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

Ekaterina Dukhanina, MINES ParisTech
Olivier Massol, IFP School & City University of London

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

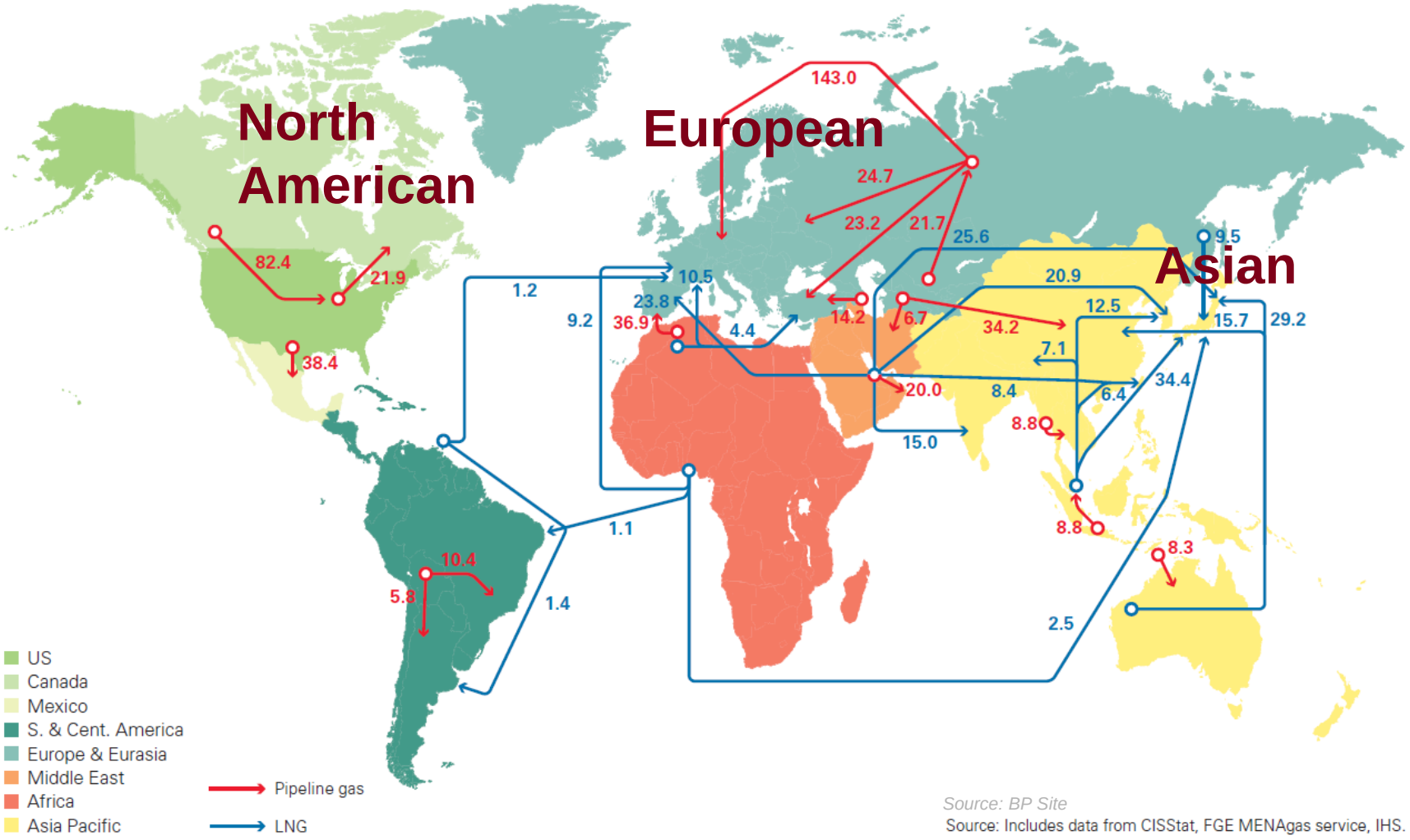
- **Goal of the paper:**

- 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 the 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 (that helps to conclude about market inefficiency)

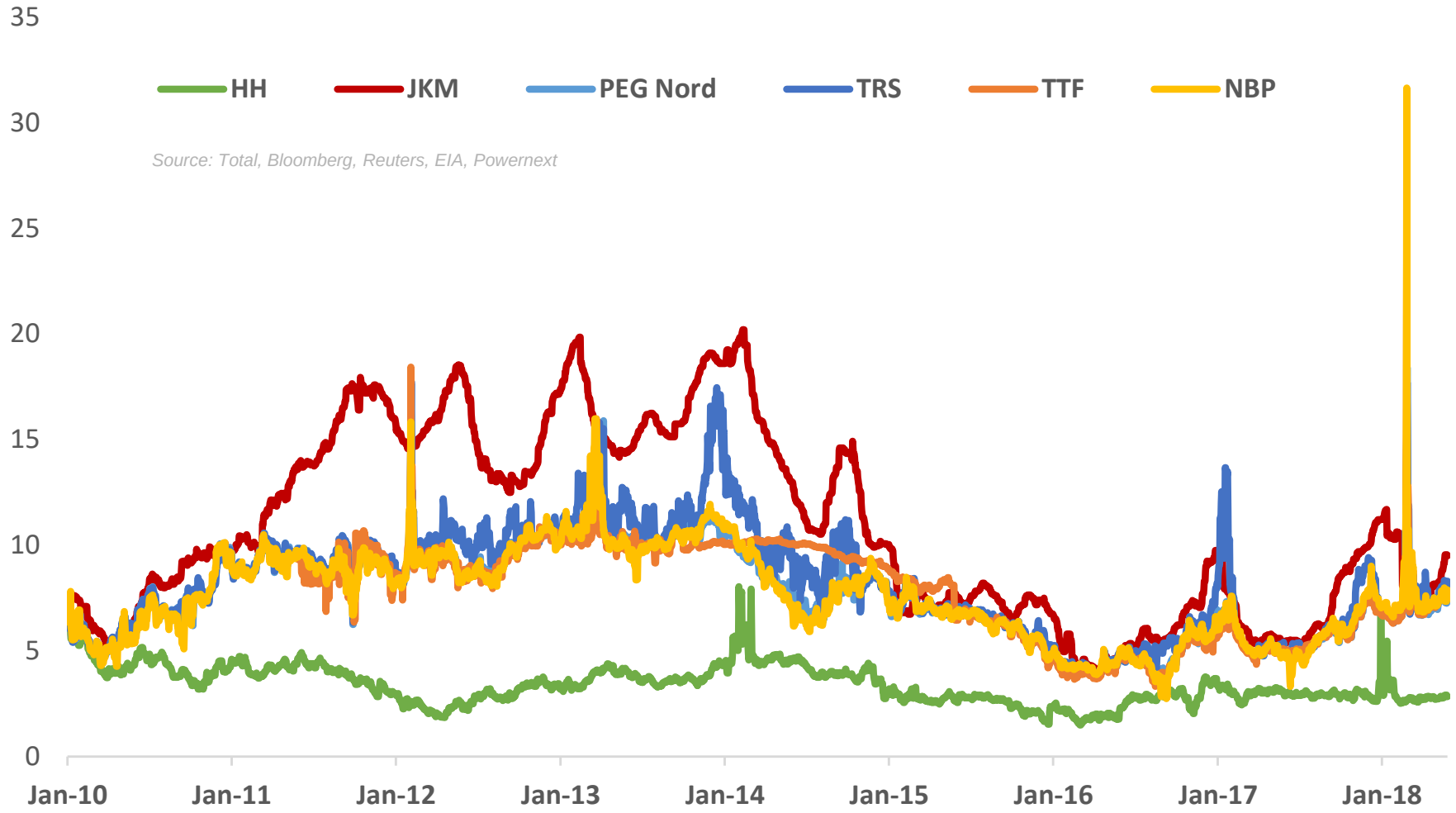
Natural gas & LNG markets



Source: BP Site

Source: Includes data from CISStat, FGE MENAgas service, IHS.

Natural gas & LNG prices



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 $Cijt$, which determines 3 regimes of a standard parity bounds model. Arbitrage costs are unobservable, but can be explained by a vector of observable variables $Ct = \alpha + \beta Xt + et$
- 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:

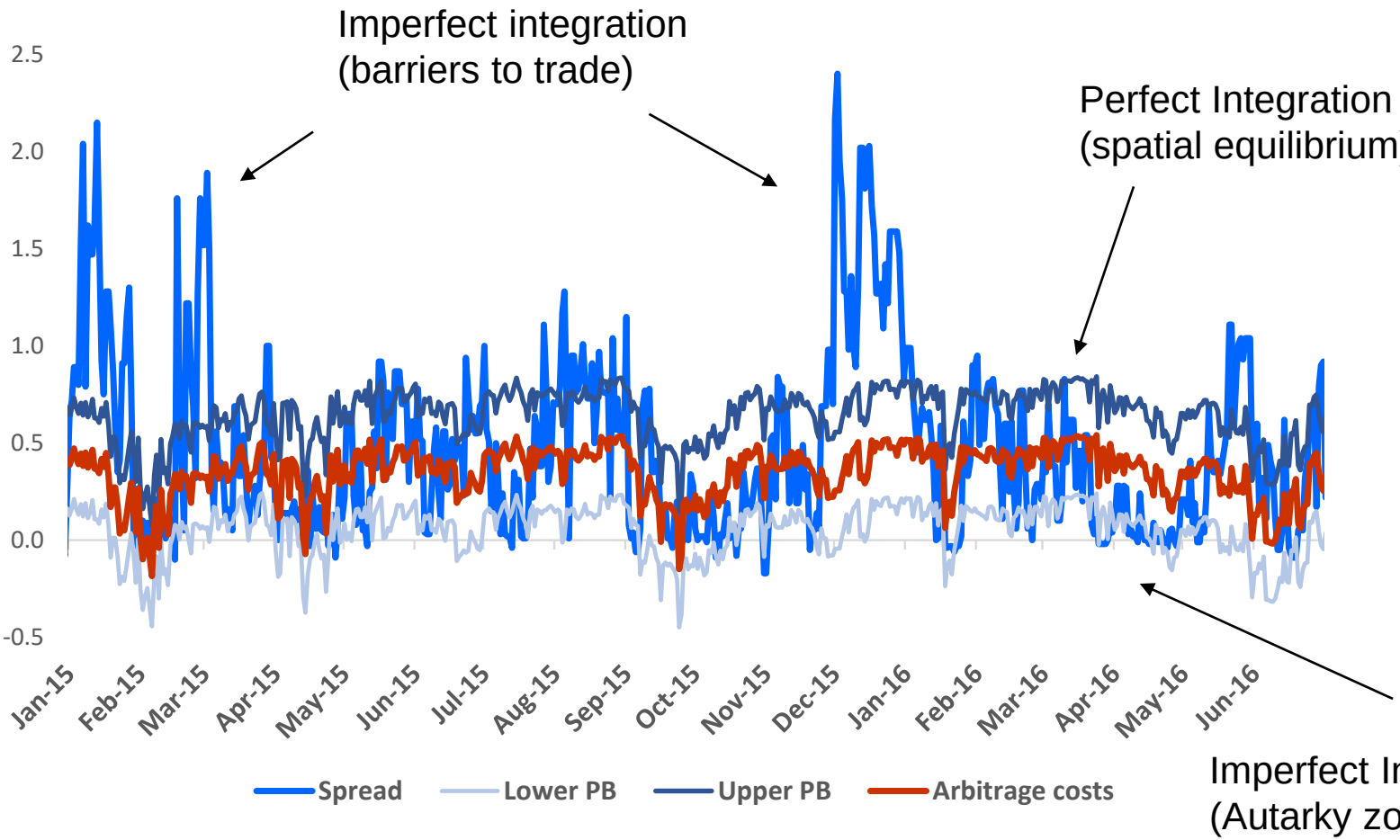
$\Delta P_{ijt} - C_{ijt} = e_t + u_t$ - Imperfect integration with positive arbitrage rent (R > 0)

$\Delta P_{ijt} - C_{ijt} = e_t - u_t$ - Imperfect integration with negative arbitrage rent (R < 0)

$\Delta P_{ijt} - C_{ijt} = e_t$ - 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 σ_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 σ_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

Direction	Period	2010-2018		
From trading perspective	Parameters ->	λ1 (R>0)	λ2 (R<0)	λ1 (R=0)
Europe - Asia	NBP - JKM	0.25	0.01	**0.74**
	TRS - JKM	0.65	0.20	0.15
	TTF - JKM	0.23	0.01	**0.76**
Europe - Europe	NBP - TRS	0.37	0.01	**0.62**
	PEGN - TRS	0.48	0.00	**0.52**
	NBP - PEGN	0.04	0.01	**0.95**
US - Asia	HH - JKM	**1.00**	0.00	0.00
US - Europe	HH - NBP	**1.00**	0.00	0.00
	HH - TRS	**1.00**	0.00	0.00
	HH - TTF	0.75	0.25	0.00
From producer's perspective	Parameters ->	λ1 (R>0)	λ2 (R<0)	λ1 (R=0)
US vs Europe	HH - NBP	**0.71**	0.29	0.00
Europe vs Asia	NBP - JKM	**1.00**	0.00	0.00
	TRS - JKM	**0.45**	0.30	0.26
Asia vs US	HH - JKM	**1.00**	0.00	0.00

- 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 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

Conclusions

- Natural gas and LNG markets do not have the same degree of integration worldwide
- The study detects the presence of imperfect integration with the cases of positive arbitrage rents which points out that markets are not spatially efficient
- Too early to speak about globally integrated market

THANK YOU!