Determinants of liquefied natural gas prices

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Office of Energy Production & Markets Analysis

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Academic literature on LNG

- 98 published research articles:

  - Top ranked journals: Energy Economics; Energy Journal; Energy Policy; Applied Energy

  - Most cited (413 citations) paper: "What drives natural gas prices?", Brown and Yucel, 2008, Energy Journal

- Research topics:

  - Integration of regional NG markets into a global market (LNG)

  - Factors affecting the price formation and volatility

  - LNG, oil and coal relationship

  - Power markets, renewables and emissions

- In this talk, we summarize some of the published results.

Academic research on hubs development in Asia

- Articles published in Energy Policy, Energy Economics, Natural Gas Industry, The Oxford Institute for Energy Studies, EIA

- Publication years: 2014 – 2021

- Major findings:

  – LNG markets are fragmented, and multiple LNG benchmark trading hubs may be needed to reflect different fundamentals.

  – Due to difficulties associated with domestic market reforms, LNG hub development will take time. Some authors suggest virtual hubs as a better option. Some authors predict it may take until 2030 or later to see such developments.

  – China and Russia will be major players in the process.

# Relationship between number of importing terminals and LNG spot trading
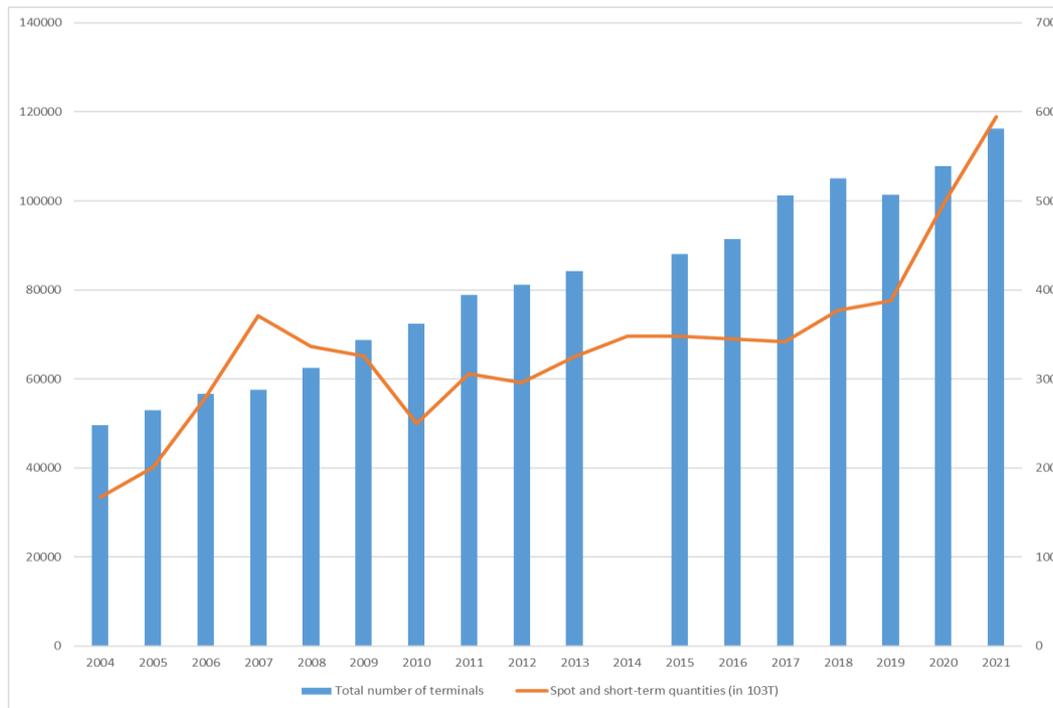
Spot and short-term quantities received under contracts of duration of 4 years or less

Correlation between total number of terminals and spot contracts is 0.78

Source: GIIGNL. Data missing for 2014. Data hand collected from annual reports. Calculations and graphs done by authors.

Academic research on pricing systems and empirical methodologies

- Oil-indexation (OPE) vs gas-on-gas (GOG)

- Global trends strongly favored gas-on-gas pricing

- Academics have proposed a wide variety of methods for determining the strength of oil-gas relationship:

  - **Cointegration – most used methodology**
  - Ordinary Least Squares (OLS) and Simple Regression
  - Vector Auto Regressive (VAR)
  - Generalized Auto-regressive Conditional Heteroskedasticity (GARCH)
  - Time-Series Smoothing Models
  - Various Alternative Approaches

Number of countries where OPE or GOG is the majority mechanism
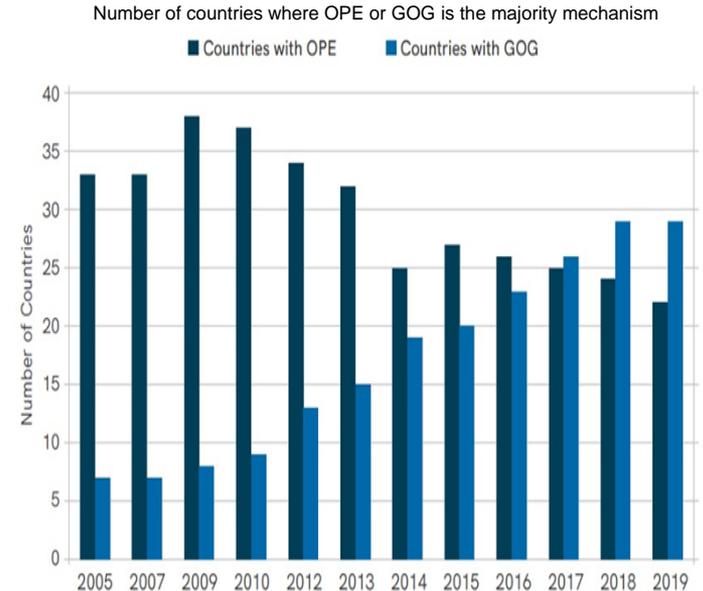
Source: IGU Wholesale Gas Price Survey 2020 Edition

OPE: The price is linked, usually through a base price and an escalation clause, to competing fuels, typically crude oil, gas oil and/or fuel oil. In some cases, coal prices can be used as can electricity prices.
GOG: The price is determined by the interplay of supply and demand – gas-on gas competition – and is traded over a variety of different periods (daily, monthly, annually or other periods). Trading takes place at physical hubs (e.g., Henry Hub) or notional hubs (e.g., NBP in the UK). There are likely to be developed futures markets (NYMEX or ICE). Not all gas is bought and sold on a short-term fixed price basis and there will be longer term contracts, but these will use gas price indices to determine the monthly price, for example, rather than competing fuel indices. Also included in this category are spot LNG cargoes, any pricing which is linked to hub or spot prices and also bilateral agreements in markets where there are multiple buyers and sellers.

Cointegration Literature Sample Ranges
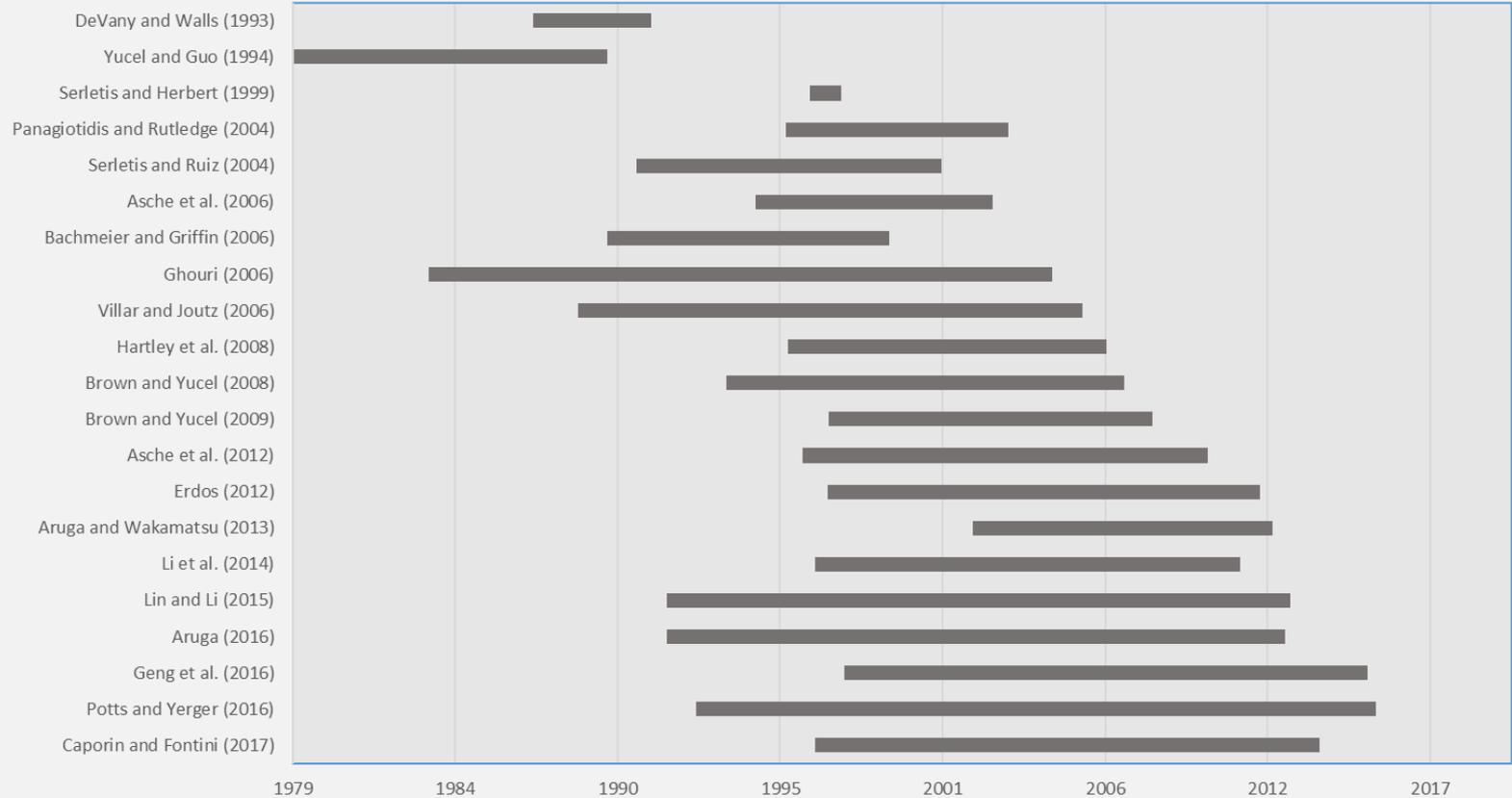
Source: Authors.

Academic literature on the decoupling

- The overwhelming consensus of the literature is that 'shale gas revolution' occurred between 2008 and 2009

- Alternative models evidence:

  - Markov Switching Models show HH decoupled from oil after 2008

  - Bai-Perron test applied in Japanese markets shows structural breaks in 2005 and 2009

  - Long-Memory Ordinary Least Squares, Philips-Sul and Kalman Filters, Multi-variate Threshold Testing, and Global Multi-Sector General Equilibrium models

  - Evidence that the North American shale revolution is the primary factor for US LNG and natural gas prices decoupling from oil

- We used a Gregory-Hansen structural break test on the Engle-Granger cointegrating relationship between LNG and WTI Crude prices. We also utilize the most current EIA data (January 2001 to June 2021).

Our results confirm findings in the academic literature

LNG/WTI Relationship and Break Date
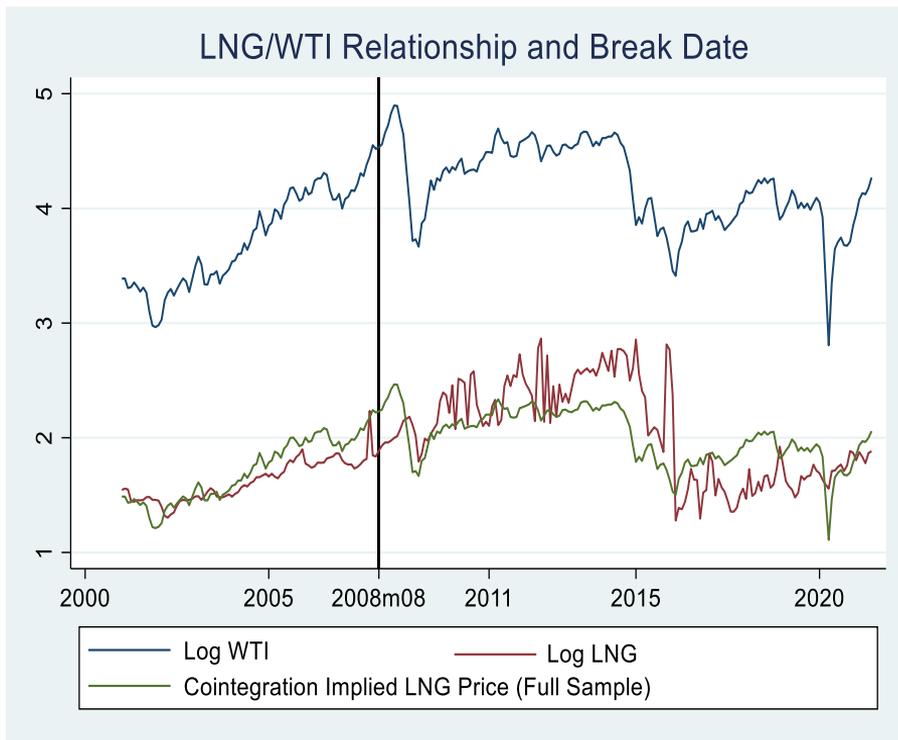
Source: Authors.

- Cointegration found using full sample

- Gregory-Hansen test statistics strongly suggest August 2008 break date

- Pre-break LNG/WTI prices related

- Post-break no longer related

Academic literature on convergence to no-arbitrage relationship

- Separate literature has examined whether regional gas markets are linked and arbitraged across regions.

- Researchers found that while LNG prices appear strongly oil-linked, LNG-oil relationships are asymmetric within importing countries. Moreover, structural breaks are found to be quite common in Asian markets.

- A variety of region-specific convergence breaks are found, two periods stand out:
  - The first is 2008-2009, where a cluster of structural breaks correspond to oil price volatility and the global financial crisis.
  - The second is the Fukushima disaster of 2011, where Japanese LNG import prices markedly increased in response.
  - However, the LNG-oil relationship didn't respond, consistent with long-term contracts providing a form of insurance against unexpected energy shocks.
  - Interestingly, after 2011 fewer structural breaks are found. In general, Asian markets have been less prone to convergence than their global counterparts, likely due to the continuing ubiquity of long-term oil-linked contracts.

Academic research on trends in the coal – gas relationship

- The general findings of the literature is that the coal and natural gas relationship, and by proxy LNG, is weak to nonexistent in the long-run, but strong and significant in the short-run.

- Natural gas demand is expected to be a dominant fuel in the future for quite some time.

- The cost of carbon and climate change policies will favor gas; thereby reducing dependency on oil and coal.

- In the short-run LNG shipping will fill most of the demand, until regasification capacity and pipeline expansion begins to meet demand closer to 2030.

Academic research on power markets, renewables, and emissions

- Increased prevalence of using gas and LNG will likely have positive climate benefits.

- Increased natural gas usage leads to lower CO_2 emissions. The near 70% drop in gas prices from 2008-2012 is associated with a 19% to 33% decrease in emissions for Investor-Owned Utilities (IOUs).

- Economic prosperity and infrastructural development, due to natural gas expansion, has made it easier and cheaper to integrate renewables into the grid.

- However, the lower prices of natural gas have also made it more difficult for renewables to compete with gas-fired generation.