LNG Pricing Differences across the Atlantic -
a Comparison between the United States and Europe

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Outline

1. Motivation

2. Determinants of LNG Prices

3. Methodology

4. Data

5. Results

6. Conclusion
How does the IEA see the future?

Natural gas demand projections to 2035

- United States
- Middle East
- European Union
- Russia
- China
- India
- Japan

Source: IEA WEO 2013

European Union natural gas supply and demand balance

China natural gas supply and demand balance

Source: IEA WEO 2013
How does the EIA see the future?

World energy consumption by fuel type 1990-2040

World natural gas consumption by economic sector

World electricity generation by energy source

Source: EIA, International Energy Outlook 2013
Research Question

1. Which factors determine LNG import prices in the different world regions?
2. How do determinants affect regional LNG import prices?
3. Can price differences be explained by the impact of the determinants on LNG import prices?
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### Determinants of LNG Import Prices

Main differences in price determinants:
- Price mechanisms
- Political and environmental factors
- Imports dependency
- Liquidity spot markets

<table>
<thead>
<tr>
<th>Fundamental Factors</th>
<th>Financial Market Factors</th>
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<tbody>
<tr>
<td><strong>Supply</strong></td>
<td>Spot prices</td>
</tr>
<tr>
<td>Domestic production</td>
<td>- Natural gas</td>
</tr>
<tr>
<td>Number of market suppliers</td>
<td>- Crude oil</td>
</tr>
<tr>
<td>Storage capacity and levels</td>
<td>Futures</td>
</tr>
<tr>
<td>Available resources</td>
<td></td>
</tr>
<tr>
<td><strong>Demand</strong></td>
<td>Events of political nature</td>
</tr>
<tr>
<td>LNG consumption</td>
<td>Acts of nature</td>
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<tr>
<td>Import capacity</td>
<td>Temperature</td>
</tr>
<tr>
<td>( \text{CO}_2 \text{ price} )</td>
<td></td>
</tr>
<tr>
<td>Economic growth</td>
<td></td>
</tr>
</tbody>
</table>

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Vector Autoregression (VAR)

\[ y_t = \mu + A_1 y_{t-1} + \cdots + A_p y_{t-p} + e_t \]

*white noise: \( e_t \sim (0, \Sigma_e) \)

\[ y_t = \nu + e_t + \phi_1 e_{t-1} + \phi_2 e_{t-2} + \cdots \]

\[ y_t = \mu + \sum_{i=0}^{\infty} \phi_i + e_{t-i} \]

**PROBLEM:** contemporaneous correlation

**SOLUTION: SVAR**

\[ \Sigma_e = PP' \]

So that: \( P^{-1} \Sigma_e P'^{-1} = I_k \)

Use \( P^{-1} \) to convert \( e_t \)

\[ y_t = \mu + \sum_{i=0}^{\infty} \tau_i + u_{t-i} \]

**\( \phi_i \) = simple IRFs**

**\( \phi_0 = I_k \)**

**\( \tau_i = 0IRFs \)**

**\( \eta_t = P^{-1} e_t \)**

Here: \( P=\)lower triangular matrix (Sims, 1980)
Structural Vector Autoregression (SVAR)

The A Model

\[ Ay_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + \varepsilon_t \]
\[ \varepsilon_t = \varepsilon_t \sim (0, \Sigma \varepsilon = A \Sigma_u A') \]

\[
\begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & a_{21} & 1 & a_{23} & a_{24} & a_{25} & 0 & 0 \\
0 & a_{31} & a_{32} & 1 & a_{34} & a_{35} & 0 & a_{37} \\
0 & a_{42} & a_{43} & 0 & a_{45} & 1 & 0 & a_{47} \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & a_{63} & a_{64} & a_{65} & 1 & 0 \\
0 & a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & 0 & 1
\end{bmatrix} \cdot 
\begin{bmatrix}
hdd \\
prod \\
price \\
sp \\
oil \\
ipi \\
cons
\end{bmatrix}
= A_t 
\begin{bmatrix}
hdd_{t-1/2} \\
prod_{t-1/2} \\
price_{t-1/2} \\
sp_{t-1/2} \\
oil_{t-1/2} \\
ipi_{t-1/2} \\
cons_{t-1/2}
\end{bmatrix}
+ \Sigma_t
\begin{bmatrix}
\varepsilon_{t}^{hdd} \\
\varepsilon_{t}^{prod} \\
\varepsilon_{t}^{price} \\
\varepsilon_{t}^{sp} \\
\varepsilon_{t}^{oil} \\
\varepsilon_{t}^{ipi} \\
\varepsilon_{t}^{cons}
\end{bmatrix}

\[ y_t = \theta_0 \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \cdots, \]
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# Implemented Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Source</th>
<th>Periodicity</th>
<th>Expected Impact</th>
<th>Unit of measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>( PLNG_{t,US} )</td>
<td>US LNG Import Price</td>
<td>IEA</td>
<td>monthly</td>
<td></td>
<td>US$/MMBtu</td>
</tr>
<tr>
<td>( PLNG_{t,EU} )</td>
<td>EU LNG Import Price</td>
<td>IEA</td>
<td>monthly</td>
<td></td>
<td>US$/MMBtu</td>
</tr>
</tbody>
</table>

**Covariates: Supply \((S_{t,ij})\)**

<table>
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</thead>
<tbody>
<tr>
<td>( Prod_{t,US} )</td>
<td>Production: Natural Gas Gross</td>
<td>EIA</td>
<td>monthly</td>
<td>–</td>
<td>MMcm</td>
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<tr>
<td>( Prod_{t,EU} )</td>
<td>Withdrawals</td>
<td>IEA</td>
<td>monthly</td>
<td>–</td>
<td>MMcm</td>
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</tbody>
</table>

**Demand \((D_{t,ij})\)**

<table>
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<tr>
<th>Variable</th>
<th>Description</th>
<th>Source</th>
<th>Periodicity</th>
<th>Expected Impact</th>
<th>Unit of measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Cons_{t,US} )</td>
<td>US Natural Gas Total Consumption</td>
<td>IEA</td>
<td>monthly</td>
<td>+</td>
<td>MMcm</td>
</tr>
<tr>
<td>( Cons_{t,EU} )</td>
<td>EU Natural Gas Total Consumption</td>
<td>IEA</td>
<td>monthly</td>
<td>+</td>
<td>MMcm</td>
</tr>
<tr>
<td>( IP_{t,US} )</td>
<td>US Industrial Production Index</td>
<td>FRED</td>
<td>monthly</td>
<td>+</td>
<td>Index</td>
</tr>
<tr>
<td>( IP_{t,EU} )</td>
<td>EU Industrial Production Index</td>
<td>Eurostat</td>
<td>monthly</td>
<td>+</td>
<td>Index</td>
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</table>

**Financial Market \((FM_{t,ij})\)**

<table>
<thead>
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<th>Expected Impact</th>
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</tr>
</thead>
<tbody>
<tr>
<td>( SP_{t,US} )</td>
<td>Henry Hub Natural Gas Spot Price</td>
<td>EIA</td>
<td>monthly</td>
<td>+</td>
<td>US$/MMBtu</td>
</tr>
<tr>
<td>( SP_{t,EU} )</td>
<td>Average European Natural Gas Spot Price (NBP, ZEE, TTF)</td>
<td>EIA</td>
<td>monthly</td>
<td>+</td>
<td>US$/MMBtu</td>
</tr>
<tr>
<td>( WTI_t )</td>
<td>Western Texas Intermediate Spot Price FOB</td>
<td>EIA</td>
<td>monthly</td>
<td>+</td>
<td>US$/barrel</td>
</tr>
<tr>
<td>( Brent_t )</td>
<td>European Brent Spot Price FOB</td>
<td>EIA</td>
<td>monthly</td>
<td>+</td>
<td>US$/barrel</td>
</tr>
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</table>

**Seasonality \((Se_{t,ij})\)**

<table>
<thead>
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<th>Periodicity</th>
<th>Expected Impact</th>
<th>Unit of measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>( HDD_{t,US} )</td>
<td>US Heating Degree Days</td>
<td>NCDC</td>
<td>monthly</td>
<td>+</td>
<td>days</td>
</tr>
<tr>
<td>( HDD_{t,EU} )</td>
<td>EU Heating Degree Days</td>
<td>Eurostat</td>
<td>monthly</td>
<td>+</td>
<td>days</td>
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Impulse Response Analysis I

US Temperature Shock

EU Temperature Shock

US Domestic Production Shock

EU Domestic Production Shock
Impulse Response Analysis III

WTI Oil Price Shock

Brent Price Shock

Henry Hub Price Shock

EU Spot Prices Shock
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Conclusions

How do determinants affect regional LNG import prices?

• EU absorbs demand/supply shocks quicker
• US absorbs spot price shocks quicker

→ Largest responses:
• US: changes in natural gas spot price
• EU: Demand / natural gas spot price

Can price differences be explained by the impact of the determinants on LNG import prices?

• Only partially

→ Further research needed:
• Include political aspects, storage levels, CO\textsubscript{2} prices, etc.
• Long run SVAR
• Modelling of different price mechanisms
THANK YOU FOR YOUR INTEREST!

QUESTIONS? SUGGESTIONS?

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Selected References


