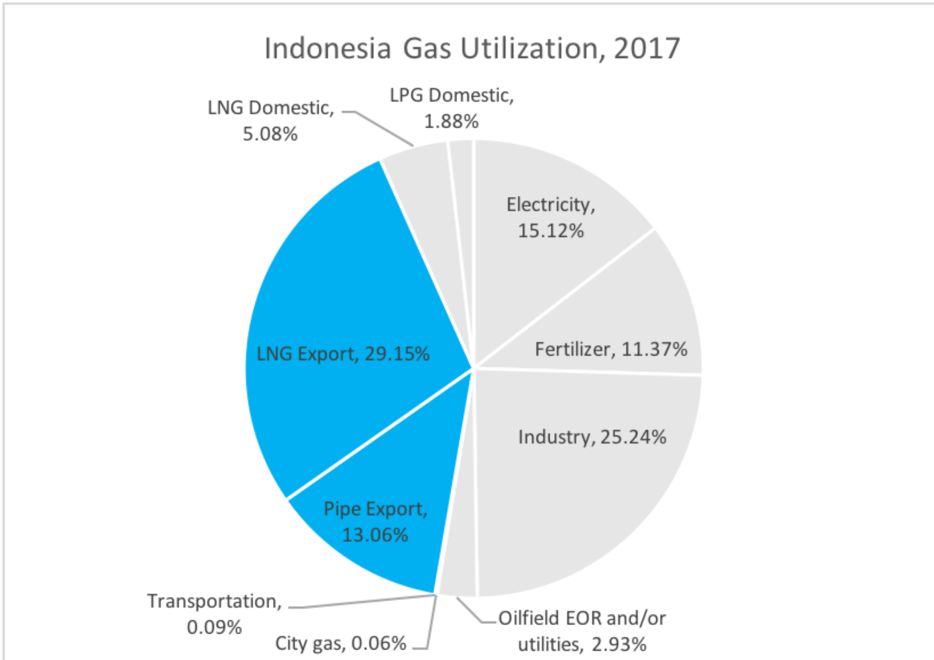

Figure 2.3: Indonesia gas utilization in 2017. Data from SKK Migas (2017b)

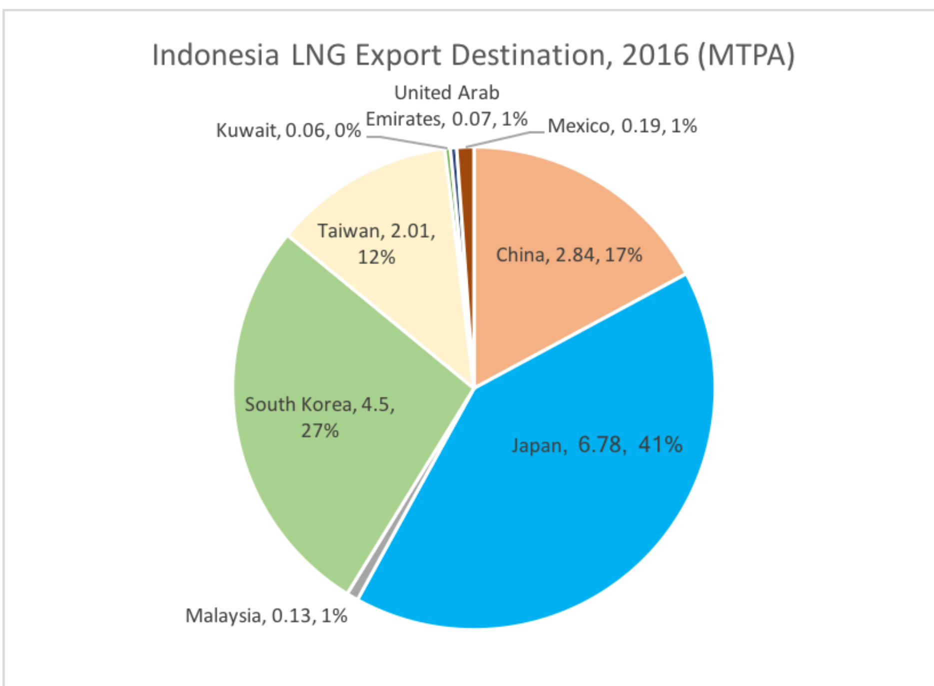

Figure 2.4: Indonesia LNG export destination. Data from IGU (2017)

2.2 Cause of the Change in Japanese LNG Pricing

Traditionally, LNG is sold to Japan under long-term (20-25 years) contracts. The LNG contract pricing is linked to a time-averaged value of crude oil, typically the Japanese Customs-Cleared crude price (JCC, also colloquially known as Japanese Crude Cocktail). The initial LNG trade in the 1970s and several modern contracts used 14.85% as the coefficient of LNG and JCC price linkage (the "slope"), and is given by the following linear formula (Flower and Liao, 2012):

$$LNGPrice = 14.85\% \times JCCPrice + \alpha \tag{1}$$

The slope used in various long-term contracts has changed over time following the LNG market condition (Flower and Liao, 2012). As mentioned before, the initial LNG contracts in the 1970s used 14.85% as the slope. The buyer's market condition between 2001-2005 have seen the slope as low as 5.25%, with JCC price floor and price ceiling arrangement. The return to seller's market condition in around 2005 has changed the slope of long-term LNG contracts negotiated in this period to 15-16.3%. Modern LNG contracts sees the return of slope to 14-15% and the reintroduction of "S-curve", which will be described in the following section. The parity of LNG with crude oil happens at 17.2% slope (Figure 5), so the slope in Japanese LNG long term contracts means that LNG will trade at a discount compared with crude oil in a high (>US$30/bbl) JCC price.

Some contracts have a non-linear formula which forms an "S-curve", with gentler slope when the oil price is below US$30-60/bbl and above US$90-110/bbl (Figure 2.5). It was first introduced in the 1990s to protect sellers from low oil price in this decade, but the recent reintroduction was made to soften the impact of very high oil prices on the buyer side (Flower and Liao, 2012). The S-curves vary between contracts, and the observed monthly oil and gas prices are not always on the line due to time-lags from the averaging of oil prices (typically over three or six months).

Under these contracts, the buyer has to commit to purchase a minimum volume of gas (the "take-or-pay" level), typically around 80-85% of the contract quantity. To fulfill their demand above the take-or-pay level, a contracted buyer has the choice between buying gas from the spot market or taking their contract nomination. In contrast with European long-term contracts, most Asian LNG contracts rarely have the explicit provision for periodic review, resulting in a very wide range of contract prices (Rogers, 2012). However, some of the newer contracts have more flexibility on price renegotiation with a 3-5 year review period typical (Cassidy and Kosev, 2015).

The long term contract enables the market to address the fundamental risks associated with gas trade (Stern, 2014b). These fundamental risks are price risk and volume risk. The price risk is related to the market price volatility of the alternative fuels (mostly refined products of crude oil), while the volume risk is related to the availability of the gas demand that makes investments in gas exploration and production justifiable. This is an example of the economic principle of opportunity cost expressed in commercial contracts.

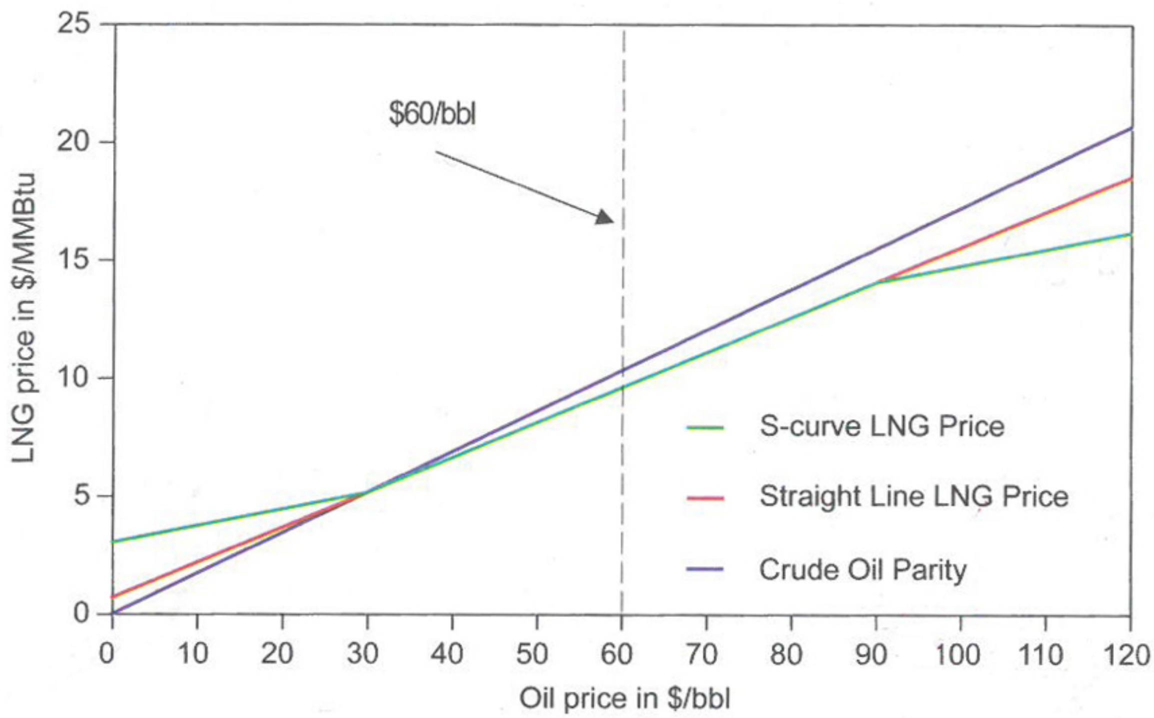

Figure 2.5: The recent version of 'S-curve' (Flower and Liao, 2012)

Under the long-term contract, the producer-exporter is willing to assume oil price risk, as long as the price is sufficient to cover the cost of production and transportation of gas, because the alternative to gas project investments for those companies is oil projects. The importer is willing to assume the volume risk, because it is confident in the downstream demand for the gas ensuring that a large enough market is available for certain volume of gas. Pricing formula with link to oil price was based on the assumption that the next best alternative to long-term gas supply for the buyers would be fuel oil or distillates.

However, the period of 2009-2012 has disrupted this logic of gas price formation to the extent that bilateral allocation of risks via contracts, expressing the opportunity costs of one buyer and one seller is no longer the only consideration. The natural gas market in continental North America long ago matured from contracts based on bilateral buyer-seller relationships, to a large network with many producer-sellers and many buyer-consumers, risk management via traders, and deep links with financial markets. Due to the shale gas revolution in the US, North America (Canada, the United States and Mexico) has become a self-sufficient gas market and even created the opportunity for substantial exports from the region. As a result, a large volume of LNG became available to the world's gas market, contributing downward pressure to LNG spot prices. Balancing this new supply, the closure of nuclear reactors post-Fukushima in Japan has resulted in a significant increase of short term LNG demand (and oil demand) for power generation, which helped to sustain oil and LNG prices.

Subsequently, as the market gradually rebalanced, prices fell.

On the other hand, the increase of oil price beyond US$100/bbl in this period also increased the oil-linked, long term gas contract prices used in Japan. The Henry Hub-linked pricing was $3-4/MMBtu cheaper than JCC-linked LNG contracts in Japan (Stern, 2014b). Due to this chain of events, various authors have argued that JCC-linked pricing has failed to represent the gas market fundamentals, i.e. supply and demand condition, in Japan (Rogers and Stern, 2014; Stern, 2014b; Shi, 2016).

The financial impact from changes in Japanese electricity generation sector post-Fukushima has put Japanese utility companies under pressure. Figure 2.6 shows the annual net profit/loss for the 10 largest Japanese power utilities (JPUs). The high gas price due to oil-linked pricing has increased their costs in recent years, partly contributing to the financial losses. This condition is aggravated as the government is limiting the amount of cost pass-through allowed to their customers (Rogers and Stern, 2014). The failure of oil indexed, long-term contract to reflect the gas market fundamentals in price formation has brought financial distress to gas suppliers and midstream incumbents. This could become an impetus towards more flexibility in Japanese LNG supply sector, which provides opportunity for LNG exporting countries.

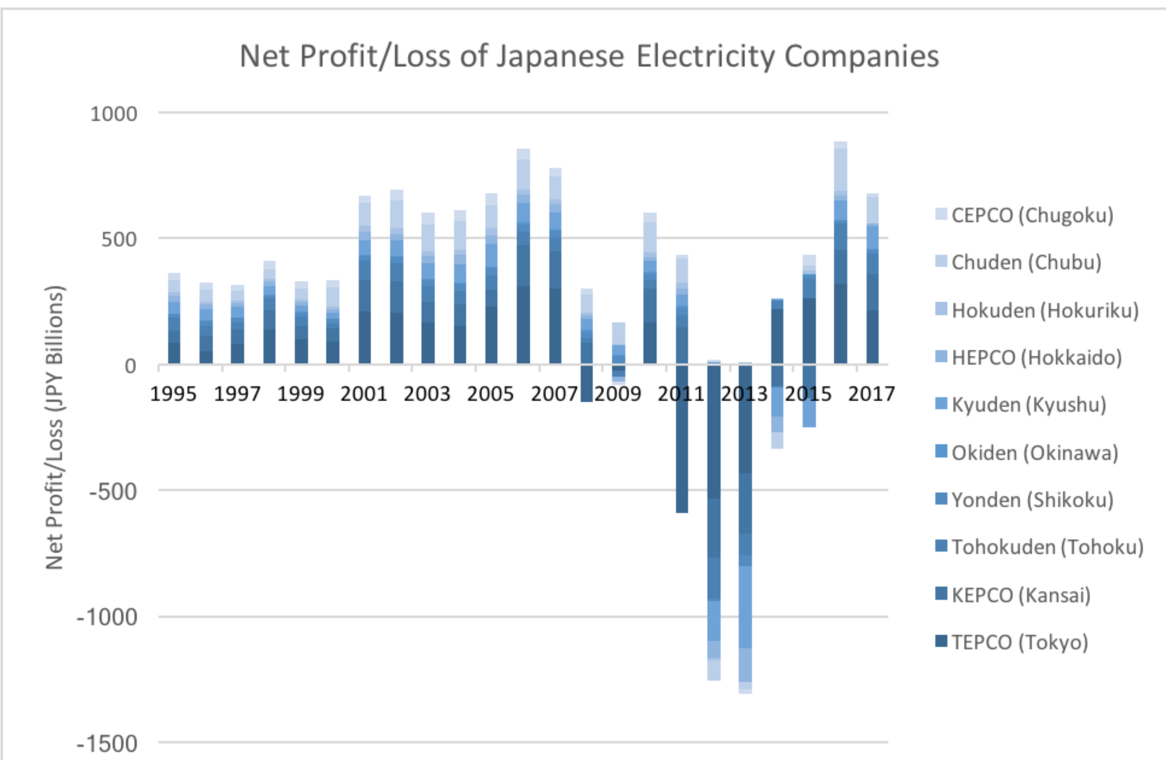

Figure 2.6: Annual net profit/loss of Japanese electricity companies. Data from Bloomberg

2.3 The Relationship Between Spot LNG Import Price and Other Energy Commodity Prices in Japan

The analysis of spot cargo import price is useful as it reflects the arbitrage process between the spot gas and the oil-indexed gas. The arbitrage between these two is possible due to the minimum take-or-pay obligation in oil-indexed contracts. Figure 2.7 shows a simple supply-demand model of the process. This arbitrage process can be explained as follows (Stern and Rogers, 2014):

- If the spot price is below the oil-indexed contract price, the end-users will buy more spot priced gas and less oil-indexed gas. The increased demand for spot gas will increase its price. Meanwhile, end-users with oil indexed long-term contract will reduce their contract nomination to take those spot gas.
- The process repeats itself until:
  - the spot price becomes the same as oil-indexed price, or
  - the supply of oil-indexed gas has been reduced to take-or-pay level, and the consumers cannot take additional spot gas.

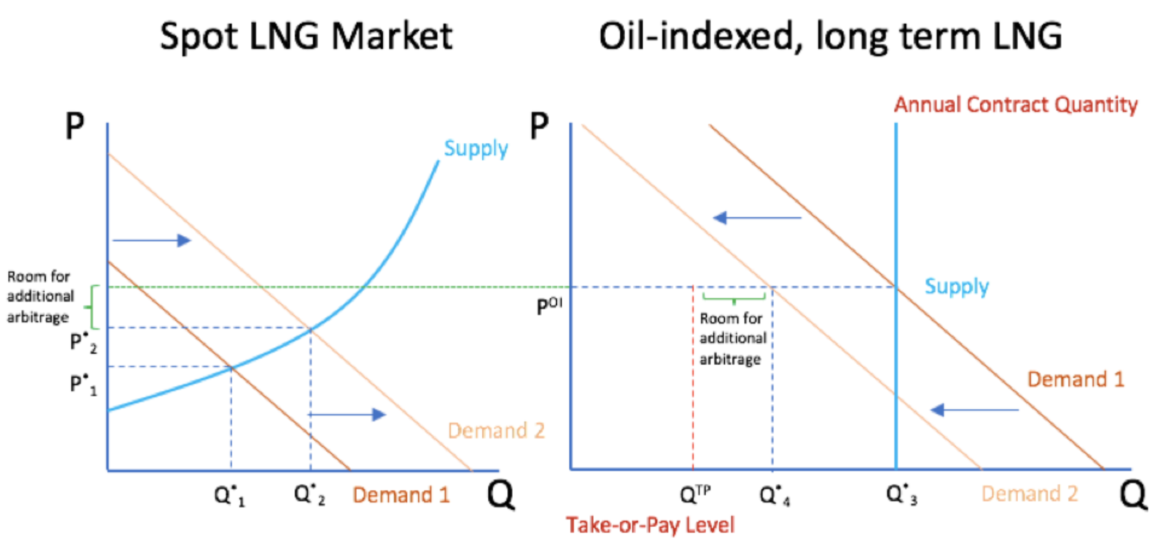

Figure 2.7: Arbitrage of spot LNG and oil-indexed LNG when spot price (P^*_1) is lower than oil-indexed price (P^*). The increase of spot LNG demand will increase its price (P^*_1 to P^*_2). To accommodate this volume of gas, the demand for oil-indexed LNG above the take-or-pay level will decrease (Q^*_3 to Q^*_4). This process will repeat itself until the price of spot LNG is the same as oil-indexed price (POI), or demand for oil-indexed LNG is at the take-or-pay level as no additional gas supply can be absorbed.

Another energy commodity that might affect spot LNG price are oil, coal, and gas price in mature hubs. Short-run fuel switching from gas to oil might be obsolete by now in Japan. However, due to the arbitrage process mentioned above, the price of oil remains important to the pricing of LNG spot cargo import price in Japan. The price of coal will be included in the analysis to capture the effect of fuel substitution between gas and coal in Japanese electricity sector (if any). Gas pricing linked to mature hub such as US's Henry Hub (HH) or UK's National Balancing Point (NBP) can be a short-term solution to the price level problem due to high oil price, prior to the formation of a price mechanism that could reflect Japanese supply and demand (Rogers and Stern, 2014).

3 Analysis of Japan‘s Spot LNG Import Pricing

3.1 Vector Auto-Regression (VAR) Model

To know whether LNG pricing in Japan is moving away from JCC-linked pricing or not, an understanding of the relationship between Japanese LNG price and other hub prices is required. The relationship of those variables can be quantified by doing the impulse response function estimation and historical decomposition of a VAR model. VAR model has been widely used in econometric research since the publication of Sims (1980) paper and also in the energy research, such as explaining the effect of oil price shock (Kilian, 2009) and the discussion of gas pricing topics (Nick and Thoenes, 2013; Zhang et al., 2018).

Before discussing a VAR model, consider the following simple univariate autoregressive (AR) model with one lagged value:

$$y_t = \alpha_1 y_{t-1} + e_t \tag{2}$$

In the model, the value of y_t depends on its own first lag y_{t-1}. The parameter α_1 denotes the coefficient of the variable at 1st lag and e_t is the error term, which assumed to be normally distributed with variance σ^2 and zero mean. However, regressing a variable solely on its own lag might be too restrictive in the context of econometrics study. Usually an understanding of the relationship between multiple variables is required. Hence, "vector" auto-regression (VAR) approach is used. A VAR model with one lagged value and two variables y_{1t} and y_{2t} can be simply written as follows:

$$\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix} + \begin{pmatrix} y_{1t-1} \\ y_{2t-1} \end{pmatrix} + \begin{pmatrix} e_{1t} \\ e_{2t} \end{pmatrix} \tag{3}$$

or

$$y_t = A_1 y_{t-1} + e_t \tag{4}$$

where $y_t = \left(\begin{smallmatrix} y_{1t} \\ y_{2t} \end{smallmatrix}\right)$, $A_1 = \left[\begin{smallmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{smallmatrix}\right]$, and $e_t = \left(\begin{smallmatrix} e_{1t} \\ e_{2t} \end{smallmatrix}\right)$ representing structural errors. The VAR model implies that all variables are endogenous. But from the example above, each row can also be written as separate equations, which are $y_{1t} = \alpha_{11} y_{1t-1} + \alpha_{12} y_{2t-1} + e_{1t}$ and $y_{2t} = \alpha_{21} y_{1t-1} + \alpha_{22} y_{2t-1} + e_{2t}$.

The VAR model can be rewritten in vector moving average form as:

$$y_t = \sum_{t=0}^{\infty} A_i e_{t-i} \tag{5}$$

where A_i is the $K \times K$ coefficient matrix to be estimated. The response of variable j, i period after an impulse (i.e. instantaneous change at one time) in variable k is reflected in $a_{jk,i}$, which is the jk-th element of matrix A_i (Nick and Thoenes, 2013). This is the principle of impulse response function estimation.

Based on the moving average representation above, the contribution of changes in variable k to the error variance of a h-step forecast of variable j can be written as:

$$\omega_{jk,h} = \sum_{i=0}^{h-1} e' \alpha_i^2 e_k / MSE[y_{j,t}(h)] \tag{6}$$

with $MSE[y_{j,t}(h)]$ as the mean square error of the forecast for j. This means that $\omega_{jk,h}$ represents the fraction of j's variance that can be explained by the changes of another variable used in the VAR model (Nick and Thoenes, 2013). The process is called variance decomposition.

In this study, a VAR model with the lag length of 1 (selected based on Schwarz Criterion) will be used to estimate the impulse response function from other hub prices and JCC price to the Japanese spot LNG price. Historical variance decomposition will be done to analyze the extent of those variable's contribution towards spot LNG price variance over time. By doing the impulse response function estimation and historical variance decomposition, the extent of other gas hub and JCC price effect towards the variance of spot LNG price in Japan can be known.

3.2 Price Series and Data Sources

Table 3.1 shows the summary of the price series and data source used in the analysis.

Table 3.1: Summary of data used in the analysis

Data	Variable Name	Original Unit	Data Source
Japan LNG spot cargo import price	JPSPOT	USD/MMBtu	METI (2018)
Japan Customs-Cleared crude price	JCC	JPY/kl	MoF (2018)
Japan imported coal price	JCOAL	USD/Mt	MoF, in Bloomberg
US Henry Hub spot price	HH	USD/MMBtu	EIA (2018)
UK NBP within-day price	NBP	GBP pence/therm	Bloomberg

The LNG price analyzed in this research is the Japanese spot cargo import price, published by the Japanese Ministry of Economy, Trade and Industry since March 2014 (METI, 2018). The prices are based on monthly census conducted by METI to around 15 spot LNG end-users in Japan. The number is a simple averaging of at least two reports of spot LNG prices from those end-users; METI won't publish the price if there are less than 2 respondents that imported spot LNG.

The "contract-based" price (i.e. cargo arrival in the contract month) from the dataset was used in the analysis. There are at least 5 months with no contract-based price published. For the purpose of the analysis, 4 of these missing values was replaced by the "arrival-based" price (i.e. cargo arrival not in the contract month), and 1 value was replaced by linear interpolation due to no price report at all.

The analysis also included the monthly JCC crude oil price, published by the Japanese Ministry of Finance (MoF, 2018). This research uses Japan coal import price from Japanese MoF, available in Bloomberg. To know the relationship between these hub prices and the extent of their contribution towards recent Japan spot LNG price movement (if any), the HH price from the US Energy Information Administration (EIA, 2018), and NBP "within-day" (i.e. price for delivery at the same day) price from Bloomberg were included in the analysis. All data were converted from local currencies and units to US$/MMBtu prior to the transformation.

3.3 Data Preparation

Prior to the VAR analysis, the data was plotted to visually characterize the relationship between Japanese spot LNG price with JCC, coal, and other gas hub prices. Figure 3.1 shows the time series plot of Japan spot LNG, JCC, coal, US HH, and the UK NBP prices, relative to their March 2014 level.

Visually, it seems that the Japanese spot LNG price tends to diverge from JCC price, especially in times when the JCC is showing upward trend (e.g. around June 2015, June 2016, and April 2017). On the other hand, it shows similar upward and downward patterns with other hub prices, especially with NBP price (e.g. price drop around July 2014 and June 2017, also price rise around January 2017). This could be an early indication of change towards HH/NBP benchmarking for spot LNG import in Japan. Meanwhile, coal price exhibits different trend with other prices.

All data were transformed into their natural logarithm for the purpose of VAR analysis, as this research is more focused on the relationships within the variables, rather than any cointegration or stationarity of the data. This is also practiced by Nick and Thoenes (2013) in their VAR analysis on gas pricing in Germany. Figure 3.2 shows the time series of transformed data.

3.4 Results

Figure 3.3 shows the impulse response function estimation results from shocks in other variables to Japan spot LNG price. These figures can be interpreted as the change of Japan spot LNG price in response to 1 (one) standard deviation change of other variables. The results show that the increase of HH and NBP price resulted in a relatively strong and immediate increase of Japan spot LNG price in the short term. The effect of JCC price shock is weaker than the effect of HH and NBP, and the peak occurs in mid-term. On the other hand, a shock in Japan imported coal price has the weakest effect towards Japan spot LNG price, with the peak effect occurring in longer term.

The next figures will show the historical decomposition of the variance in the Japan spot LNG price that is attributable to the other variables in the model. A normalized Japan spot LNG price curve is also included in the figure. However, note that the actual change in a specific period is also affected by the shocks prior to that period, which is not considered in the decomposition at that specific period. Hence, the decomposition

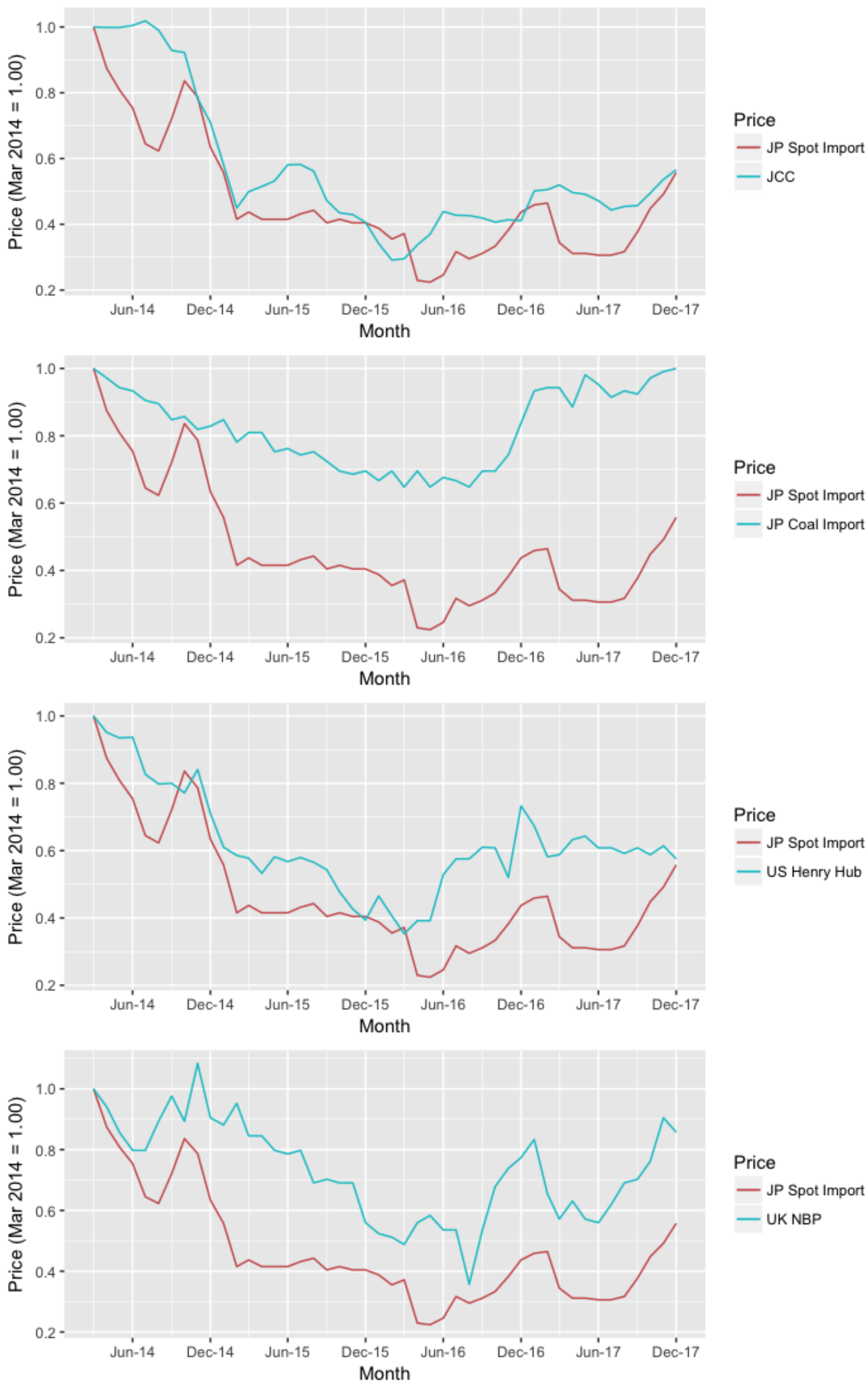

Figure 3.1: Japan spot LNG compared to JCC, coal, HH, and NBP price between March 2014 - November 2017, relative to March 2014 level. Japan spot LNG price tends to diverge from JCC during upward trend of JCC, while it shows similar pattern with HH and especially NBP

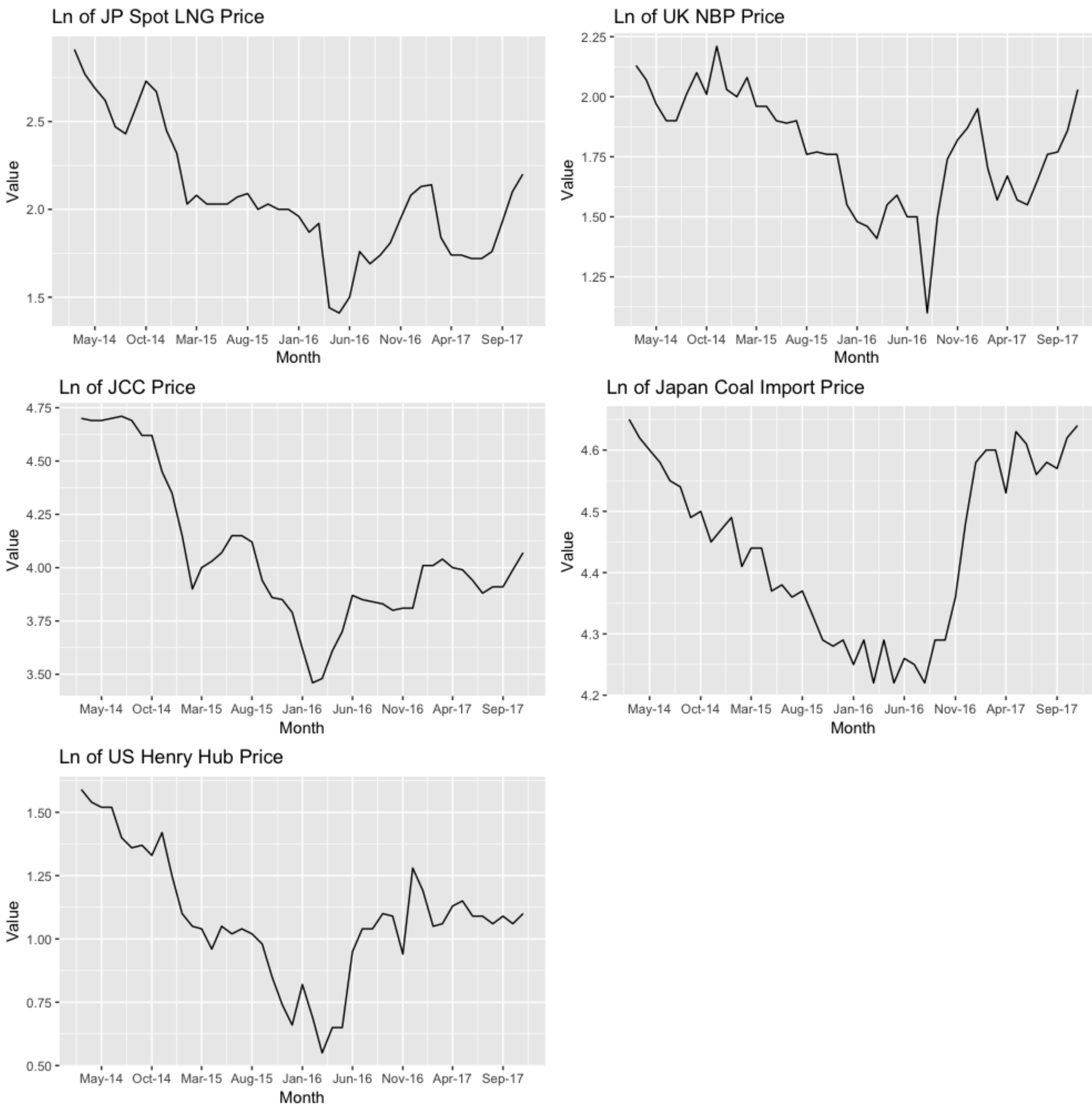

Figure 3.2: Time series of the transformed data included in the analysis

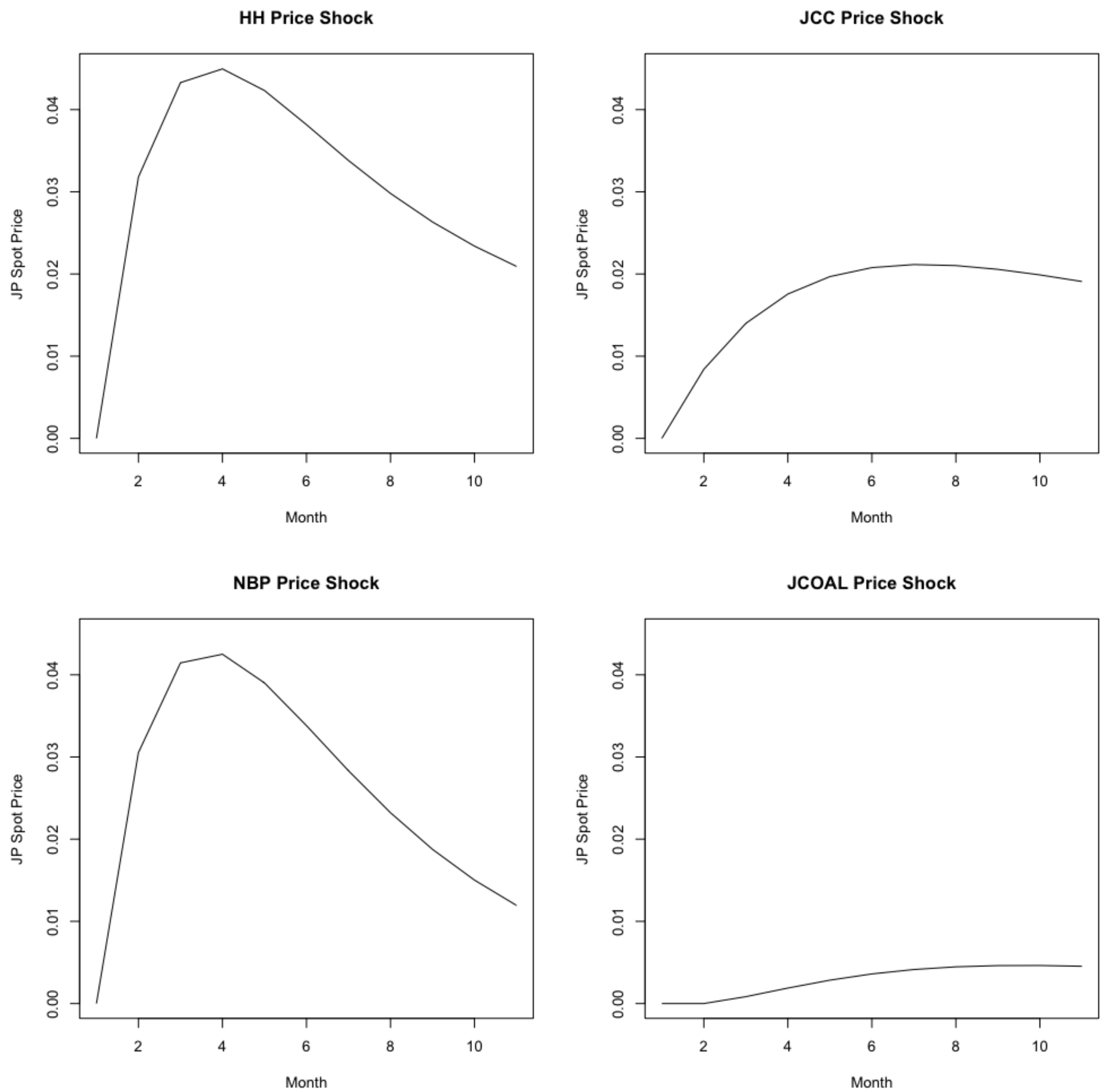

Figure 3.3: Responses of Japan spot LNG price to the shock of other variables

does not necessarily fit the actual change of Japan LNG spot price and the price is displayed for illustrative purpose only.

Figure 3.4 shows the historical decomposition of JCC influence towards the Japan spot LNG price. It shows that JCC price could explain up to 13% of Japan spot LNG price variance for the period. As expected, JCC price still affect the pricing of Japanese spot LNG price; however, its effect is less dominant compared with the effect of mature gas hub prices as shown in the next figures.

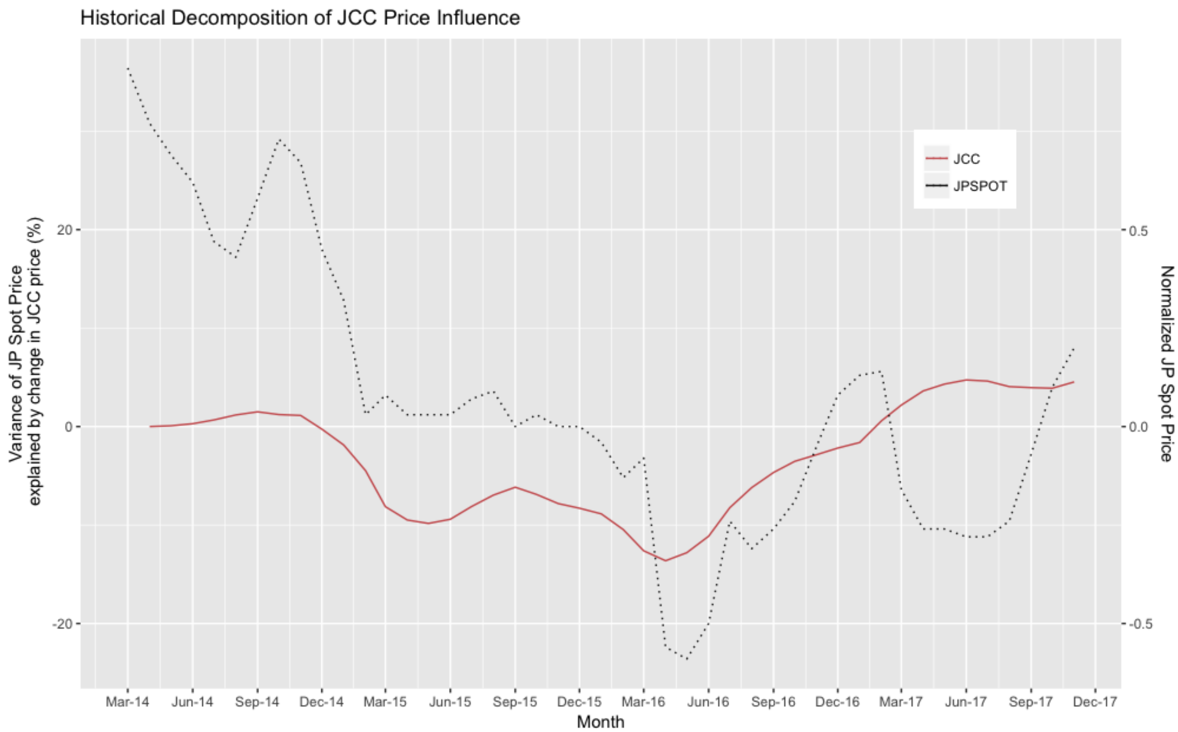

Figure 3.4: Historical decomposition of Japan LNG spot price variance which is attributable to JCC price

Figure 3.5 shows the historical decomposition of US HH hub price influence. It shows that HH price explained the spot LNG price drop around March 2016 - May 2016 better than the JCC price did. In this low-price period, the price of HH reached US$ 1.73/MMBtu. The stronger relationship with mature gas hub price in Japanese LNG spot trade is not surprising, but it turns out that the nature of this relationship is not static, as shown in the next figure.

Figure 3.6 shows the historical decomposition of UK NBP hub price influence. While the NBP price didn't show as much influence as HH price in the period of March 2016 - May 2016, it shows bigger influence in the recent Japan spot LNG price drop around March 2017 - August 2017. In this period, the NBP price reached US$ 4.8/MMBtu. This demonstrates that, while mature gas hub prices explain movement in Japanese spot LNG price better than JCC price does, the relationship is more dynamic. At one

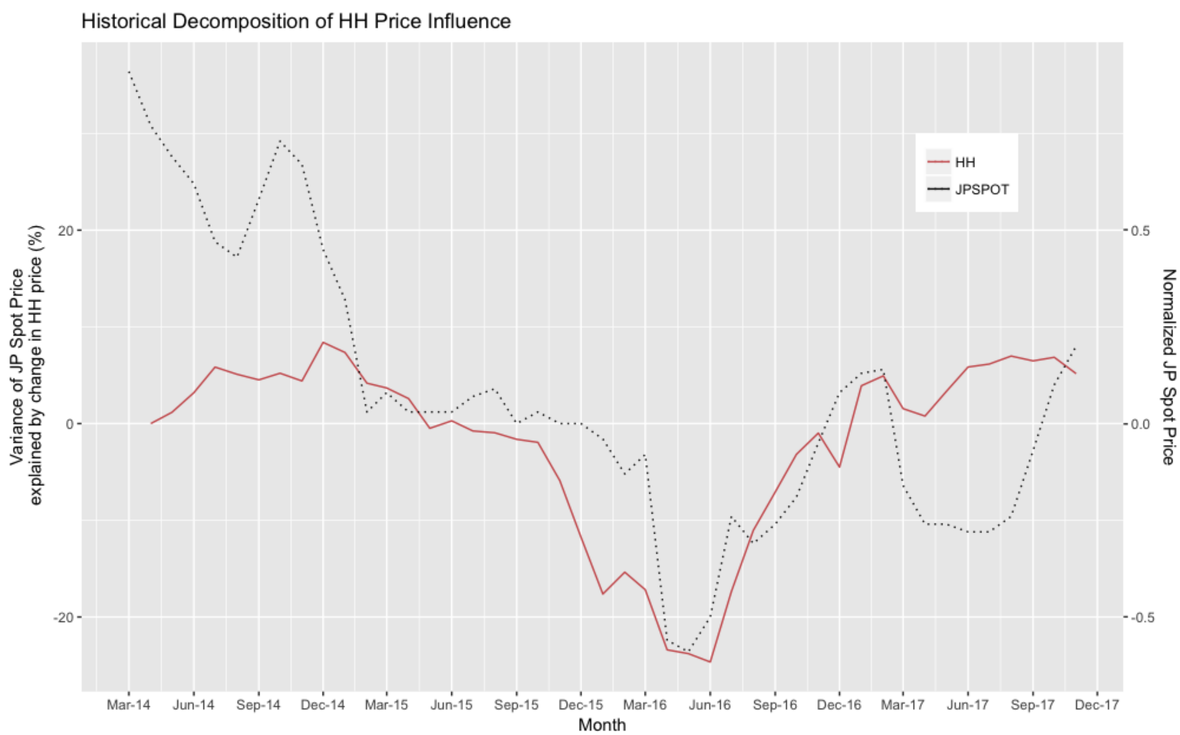

Figure 3.5: Historical decomposition of Japan LNG spot price variance which is attributable to Henry Hub price

period, HH price could affect the Japan spot LNG price more, and it could change to NBP-dominated in another period, depending on the price level.

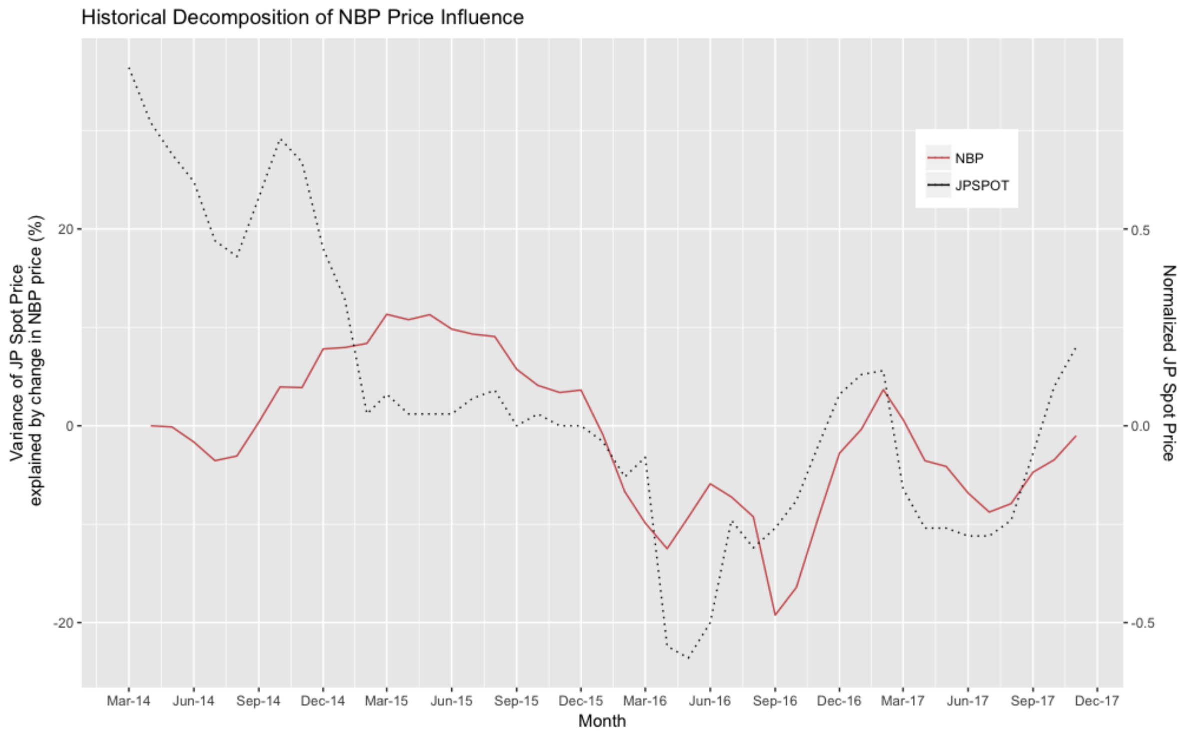

Figure 3.6: Historical decomposition of Japan LNG spot price variance which is attributable to NBP price

Figure 3.7 shows the historical decomposition of Japan imported coal price influence. Consistent with the finding from impulse response function estimation, the role of coal price in explaining the variance of Japan LNG spot price is relatively small, compared to JCC and another hub prices'role.

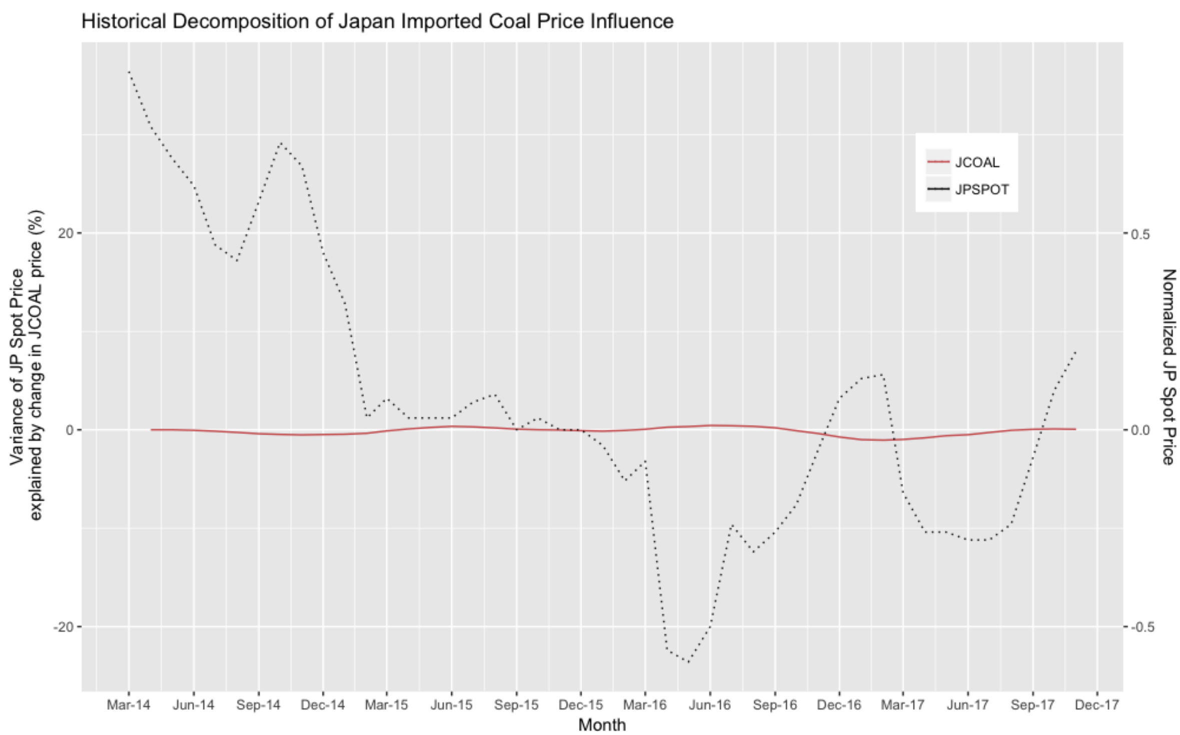

Figure 3.7: Historical decomposition of Japan LNG spot price variance which is attributable to Japan imported coal price

4 Overview of Future Demand in the Main Export Destinations

As shown in Figure 2.4, Japan, South Korea, China, and Taiwan has become Indonesian LNG main export destination in 2016. The knowledge of potential future gas demand in these markets, which uses JCC-indexed long-term contracts, should be taken into account in gas-related policy making process. However, a research by Honoré et al. (2016) suggests that the growth potential in these mature markets is limited. The limited growth potential is mostly due to changing economic condition in these markets and the uncertainties of government's energy policy.

There are two main factors which could significantly affect Japan's future gas demand, which are its ambitious energy efficiency plan and the rate of nuclear reactor restart post-Fukushima (Honoré et al., 2016). The energy efficiency plan aims to decrease their energy consumption in 2030 from 411.3 billion liter oil equivalent (bloe) in business-as-usual scenario to 326 bloe. Although the plan is difficult to achieve as Japan has been regarded as one of the most energy-efficient country in the world, the efficiency path is similar with the previous plan which has been achieved in 1970-1990.

Meanwhile, Japan has been restarting its nuclear reactor since 2015. The restarting of a reactor requires a safety assessment by Japan's Nuclear Regulation Authority (NRA) and coordination with local governments. As of April 2018, seventh out of 42 operable reactors have resumed operation (KEPCO, 2018), however the delay in the process due to lengthy legal requirements is likely to continue in the future.

Figure 4.1 shows the reflection of these scenarios in Japanese gas supply and demand. Under various nuclear restart and gas demand scenarios, Japanese gas balance is possibly manageable up to early-2020s by using spot import. However, it is likely that Japan will need a new mid or long-term LNG contract starting from mid-2020s.

Indonesia's 2nd largest export destination South Korea enjoyed high economic growth in recent decades. However, it is currently facing slowdown of export market and several longer-term challenges such as ageing population and rigid labor market. South Korea's gas demand has become uncertain as the reduced consumption in its manufactured goods in export market has slowed down overall energy consumption since 2010 (Honoré et al., 2016). Figure 4.2 shows South Korean gas supply-demand balance projection. It is likely that South Korea will require mid or long-term contract post 2025.

The double-digit economic growth period in mid-2000s has increased the energy commodity import in China, but the growth is slowing down in recent years. This “new normal” of China's lower economic growth coincides with the government's plan to refocus Chinese economy from energy intensive economy towards high-tech, service economy. The slowing down of Chinese economy has made future gas demand uncertain, and this is further exacerbated by the minor role of gas in China's energy policy, and the possible over-contracted condition in the supply side (Honoré et al., 2016).

Chinese energy policy encourages nuclear and renewable energy to substitute coal

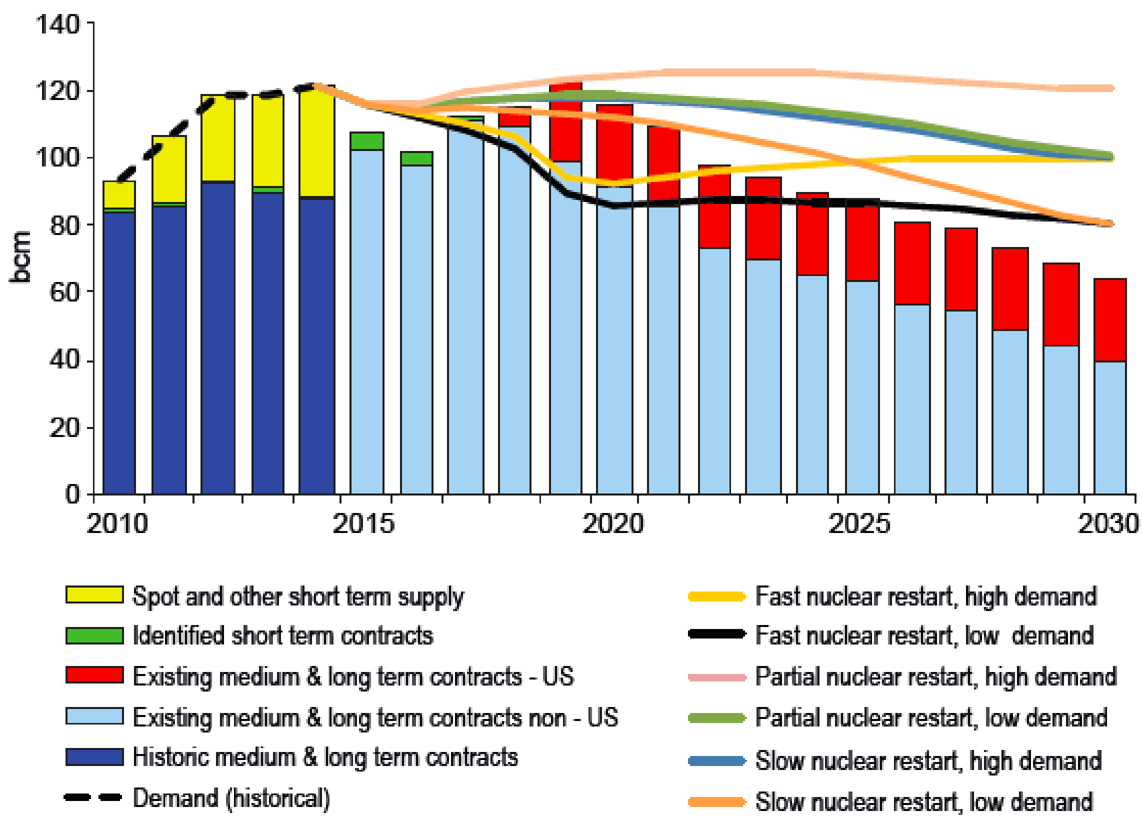

Figure 4.1: Projected gas supply and demand in Japan (Honoré et al., 2016)

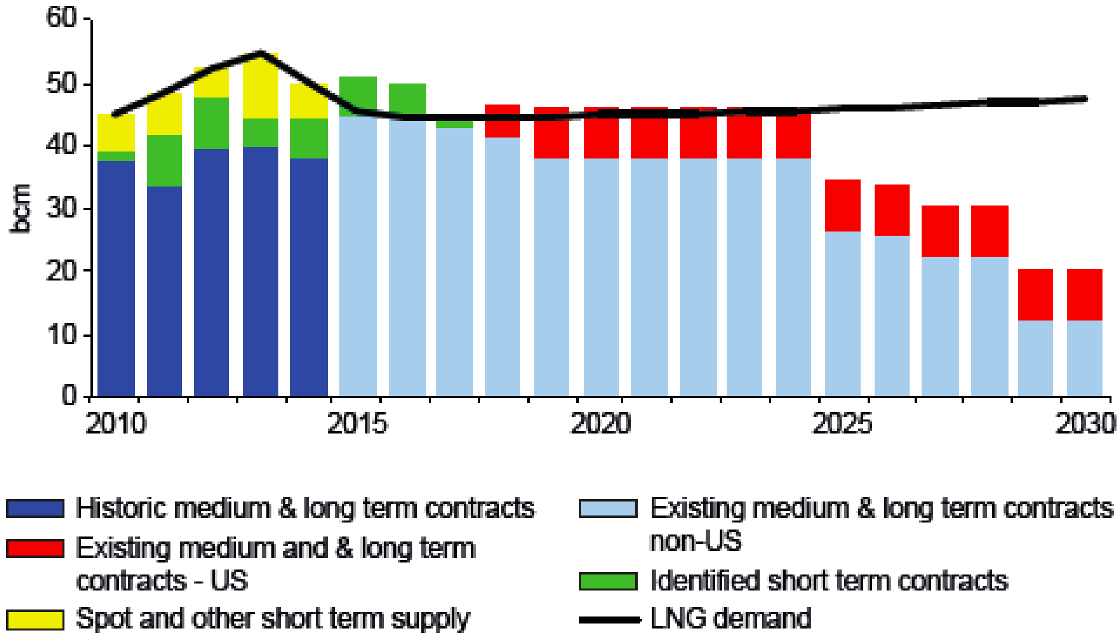

Figure 4.2: Projected gas supply and demand in South Korea (Honoré et al., 2016)

generation (EIA, 2017). This results in low utilization of gas in electricity generation, with expected growth of only 6.5% between 2015 and 2040. Currently, gas played minor role in electricity generation, relative to coal and hydropower.

On the other hand, China's gas supply is saturated in this decade. Domestic production is growing, partly due to higher domestic gas price after natural gas pricing reform since 2011. However, the price gap between the new price formula and the old pricing regime is narrowing down after several adjustments from the authority (Paltsev and Zhang, 2015). Several pipeline gas supplies from East Siberia, Turkmenistan, Central Asia, and Myanmar were on line in 2010s with planned capacity raise over the next decades. As a result of these factors, it is possible that China is in "over-contracted" condition up to mid-2020 (Figure 4.3), which creates uncertainties in LNG growth potential.

The consumption of gas in Taiwan in the future will depends on its effort to reduce carbon emission in electricity generation sector (Honoré et al., 2016). The energy policy focuses on renewable generation growth and nuclear phase out, after negative public opinion post-Fukushima incident. The government did not explicitly mention to cut coal consumption, hence the demand for gas will depend on its competitiveness with coal in electricity generation, and whether the government will favor gas in its future energy policies.

Due to the competition with coal, the low domestic gas and electricity price has become barrier to increased gas consumption. This has made the local utilities suffer financially and favor coal generation, which is more cost-competitive. The government also restricts decarbonization cost pass-through to the consumers.

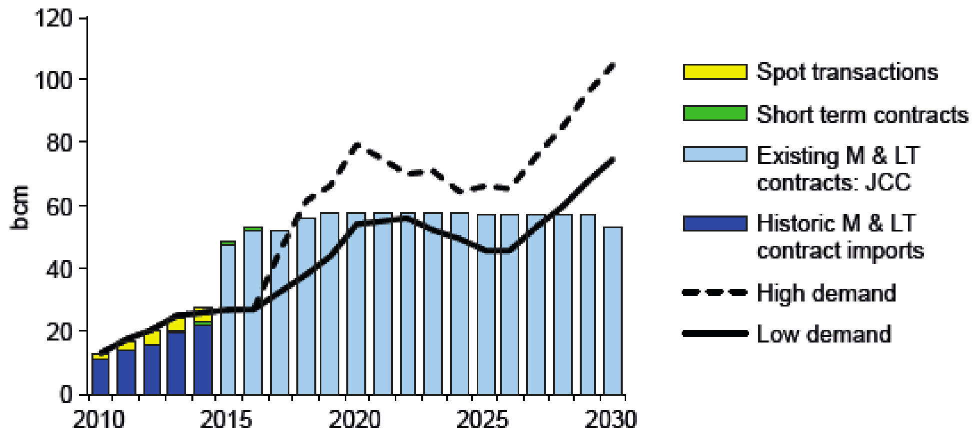

Figure 4.3: Projected gas supply and demand in China (Honoré et al., 2016)

Figure 4.4 shows Taiwan future gas supply-demand balance which, despite the uncertainties, presents opportunity of growth for LNG. It might require new mid or long-term LNG contract by the end of this decade.

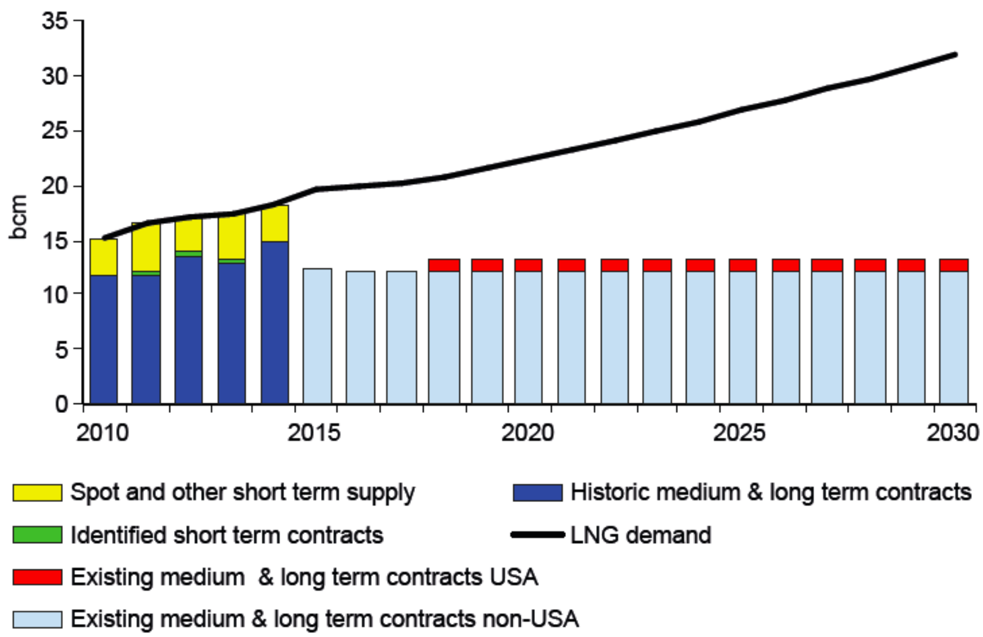

Figure 4.4: Projected gas supply and demand in Taiwan (Honoré et al., 2016)

5 Discussion and Conclusion

Japan has been an important gas export destination ever since the start of LNG industry in Indonesia. The recent very tight gas market in Japan following the Fukushima nuclear reactor shutdown and the high oil price at that time significantly increased the gas price in Japan. That experience encouraged Japan to look for opportunities to change the LNG pricing mechanism, from oil-indexed pricing to another pricing mechanism in the hope of reducing the price level.

The result of the VAR analysis demonstrates the correlation between European and US gas hub prices with Japanese spot LNG import price. Furthermore, the relationship is dynamic and changing from domination by one hub with another. This finding is in line with the notion in Stern (2014a), in which the "globalization" of gas market should not necessarily means a *uniformity* of price (allowing for transportation cost) but rather a greater *connectivity* of prices between regions, where price in one region is increasingly affected by market condition in another region.

The potential of future demand growth in major export market is limited due to the plateauing demand of East Asian developed economy and their energy policies in response to COP21 agreement, as well as the possible over-contracted condition in China. The slight deficit of gas supply and demand in late 2010s - early 2020s possibly can be fulfilled by using spot cargo. This condition might put pressure towards oil-indexed gas price in Japan and East Asia in the upcoming years. As the old contracts in the importing countries expired, the demand for mid and long-term supply will resume in mid-2020s. Under this limited demand condition, the buyers could initiate a move away from JCC-indexed pricing for new contracts if they want to do so.

In July 2017, the Government of Indonesia through the Ministry of Energy and Mineral Resource has mandated the price ceiling for piped gas in gas-powered generator plant gate at 14.5% of Indonesian Crude Price (ICP) (ESDM, 2017). If piped gas price is higher than 14.5% of ICP, then the generator could opt to buy domestic LNG below that price at plant gate (including regasification and distribution cost). Meanwhile, LNG import has to be determined by further Ministerial regulation.

Figure 5.1 shows the historical comparison of gas price under this Minister's Regulation and netback price of Indonesian LNG from Tokyo. Due to the high regasification cost in Indonesia (SKK Migas, 2017a), this translates to average difference of around US$3/MMBtu with the export netback price at Destination Ex Ship (DES) basis. Indonesian gas producers would still choose to export their production in this condition.

On the other hand, note that the domestic gas price is just slightly lower than Japanese spot import netback price between March 2017-August 2017, which is correlated with NBP price as per the VAR analysis. If the price level of Japanese LNG is at this level, Indonesian domestic gas producers might choose between continuing export to Japan or supplying domestic LNG demand. The continuation of NBP impact towards gas pricing in Japan might reduce the price to the level at which fulfilling the increasing domestic gas demand is more efficient than exporting LNG. However, this will depend on NBP's price volatility in the future as well.

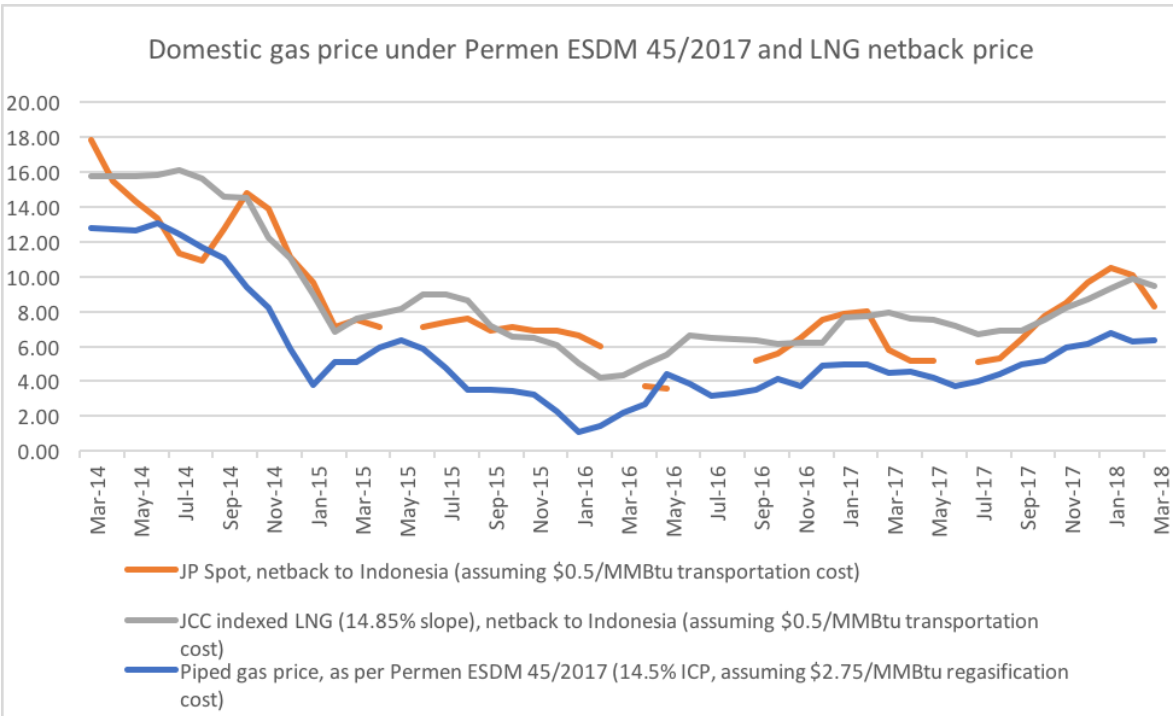

Figure 5.1: Historical comparison between domestic gas price under Permen ESDM 45/2017 and LNG netback price. Transportation cost to Japan is assumed to be US$0.5/MMBtu based on calculation method in Rogers (2018), ICP price used is Sumatra Light Crude from ESDM (2018), and Indonesian regasification cost is assumed to be US$2.75/MMBtu based on SKK Migas (2017a)

Despite the increasing price connectivity and opportunity of movement away from oil-indexed price, note that the oil-indexed pricing is still widely supported by buyers, brownfield and greenfield LNG project owners, also investors in East Asian market (Flower and Liao, 2012). Japanese utilities as buyers use long-term, oil-indexed contract to handle the price risk in the future. As seen in previous example, Indonesia and other exporting countries such as Malaysia use oil-indexing for their domestic gas pricing as well. Hub pricing is still seen as volatile, making oil-indexed project more bankable for investment banks in the region. After all, the system has worked for many years and been used comfortably by both buyers and sellers. This "comfort zone" will become barrier to movement away from oil-indexed pricing, and the willingness to keeping this zone and tolerate (possibly higher) price level could be seen in the upcoming years.

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