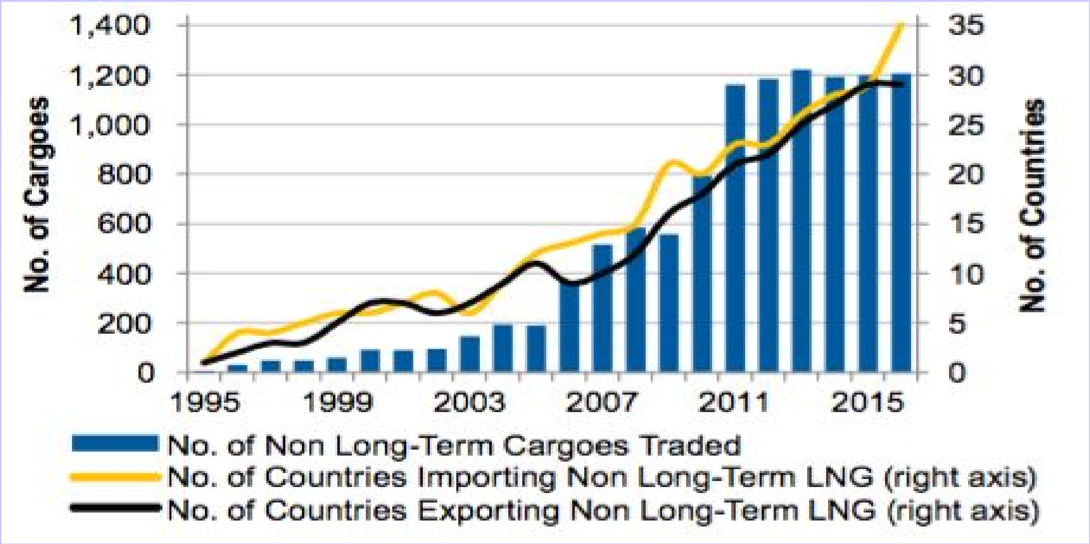
Toward an ideal international gas market : the role of LNG destination clauses

Amina BABA (University Paris Dauphine)
Anna CRETI (University Paris Dauphine)
Olivier MASSOL (IFP School)

International Conference on Natural Gas Economics
Paris, June 2017

The rise in spot and short term trade : a key change in the global LNG market



Non long term volumes, 1995-2016, Source : IGU, 2017

Supply drivers

- Spare capacity
- Diversion of LNG cargoes
- Portfolio LNG
- Aggregator model

Demand drivers

- Growing regasification capacities,TPA
- Liberalization of gas markets Trading hubs
- Growth of shipping capacities

Evolution of LNG contractual structure towards destination flexibility

- **Trends in LNG contracts**
  - Decreasing contract duration (Ruester, 2009)
  - Lower extension of expiring contracts (Corbeau *et al.* 2016)
  - Need for a hub indexation in Asian contracts : Xunpeng shi *et al.* (2016), Tong *et al.* (2014), Rogers and Stern (2014)

- **US LNG contracts and Tolling project structure**
  - Contracts without destination clauses
  - The liquefaction plant owner is not necessary a gas producer
  - Penalty for not taking contractually agreed cargoes is limited to the tolling fee rather than the full ToP penalty of traditional contracts
  - **100% destination flexibility**

Motivations

- The new LNG environment has led to more price sensitive actors challenging the conventional wisdom according to which gas prices struggles to split off from their regional dynamics.

- At the same time, getting away from long term contracts seems to be an elusive prospect when considering the huge capital cost of liquefaction capacities

Question that we aim at tackling: How valuable is the destination flexibility in the long term contracts ?

Underlying question : is the new LNG environment linking regional gas markets ?

What we do and what we get ? (I)

- Cointegration model (VECM-GARCH) to describe the stochastic dynamics of prices in the three major gas consuming regions worldwide (US, Europe and Japan).

- We extend Yepes Rodríguez (2007)'s approach: by using a real option model for the valuation of destination flexibility in long term LNG supplies. Monte Carlo simulations are used to calculate the model's results

What we do and what we get ? (II)

- Free destination option is defined as the ability, for an LNG buyer (seller or an independant trader) to flow LNG where prices are higher and thus diverting its cargo from the agreed destination in the LNG contract.

- **Regional LNG markets are found to be cointegrated with US prices being the independent leader of LNG prices and the option of free destination looks set to be an important share of the LNG value in the current context.**

Part 1 : The empirical price model

Cointegration econometrics

- Addresses the major challenge posed by macroeconomic and financial data : dealing with non stationary series and avoid the problem of spurious regressions (Granger and Newbold, 1974)

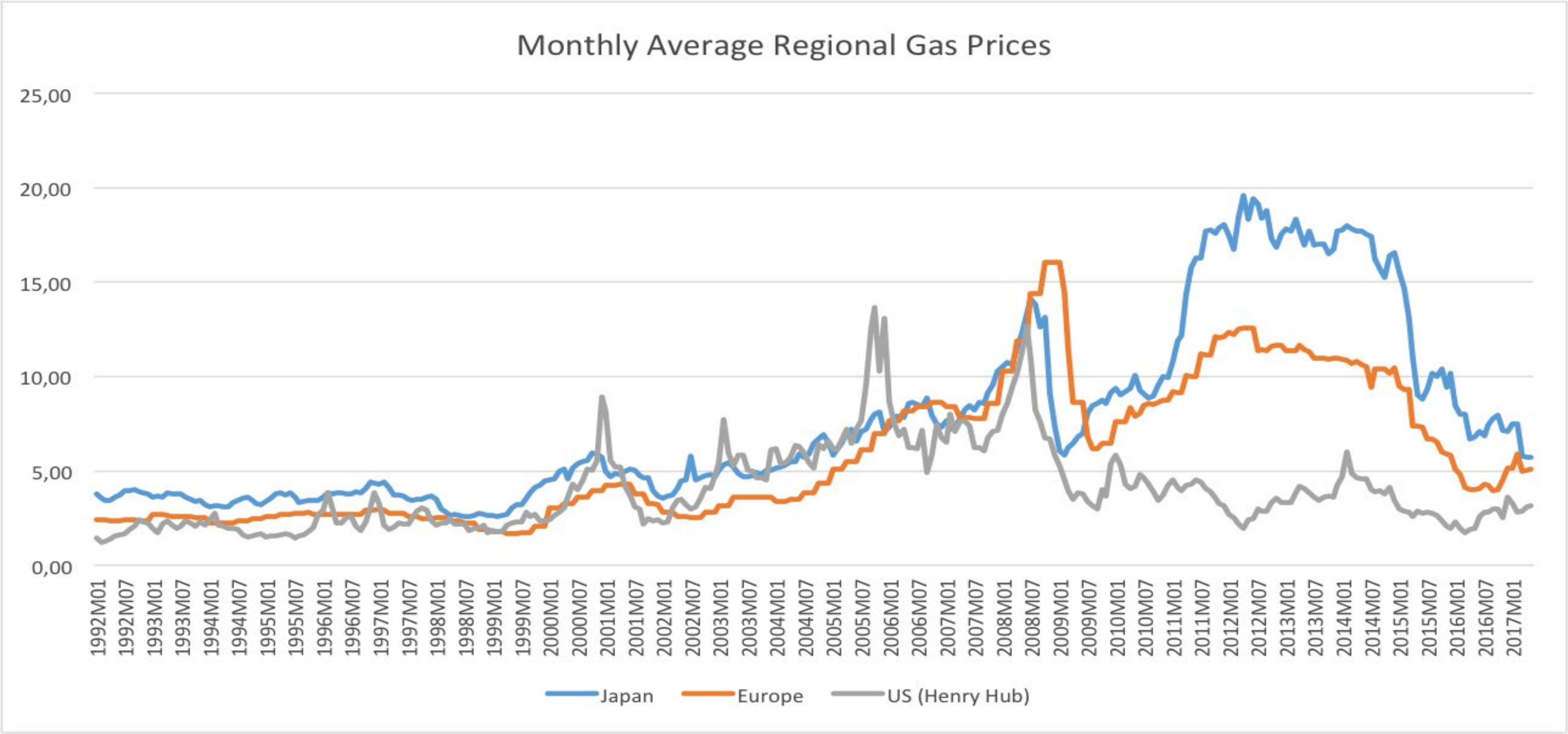
- Main idea : even if two series are not individually stationary, they will not indefinitely shift away from a long term target if a linear stationary combinaison exists. If such a relation exists, then the non stationary time series are said to be cointegrated

- A widespread technique for delineation of energy markets since their liberalisation process
- In natural gas markets :

    - Close link between oil and gas markets e.g. Brown et *al.* (2012), Hartley *et al.* (2008)
    - Question of US natural gas market integration : Serletis (1997), Cuddington *et al.* (2016)
    - Global integration of natural gas market : Siliverstovs *et al.* (2005) : European and Japanese markets are found to be cointegrated but nut no cointegration between these two regions and the US

Data:

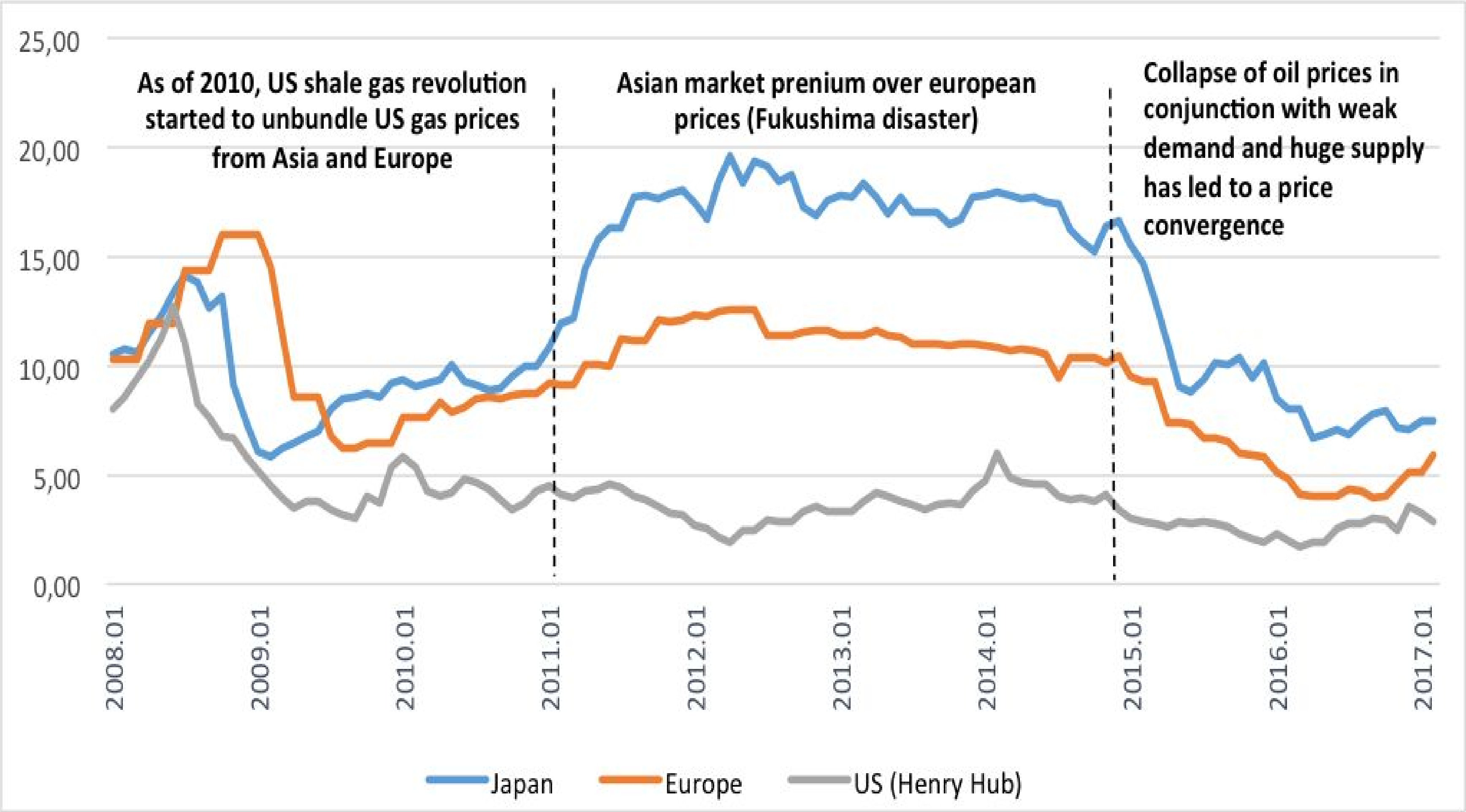
303 monthly prices from 1992:01 to 2017:03 ($/MMBTU)



Source : IMF Primary Commodity Prices

- Unit root test suggests that all series are I(1) : we can investigate a cointegration analysis
- Series in first difference exhibits signs of non-normality :
    - Excess kurtosis
    - Time dependent heteroskedasticity => The model will include GARCH specifications

Focus 2008-17 of monthly regional gas prices



Methodology

A - Conditional mean equations : a VECM

$$\Delta P_{\mathbf{t}} = \mathbf{A}_0 + \mathbf{\Pi} P_{t-1} + \mathbf{\Gamma}_{\mathbf{1}} \Delta P_{\mathbf{t-1}} + \cdots + \mathbf{\Gamma}_{k-1} \Delta P_{t-p+1} + \boldsymbol{\varepsilon}_t$$

- When there exist r linearly independent cointegrating vectors, Πk may be written −αβ′, where both α and β are N × r matrices with rank r. β contains the co-integrating vectors and α adjustment parameters and the Johansen procedure allows testing on coefficients α and β, using several likelihood ratio tests.

B - The conditional variance equation: a MV-GARCH model

$$\varepsilon_t = H_t^{1/2} \eta_t$$

- The family of correlation multivariate GARCH models:
- Where $D_t = \mathrm{diag}\left\{\sqrt{h_{i,t}}\right\}$ and $h_{i,t} = \omega_i + \sum_{p=1}^{P_i} \alpha_{i,p} \varepsilon_{i,t-p}^2 + \sum_{q=1}^{Q_i} \beta_{i,q} h_{i,t-q}$
- Bollerslev (1990) Constant Conditional Correlation (CCC) model: $R_t = \overline{R}$

Estimation

- **Step 1** : Selection of the number of lags p in the model according to the AIC and FPE criterion on the level VAR

- **Step 2** : Determining the cointegrating rank
  - Test assumption: an intercept in both the CE & the VAR
  - Both, the Trace and the λ_{max} test suggest $r = 1$ at the 5% level
  - Prices in Japan has been randomly normalised upon and the the long term relationship :

$$\mathbf{LASIA_t = 1{,}1589\ LEUROPE_t - 0{,}5516\ LUS_t + 0{,}7127 + z_t}$$

Estimation

- **Step 3** : Imposing and testing restrictions
  - The null hypothesis of long-run weak exogeneity is rejected for all prices but US prices : the 3 price series are all cointegrated with US prices being the independent leader of both Japan and European prices
- **Step 4** : Reduction to a parsimonious model
  - Sequential Elimination of regressors

Residual Diagnostics		
Multivariate tests	Statistic	p-value
Autocorrélation	LM (10)	0,142
	LM (20)	0,540
	LB (10)	0,074
	LB (20)	0,099
ARCH effects	ARCH (2)	0,000
Normality	JB (6)	0,000

Part 2 : Destination flexibility option model

Destination flexibility option model

Yepes Rodríguez (2007)

- **Geometric brownian motion processes** of prices
- **Constant volatility**
- The choice of LNG destination is updated in a **yearly** basis
- Studied case : Atlantic Basin producer with 2 choices of destination : Europe and US
- Destination flexibility option is found to be an important share of the LNG value

Our Extension

- **VECM-GARCH** model of prices
- **Time-varying volatility**
- **Monthly** data intended to capture the value of possible monthly arbitrage opportunities
- Studied cases : producer from Atlantic Basin (Nigéria), Europe (Spain) and US with 3 choices of market destination (Europe, US and Japan).
- **Destination flexibility option is still an important part of the LNG value with an increased sensitivity to transportation costs**

Destination flexibility option model

- Monte Carlo simulations generates 10,000 possible future price trajectories driven by the equations of our VECM-GARCH
- We compare a base case in which LNG could flow to a single market and a flexible case in which the destination may be chosen between one of the three markets (US, Europe and Japan)
- The option to deliver to an alternative market is supposed to be sensitive to extra-maritime cost and the unit value of destination flexibility in a given month is given by :

$$v(n) = \mathrm{Max}\,(P_{alternative}(n) - P_{initial}(n) - \Delta\, T(n), 0)$$

And the value of LNG supply without destination flexibility is :

$$\overline{v(n)} = \mathrm{Max}\,(P_{intitial}(n) - C_{initial}(n), 0)$$

- Results of each scenario are presented in terms of monthly average unit of **v(n)** to be compared with $\overline{\mathbf{v(n)}}$

Results

- The value of destination flexibility is calculated as follows :
  - 1,02 $/MMBTU when a producer located in Nigeria can choose between European and US markets : 45% improvement in comparison with the expected value without free destination option
  - The option of free destination won't be exercised for a producer located in US/Europe which has the choice between Japanese and European markets

Conclusions

- The idea of LNG exercising a globalising factor for natural gas markets is not completely rejected by our model

- The lowest participation of US LNG prices in the long term dynamics of the model is linked to the fact that this market responds to its own fundamentals

- The free destination option is still valuable and current low gas prices and margins led the actors to be more sensitive to the shipping costs

- Looking at the future of LNG markets, destination flexibility value will depend on : LNG pricing, emergence of asian hubs with reliable benchmark and the extent of spot and short term market liquidity.

THANK YOU!