Gas and LNG markets are we facing a globally integrated market?

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Introduction

- **Context of globalization:**
  - Development of the LNG industry and intercontinental arbitrage
  - Liberalization of natural gas markets in different regions worldwide
  - Declining use of oil indexed long-term contracts
  - Emergence of spot markets for natural gas

- **Integrated market:**
  - Opens more opportunities for producers
  - Provides cost efficient gas for consumers
  - Reinforces the security of supply from a public policy perspective
  - Improves possibility to forecast
Definition of integration

- **Historical definition:**
  - Two geographical markets for a tradable good are integrated if the price difference between these two markets equals the unit transportation cost (Cournot, 1838; Marshall, 1890)

- **Spatial price determination:**
  - Spatial price determination (Spiller, Huang, 1985; Enke, 1951; Samuelson, 1952; Takayama, Judge, 1971) emphasizes the role of rational arbitragers and arbitrage costs and points out time varying nature of the LOOP: two spatially distinct areas belong to the same economic market if they are linked by binding arbitrage conditions
The study

● **Goal of the paper:**

- To answer the question whether we observe the same degree of integration between the spot markets in different regions (Europe, North America and Asia) provided their heterogeneity in terms of gas supply

● **Contribution of the paper:**

- Assesses the degree of spatial integration between natural gas markets through the application of a new methodology based on theoretical notion of spatial equilibrium
- Accounts for the role played by arbitrage costs, while takes into account heterogeneity of arbitrage options
- Estimates arbitrage rent and detects cases of perfect or imperfect integration, which helps to conclude about market integration and efficiency
Natural gas & LNG prices

Source: Total, Bloomberg, Reuters, EIA, Powernext
Integration of gas markets: how to measure?

- **Classification of methodologies** (Dukhanina, Massol, 2018):
  - Early correlation-based studies (Doane, Spulber, 1994)
  - Cointegration tests (De Vany, Walls, 1993; Serletis, 1997; Asche et al., 2002, 2013 and Siliverstovs et al., 2005, Brown, Yücel, 2009; Renou-Maissant, 2012)
  - Granger causality/VAR/VECM (De Vany, Walls, 1996; Serletis, Herbert, 1999; Bachmeier, Griffin, 2006; Park et al., 2008; Brown, Yücel, 2008, 2009; Mohammadi, 2011; Olsen et al., 2015, Growitsch et al. 2015)
  - Kalman filter (King, Cuc, 1996; Neumann et al., 2006; Neumann, 2009, Neumann, Cullmann, 2012, Li et al. 2014; Growitsch et al. 2015; Mu, Ye, 2018)
  - Price convergence estimations (Li et al. 2014; Mu, Ye, 2018)
  - AR models of price spreads (Cuddington, Wang, 2006)
  - Other models (Spiller, Huang, 1985; Kleit, 1998; Micola, Bunn, 2007; Massol, Banal-Estañol, 2016)
Methodology

- **Spatial equilibrium model:**
  - Spatial price spread $P_{ijt} = P_{jt} - P_{it}$ can be equal to, lower or higher than the transportation (arbitrage) costs $C_{ijt}$, which determines 3 regimes of a standard parity bounds model. Arbitrage costs are unobservable, but can be explained by a vector of observable variables $C_t = \alpha + \beta X_t + et$
  - Combining the spatial price spread with the arbitrage costs the PBM estimates by maximizing log likelihood function the probability to be in one of three trade regimes:

    \[
    \Delta P_{ijt} - C_{ijt} = e_t + u_t \quad \text{Imperfect integration with positive arbitrage rent (R > 0)} \\
    \Delta P_{ijt} - C_{ijt} = e_t - u_t \quad \text{Imperfect integration with negative arbitrage rent (R < 0)} \\
    \Delta P_{ijt} - C_{ijt} = e_t \quad \text{Perfect integration with zero arbitrage rent (R = 0)}
    \]
  - Where $R_{ijt} = \Delta P_{ijt} - C_{ijt}$ presents marginal rent from arbitrage (price spread net of transportation costs), $e_t$ is a random shock, assumed to be normally distributed with zero mean and standard deviation $\sigma_e$ and $u_t$ is non-negatively valued random variable measuring deviation of price spread from arbitrage costs and assumed to be half-normal and distributed independently from $e_t$ with standard deviation $\sigma_u$
Parity Bounds Model: regime examples

Plot of spatial price difference, estimated arbitrage costs and parity bounds
Preliminary results

- The probabilities to be in equilibrium vary between market pairs

<table>
<thead>
<tr>
<th>Direction</th>
<th>Period</th>
<th>Parameters -&gt;</th>
<th>2010-2018</th>
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<td>From producer's perspective</td>
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- The markets worldwide do not have the same degrees of integration → It is too early to speak about a globally integrated gas market
- Some distanced markets are more integrated than neighboring ones → Signs of lower liquidity on TRS compared to NBP and TTF and/or imperfectly competitive arbitrage
- Possibility to gain from arbitrage activity for producers

Energy Markets 2018 - Rueil Malmaison, June, 19th 2018
Conclusions

- Natural gas and LNG markets do not have the same degrees of integration worldwide.
- The study detects the presence of imperfect integration with the cases of a positive arbitrage rent, which points out a spatial efficiency of the markets.
- Too early to speak about a globally integrated market.
THANK YOU!