LIQUEFIED NATURAL GAS TERMINAL AND ELECTRICITY MARKET IN SINGAPORE

Youngho Chang, Nanyang Technological University, Phone +65 63168781, E-mail: isychang@ntu.edu.sg
Benjamin Tang, Energy Studies Institute, Phone +65 65166743, E-mail: esithb@nus.edu.sg

Overview

As close to 80% of Singapore electricity generation is currently fuelled by natural gas, a key component of energy security involves diversification from purely using Piped Natural Gas (PNG); the result is the planned installation of an Liquefied Natural Gas (LNG) terminal with annual capacity of 3 metric tonnes (or around 155 billion cubic feet) by 2012.

Since the announcement of this plan, PNG capacity has been capped at current levels by the regulator; thus ensuring that growth in demand for natural gas (beyond present pipeline limits) would have to be met via the new LNG terminal. Current PNG supplies is estimated at 700-800 mil cubic feet a day, and the planned LNG terminal's capacity represents two-thirds of that volume.

Energy Information Adminstration's LNG figures put Asia and Oceania region as the main importer of natural gas (65%), with Japan, S. Korea and Taiwan as the largest importers by country. Similarly, the pacific region also has the largest liquefaction capacity. Singapore's projected terminal volume is around 3% of Asia's current import.

This study investigates the relationship between fuel and electricity prices in Singapore. Fuel cost is a significant proportion of the variable costs in electricity generation, and plays a causal role in determining downstream electricity prices. As PNG prices (which is the main bulk of electricity generation fuel) for Singapore is not public domain information, we proxy for PNG prices using Asian Spot LNG prices, crude oil and fuel oil. Residual fuel oil, as an direct electricity generation fuel substitute, is a particularly salient proxy. Subsequently, we attempt to model a historical estimate of the spot LNG prices under a natural gas shipping terminal regime, using burner-tip parity rules with added transportation costs. While this estimated spot prices might not be indicative of the contracted LPG prices, it provides a view of the potential price volatility that can be present under a LNG terminal regime, as well as supplying a means of comparision against spot prices from other LNG importers within Asia.

Methods

A Granger bi-variate causality test is performed between natural gas prices and the end retail user electricity prices bought in the New Electricity Market of Singapore (NEMS). As the import prices of piped natural gas into Singapore is contractual and confidential, we use four possible proxies for natural gas price: Japan and Korea's spot LNG prices (IEA), Singapore's Fuel Oil prices (EIA) and Singapore's Crude Oil prices (EIA data). For the electricity prices, we use the Uniform Singapore Energy Prices (USEP) which are availiable online.

The dataset obtained from various sources was converted from nominal to real figures, and where necessary, data frequency was set to monthly across the duration of January 2003 to December 2007. This is limited by the fact that USEP data was only avaliable from January 2003, after the set up of NEMS.

Prior to the bi-variate test for Granger causality, the ADF test for stationarity and a lag length test based on AIC and SIC criterions were performed. Thereafter, an impulse response and variance decompostion was conducted for variables found to be Granger causal innovators for electricity prices.

Spot natural gas prices were estimated using a "transport cost" and "energy substitution" component as proposed by Brown and Yucel (2008). Without actual figures for transport costs, we estimated the marginal cost of transportation to be $1.00 per BTU. Assuming that burner-tip parity conditions hold, we use calorific equivalent figures for the calculation of the conversion rate.

Results

All variables used for the Granger causality tests were found to be of I(1), and were first differenced to remove the trend. Subsequently, they were found to be stationary under ADF testing. For the optimal lag length, the results are presented below; on occasions were the optimal lag differs between AIC and SIC, we opt to use the former criterion.

Lag Length Test

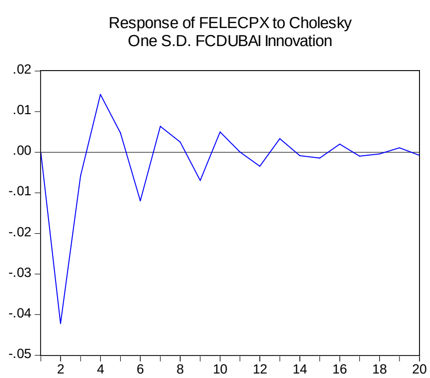
	AIC	SIC
FD Electricity Prices (FELECPX)	3	2
FD Dubai Crude Oil (FCDUBAI)	3	2
FD Natural Gas Japan (FNGJPLCY)	3	1
FD Natural Gas Korea (FNGKORLCY)	1	1
FD Residual Fuel Oil (FSGRESID)	1	0

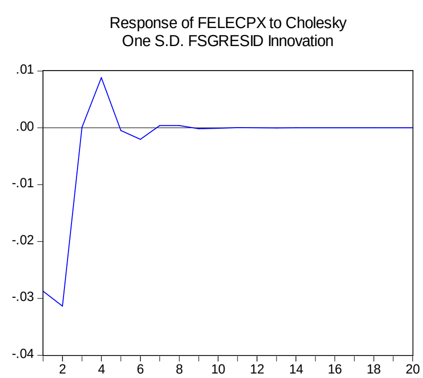
FD: First Differenced

We find statistical support (at the 5% level of significance) to ***reject*** the null hypotheses that i. Crude oil prices does not Granger-cause Singapore's electricity prices, and ii. Residual fuel oil prices does not Granger-cause Singapore's electricity prices.

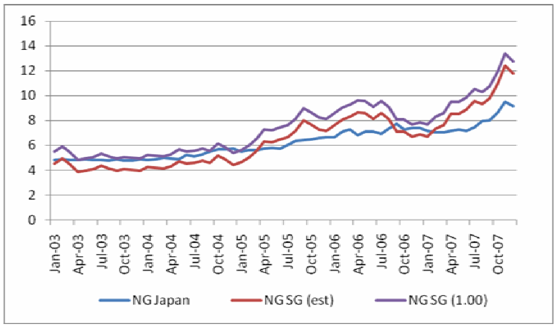
Null Hypothesis:	Obs	F-Statistic	Probability
FCDUBAI does not Granger Cause FELECPX	56	3.0559	0.0369
FSGRESID does not Granger Cause FELECPX	58	5.6093	0.0214

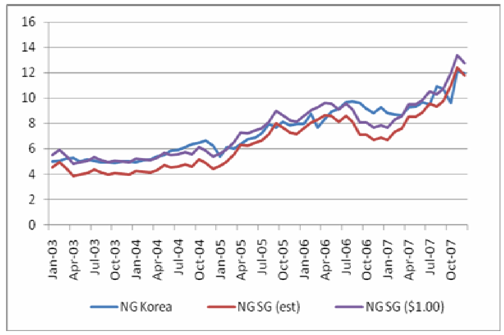
The impulse response of a one standard deviation innovation of crude oil and fuel oil prices on Singapore's electricity prices are as presented below. The impulse stabalises after 18 months for crude oil, and after 7 months for fuel oil price innovations. In addition, we find that variance decomposition on electricity prices due to crude oil and fuel oil price fluctuations contribute about 10% to the price volatility of electricity.





Using burner-tip parity and transport cost of $1/mil BTU (note: base estimate depicts zero transport cost), we find our estimated spot LNG price for Singapore to track with Japan and Korea's spot LNG prices rather closely.





Conclusions

This study finds crude oil prices and residual fuel oil prices to Granger-cause electricity prices in Singapore; implying that fuel costs play a role of about 10% in the fluctuations of electricity prices. The estimated historic "spot natural gas price" for Singapore appear to track Japan and Korea's spot prices closely, we argue that differences in transportation costs is likely to be a significant factor affecting spot price disparity. For Singapore, spot LNG prices is likely to be more volatile than contracted PNG prices, more investigation is necessary to uncover if volatility in spot LNG prices is likely to lead to an increased flucturation in downstream electricity costs.

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