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The Development of Gas Hubs in Europe

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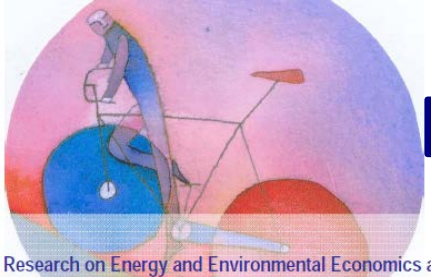
Energy Industry at a Crossroad: preparing the low carbon future
Toulouse, June 4-5, 2014

Motivation

- **Fact**: during the liberalization process several wholesale gas markets have developed in Europe, with very different volumes and liquidity.

- **Research question**: What determines the emergence of gas hubs? Is there a predictable pattern of development that helps interpreting the different situations as part of a common process?

- **This paper**:
  - We propose a **simple model** where wholesale trade represents a useful balancing tool in a liberalized market, and then, when liquidity increases, becomes a second source of gas in parallel with long term contracts
  - We compare the main predictions with the evolution of the gas hubs in the **UK, the Netherlands, Germany and Italy**.



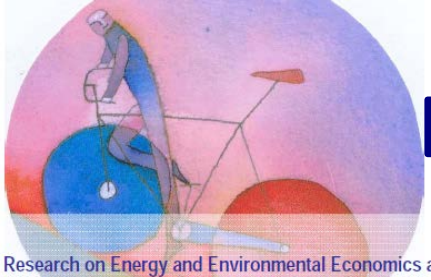
Balancing in a liberalized market

- Upstream (shippers) and downstream (suppliers, retailers) activities are run by **contracts**. In each contract, the amount of gas to be delivered and injected into the gas system is initially set according to the expectations on the demand of the buyers.

- Actual supply and demand, however, are hit by **shocks** that may make the contracted (injected) and actual (withdrawn) quantities different, creating physical and commercial **imbalances**.

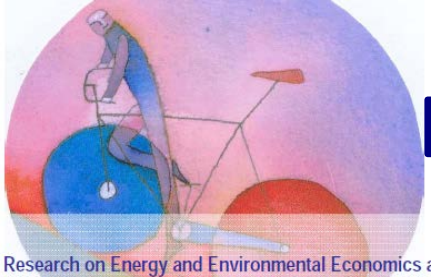
- Individual shippers may compensate some shocks **within** their portfolios of contracts and (part of) their net imbalance by **trading** with other shippers with opposite positions

- The residual individual imbalances not cleared this way add up to the **aggregate imbalance** of the system, that requires to adjust the net gas injections through **physical flexibility tools** (line pack, storage, production swing, interruptible demand.) to preserve pressure and system integrity



Balancing in a liberalized market

- In the absence of a wholesale market, the aggregate imbalance would further increases; hence, gas hubs are a useful **balancing tool**
- The more **fragmented** the market, the smaller the size of portfolios, the larger the need to trade with other shippers to clear the individual positions
- The creation of a wholesale market requires to set **rules** to ease transactions and give incentives to shippers to clear their individual positions in the market
- The fragmentation of the market raises traded volumes and increases **liquidity.** Short term **arbitrage** opportunities further increase gross trade
- Although only a fraction of total physical deliveries goes through the gas hub, a more liquid wholesale market makes the price a **reliable signal** of the overall state of the market



Balancing in a liberalized market

- Then, the wholesale market offers an opportunity of gas provision in parallel with long term contracts: **second sourcing**
- **Large domestic gas producers** can fuel the supply of gas in the hub, while upstream gas providers that buy gas under long term contracts and take or pay obligations would prefer to trade turning to downstream buyers similar commitments
- Balancing and second sourcing are related to the physical delivery of gas, and therefore develop in **each national gas system**
- Price variability requires to develop **financial products** to hedge risk
- Trade of these financial products **concentrate** in a small number of market venues.

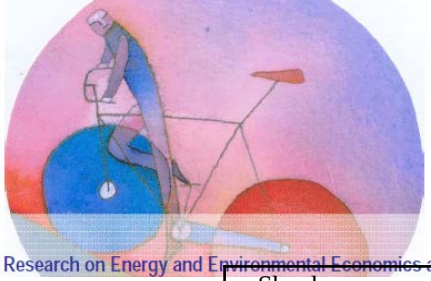
A simple model

- Suppose that in the market there are ***n*** **customers** with **inelastic demand**

$$D_i = d + \varepsilon_i$$

for $p \le v$, where $\varepsilon_i \in \{ -\varepsilon/n, \varepsilon/n \}$ are i.i.d. **shocks.**

- Each **supply contact** by a shipper is set to deliver d at a price $p \ge w$, hence ex-post excess demand or supply may occur.
- Each of the shippers $m \le n$ manages a **portfolio of contracts** involving n/m different customers.
- Some of the shocks (of opposite sign) may be adjusted **within** each portfolio, while others require to clear the portfolio imbalances through **transactions with other operators**.
- If eventually there is an **aggregate imbalance**, this can be adjusted only by dealing with upstream (production, storage) or downstream (interruptible demand) operators.



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A simple model

Shocks	1 operator		2 operators		4 operators	
States of the world	I.A.	N.I.	I.A.	N.I.	I.A.	N.I.
i) (-ε/4, -ε/4, -ε/4, -ε/4)	0	-ε	0,0	-ε/2, -ε/2	0,0,0,0	-ε/4, -ε/4, -ε/4, -ε/4
(-ε/4, -ε/4, -ε/4, ε/4)	ε/2	-ε/2	0, ε /2	-ε/2, 0	0,0,0,0	-ε/4, -ε/4, -ε/4, ε/4
(-ε/4, -ε/4, ε/4, -ε/4)			0, ε/2	-ε/2, 0	0,0,0,0	-ε/4, -ε/4, ε/4, -ε/4
ii) (-ε/4, ε/4, -ε/4, -ε/4)			ε/2, 0	0, -ε/2	0,0,0,0	-ε/4, ε/4, -ε/4, -ε/4
(ε/4, -ε/4, -ε/4, -ε/4)			ε/2, 0	0, -ε/2	0,0,0,0	ε/4, -ε/4, -ε/4, -ε/4
(-ε/4, -ε/4, ε/4, ε/4)	ε	0	0, 0	-ε/2, ε /2	0,0,0,0	-ε/4, -ε/4, ε/4, ε/4
(-ε/4, ε/4, -ε/4, ε/4)			ε/2, ε/2	0, 0	0,0,0,0	-ε/4, ε/4, -ε/4, ε/4
iii) (-ε/4,ε/4, ε/4,- ε/4)			ε/2, ε/2	0, 0	0,0,0,0	-ε/4,ε/4, ε/4,- ε/4
(ε/4, ε/4, -ε/4,- ε/4)			0, 0	ε/2, -ε/2	0,0,0,0	ε/4, ε/4, -ε/4, -ε/4
(ε/4, -ε/4, ε/4, -ε/4)			ε/2, ε/2	0, 0	0,0,0,0	ε/4, -ε/4, ε/4, -ε/4
(ε/4, -ε/4, -ε/4, ε/4)			ε/2, ε/2	0,0	0,0,0,0	ε/4, -ε/4, -ε/4, ε/4
(-ε/4, ε/4, ε/4, ε/4)	ε/2	ε/2	ε /2, 0	0, ε/2	0,0,0,0	-ε/4, ε/4, ε/4, ε/4
(ε/4,-ε/4, ε/4, ε/4)			ε/2, 0	0, ε/2	0,0,0,0	ε/4,-ε/4, ε/4, ε/4
iv) (ε/4, ε/4, -ε/4, ε/4)			0, ε/2	ε/2, 0	0,0,0,0	ε/4, ε/4, -ε/4, ε/4
(ε/4, ε/4, ε/4, -ε/4)			0, ε/2	ε/2, 0	0,0,0,0	ε/4, ε/4, ε/4, -ε/4
v) (ε/4, ε/4, ε/4, ε/4)	0	ε	0	ε	0,0,0,0	ε/4, ε/4, ε/4, ε/4

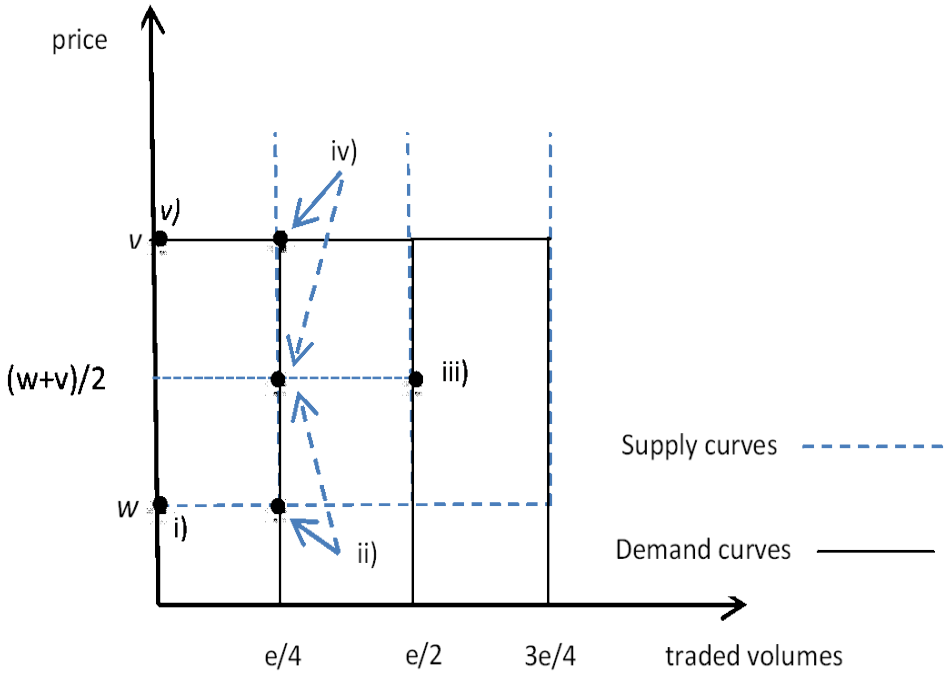
I.A. Internal adjustment of shocks within each portfolio
N.I. Net imbalance of each portfolio after internal adjustments
Highlighted areas: trade opportunities between operators to clear the net imbalances

A simple model

Market structure	Wholesale trade	Within portfolio Adjustment	Aggregate Imbalance
a) Monopoly: A(1,2,3,4)	0	5ε/16	6ε/16
b) symmetric duopoly A(1,2), B(3,4)	ε/16	4ε/16	6ε/16
c) asymmetric duopoly A(1,2,3), B(4)	2ε/16	3ε/16	6ε/16
d) asymmetric oligopoly A(1,2), B(3), C(4)	3ε/16	2ε/16	6ε/16
f) symmetric oligopoly A(1), B(2), C(3), D(4)	5ε/16	0	6ε/16

Proposition 1: *When gas customers' demand is hit by random shocks while supply contracts are set according to the expected demand, individual shippers may face ex-post individual imbalances, while the system as a whole may be unbalanced as well. These latter imbalances can be cleared only dealing with agents, and using tools, outside the network of pipelines (e.g. imports, storage). Shocks hitting individual customers' demand can be cleared through compensations within each operator's portfolio of contracts and through wholesale trade between shippers with opposite net positions. This latter tool involves larger volumes of trade the larger the number of shippers and the larger the number of shippers with small portfolios.*

A simple model



Proposition 2: *When the market structure of the shippers is not excessively asymmetric, the price that is set on the wholesale market is an unbiased signal of the state of the aggregate market for gas. When one shipper dominates the market, managing a large portfolio of contracts, it can manipulate the market price pushing it up when in a long position and down when being in a short position. In these cases, the wholesale price does not reflect the market fundamentals.*

The evolution of wholesale gas markets

From the previous arguments we can expect the following pattern in the evolution of wholesale gas markets:

1. **Balancing**: wholesale trade is driven by deals to clear individual imbalances, according to the rules and incentives defined by regulation; traded volumes increase with the fragmentation of the market and with the proper design of market rules

2. **Second sourcing**: increased liquidity makes the market price more reflective of the underline conditions, and a better signal for trade aimed at providing gas as an alternative to long term contracts

3. **Risk management**: price variability driven by market fundamentals requires financial products to hedge risks

Designing a wholesale gas market

The creation of a wholesale gas market requires to carefully design several elements:

- The choice of a **transmission system model** to allow re-trading gas provisions with entry-exit patterns different from the original ones , establishing a virtual trading zone >> EC recommends an entry-exit transmission system model

- The design of **balancing rules** to incentivize the operators to directly clear their imbalances >> EC recommends market-based mechanisms

- The provision of **information** to market participants to ease the direct clearance of imbalances >> EC recommends fundamental transparency rules.

Predictions/Educated guesses

1. *The first phase in the development of a wholesale gas market entails **balancing** as the primary objective of traders, while a more mature phase entails gas provision as a **second sourcing** in the wholesale market. Being linked to the physical delivery of gas, these phases tend to develop in **each national gas system**.*

2. *An entry-exit model, a market based balancing regimes and rules for fundamental transparency are the more favorable **market design** for the development of a wholesale market for balancing needs.*

3. *The **wider** the virtual trading area within a national gas system, the more rapid and effective the development of wholesale gas markets*

4. *Market liquidity increases more rapidly in countries endowed with significant **local gas production**.*

5. *Transactions of **financial instruments** to hedge gas price risk, the third phase of the development, concentrate in a **small number of market venues**.*

Data

- Data collected from a number of sources.
- Data on volumes:
  - Where available, data published by TSOs or hubs operators.
- Data on prices:
  - Bloomberg database;
  - ICE Endex;
  - EEX.
- Data on consumption, production, import, export:
  - IEA, Eurostat.

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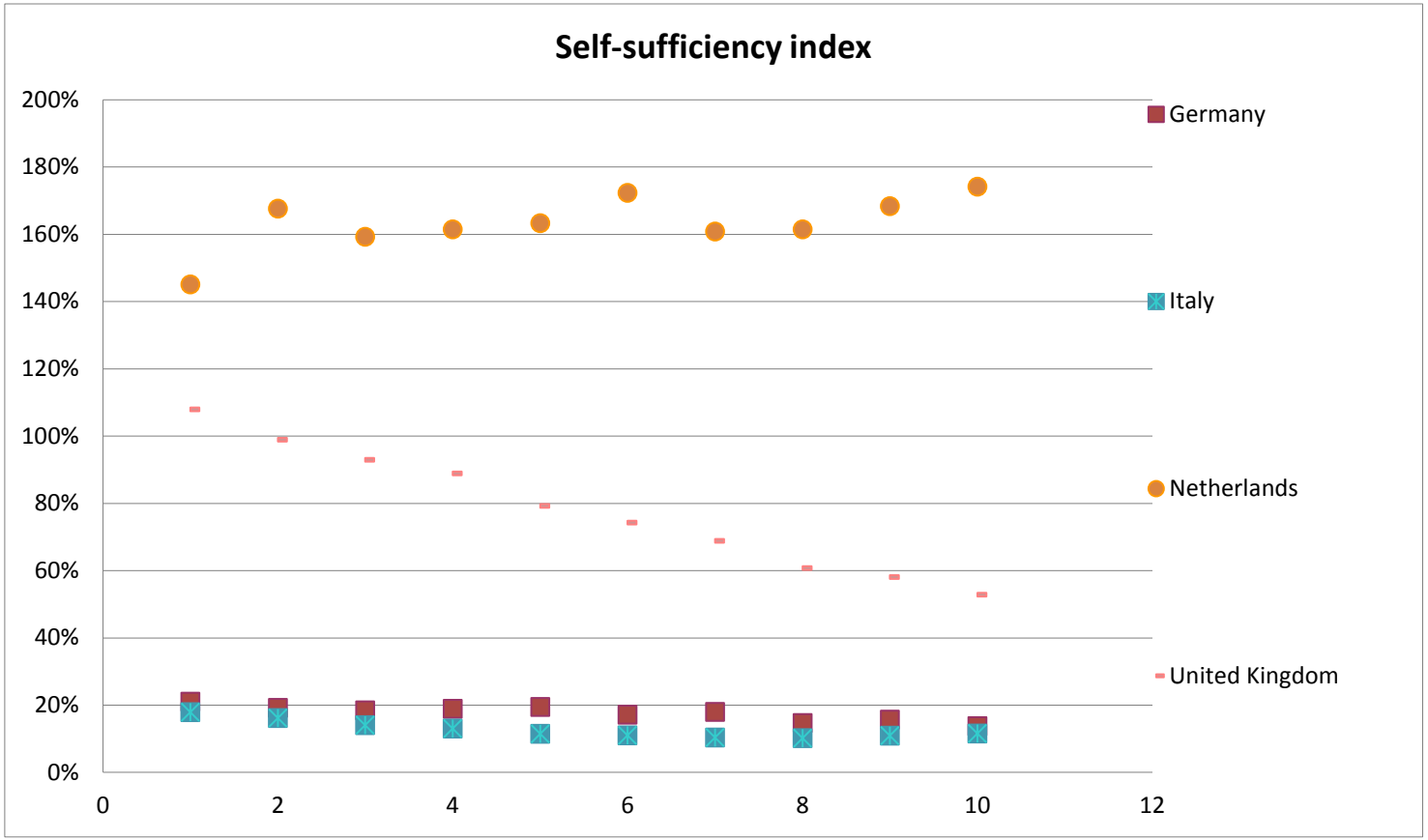
Indicators: production



Regulation

- All countries have adopted and entry-exit model and the rules for fundamental transparency (still, very different accounting criteria, non comparable data, changes in accounting rules)

- Balancing rules display some difference from country to country
  - UK and TTF: market-based
  - Germany: two balancing zones (previously 19!)
  - Italy: first attempt to promote a wholesale market for trading (unsuccessful), then a balancing platform introduced,

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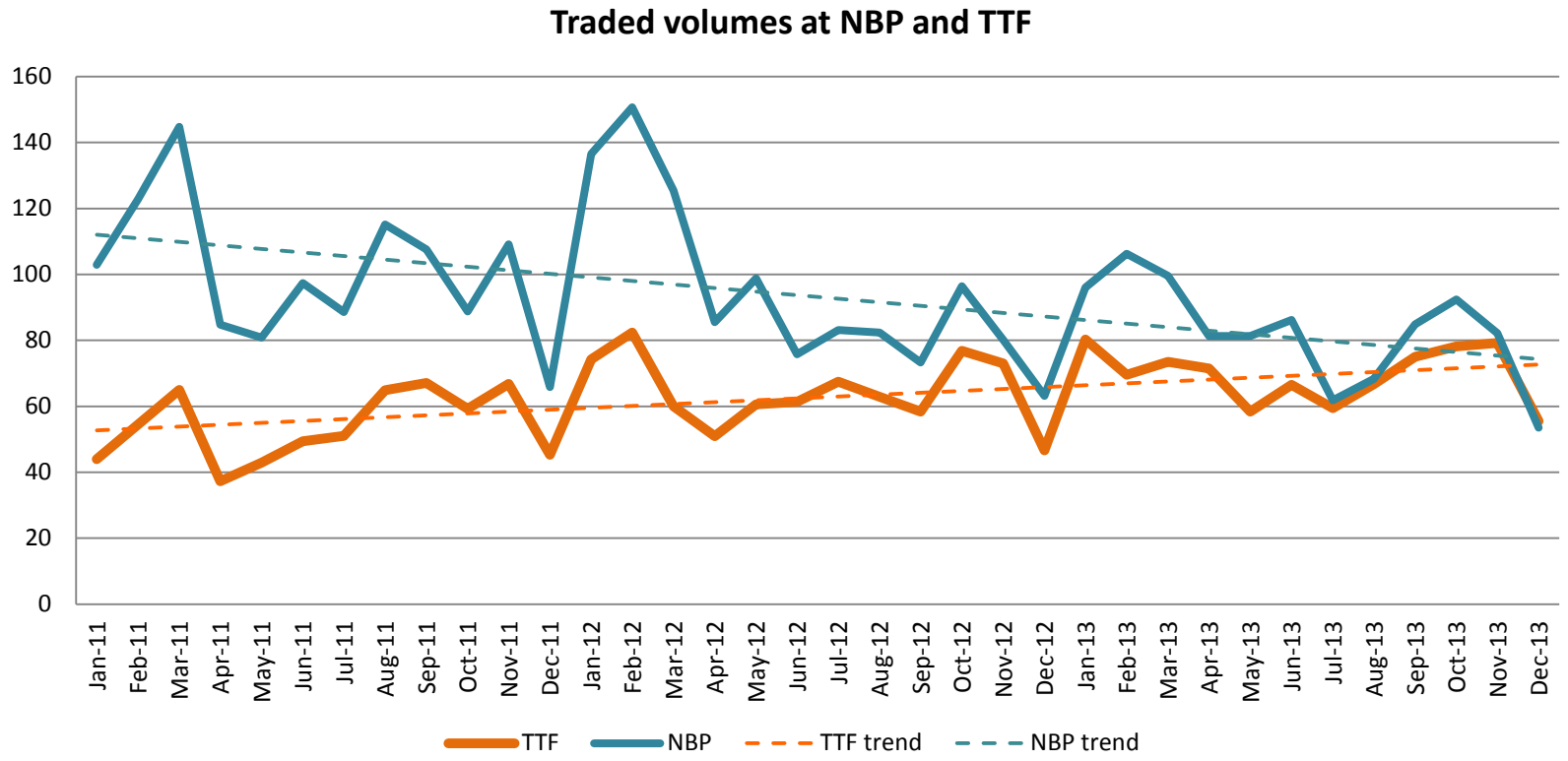
Indicators: traded volumes



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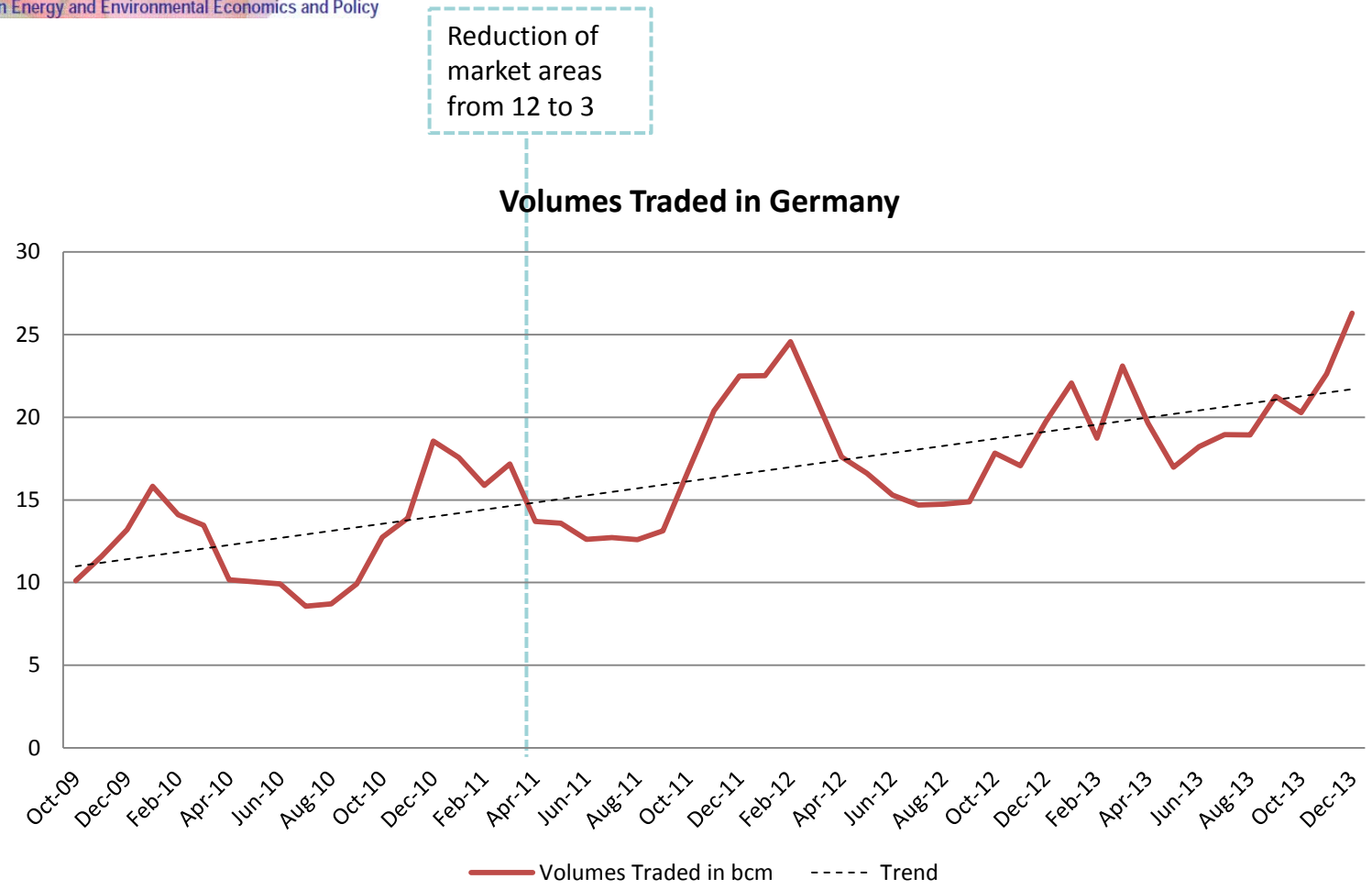
Indicators: traded volumes



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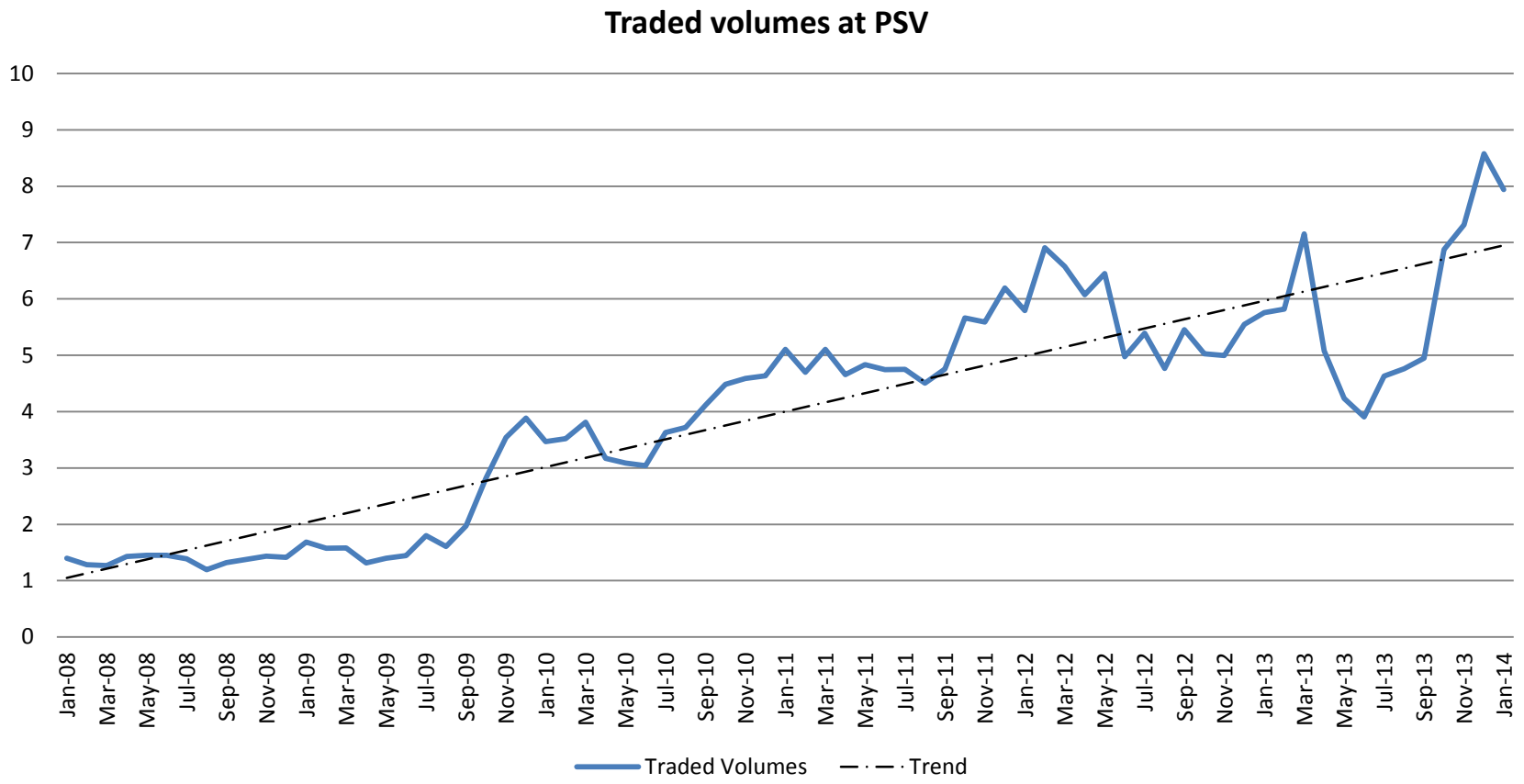
Indicators: traded volumes



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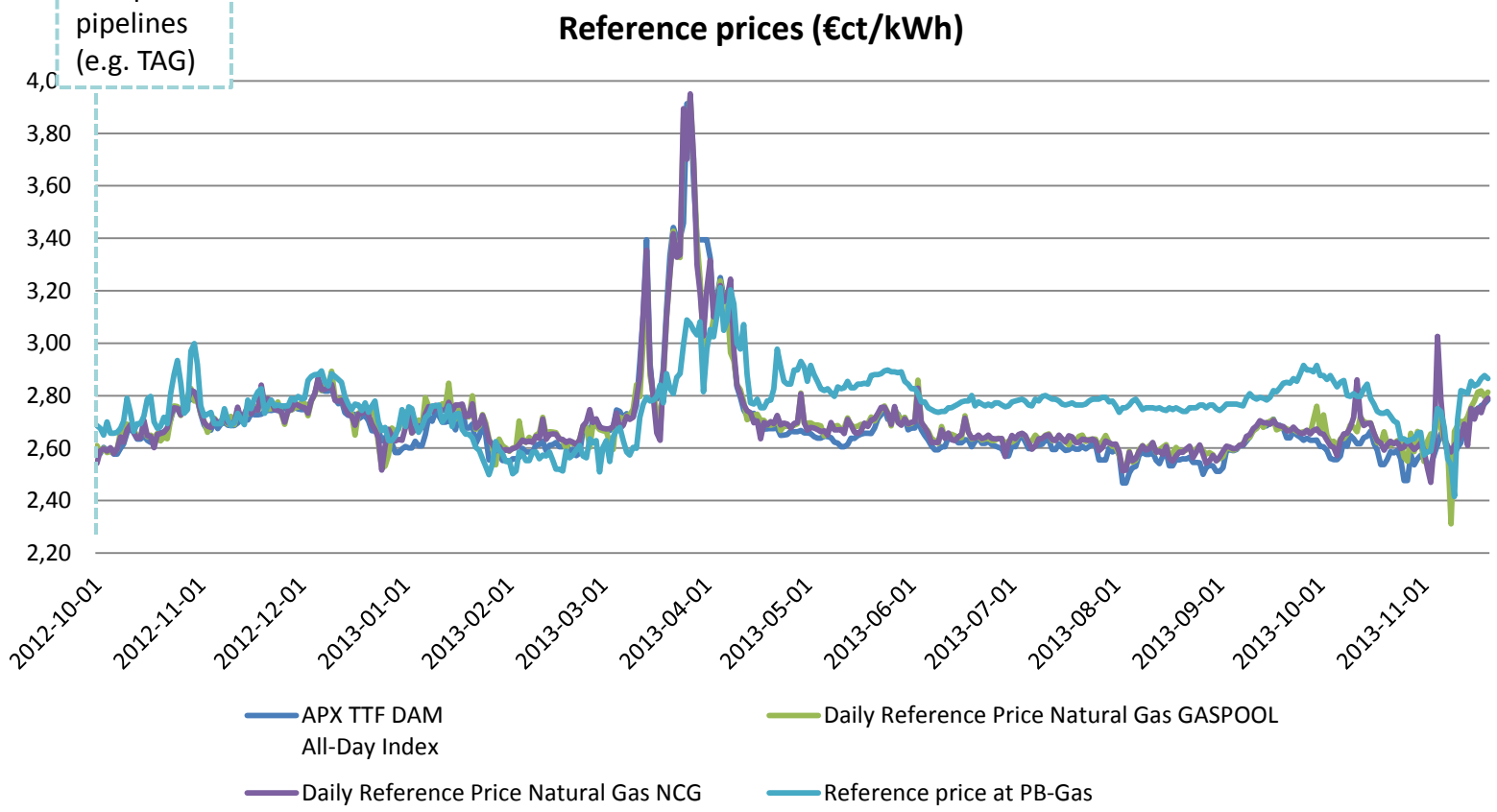
Indicators: price convergence (1)

Auctions on European pipelines (e.g. TAG)



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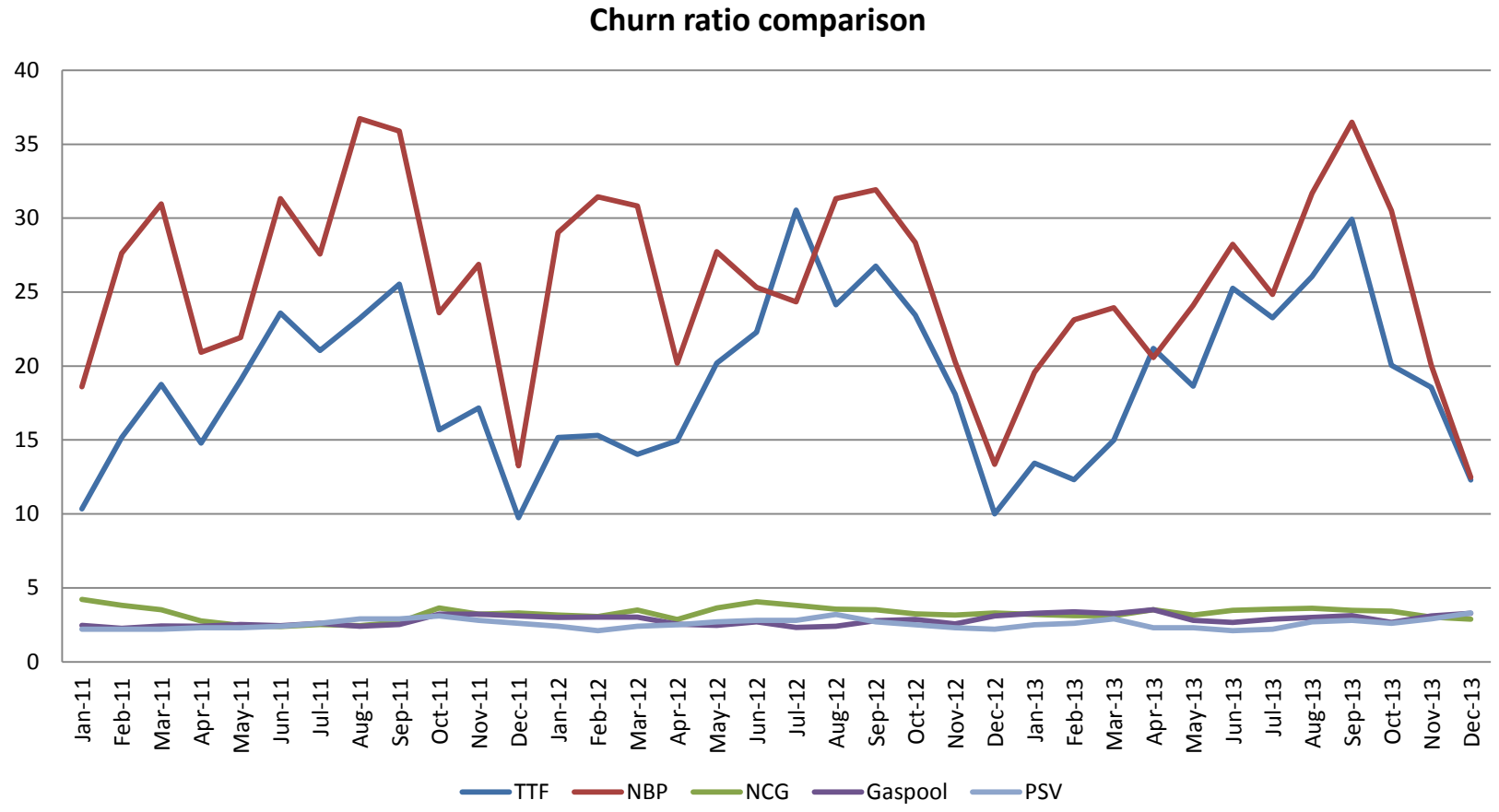
Indicators: liquidity



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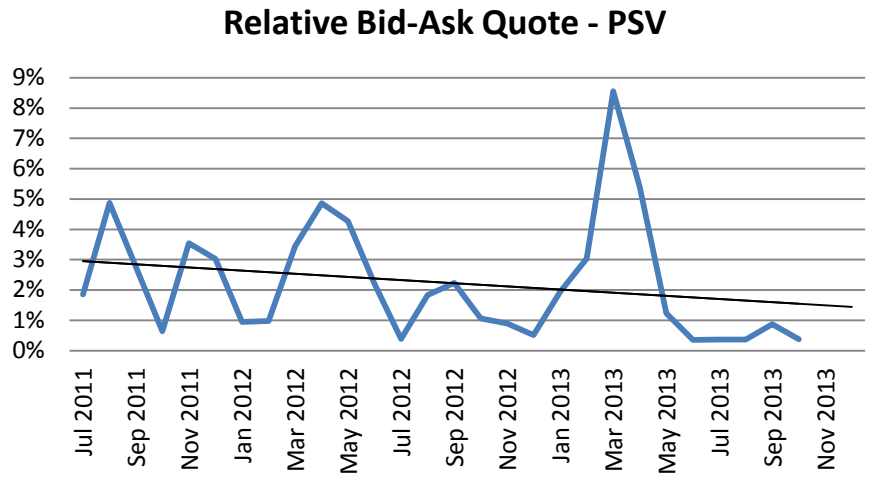
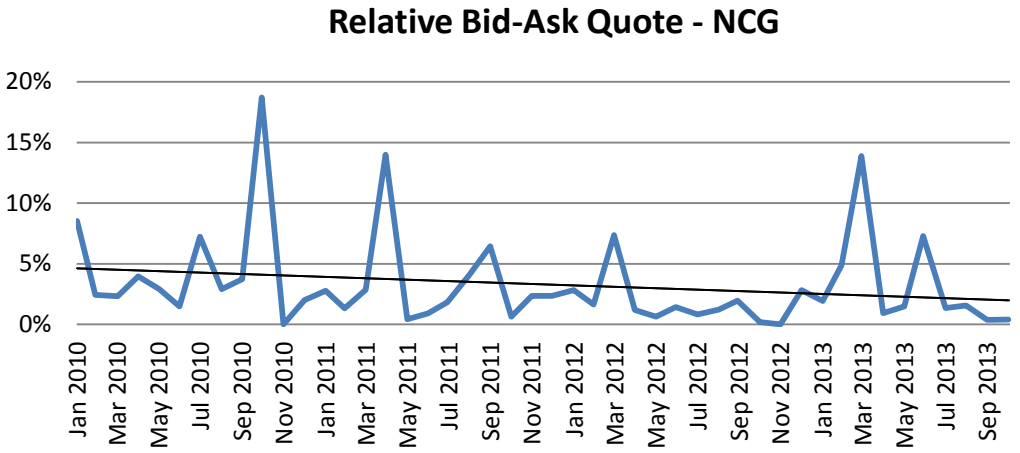
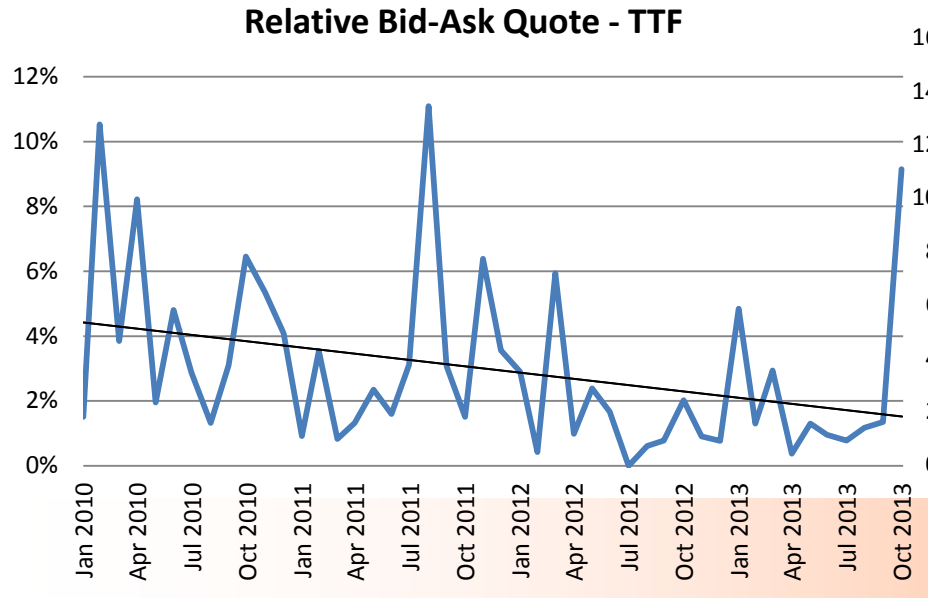
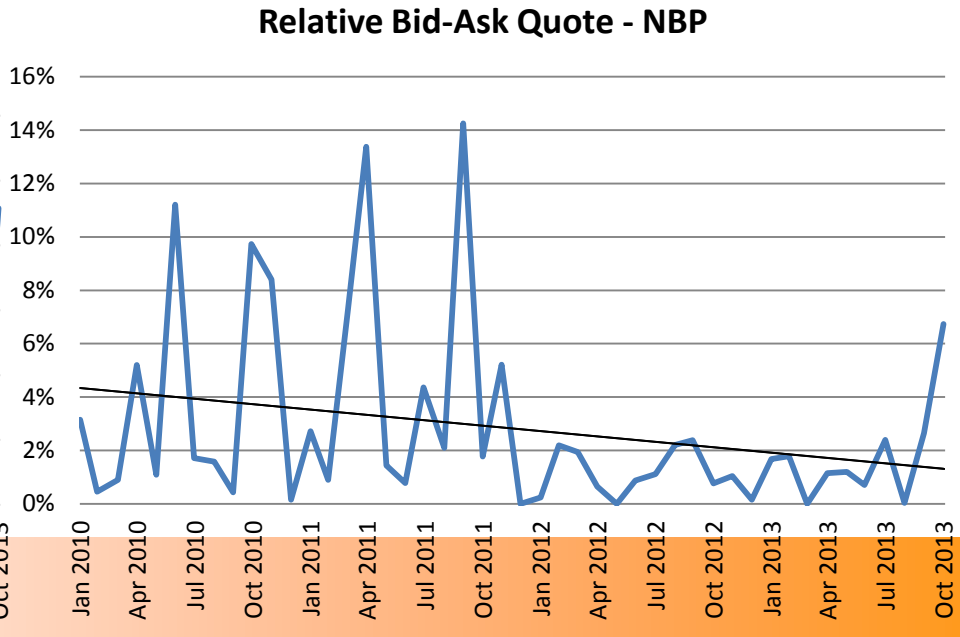
Indicators: liquidity

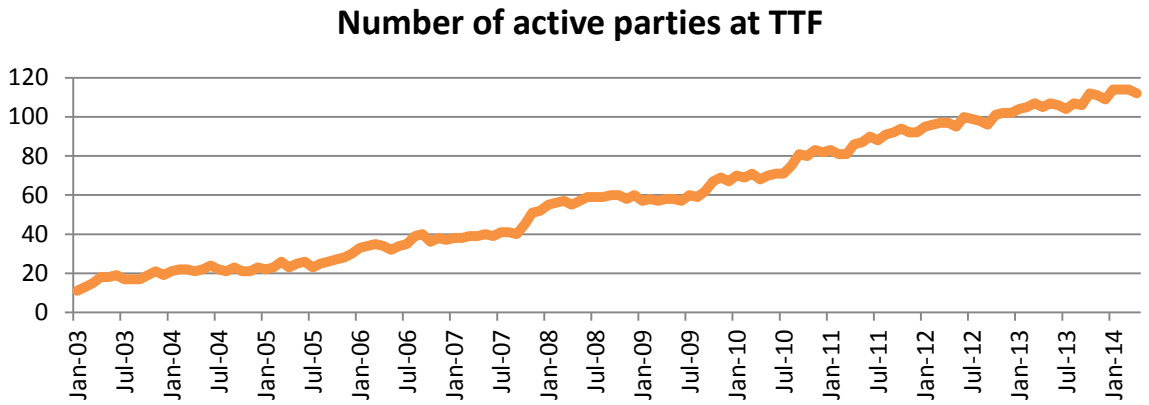


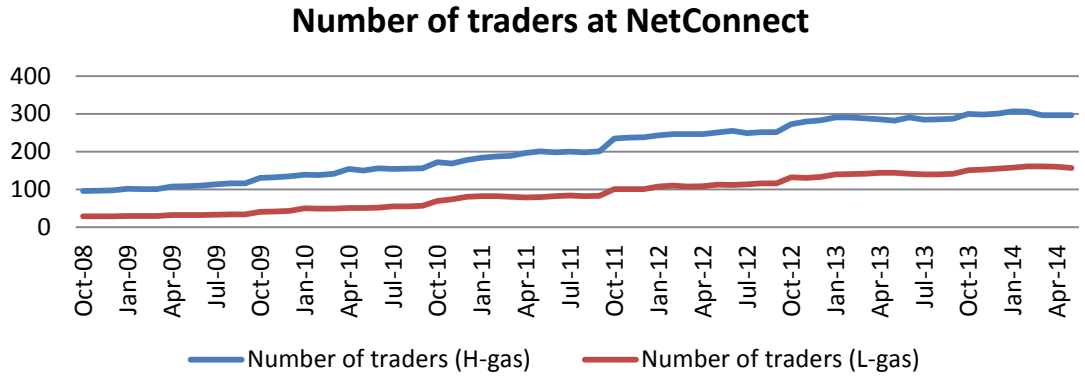




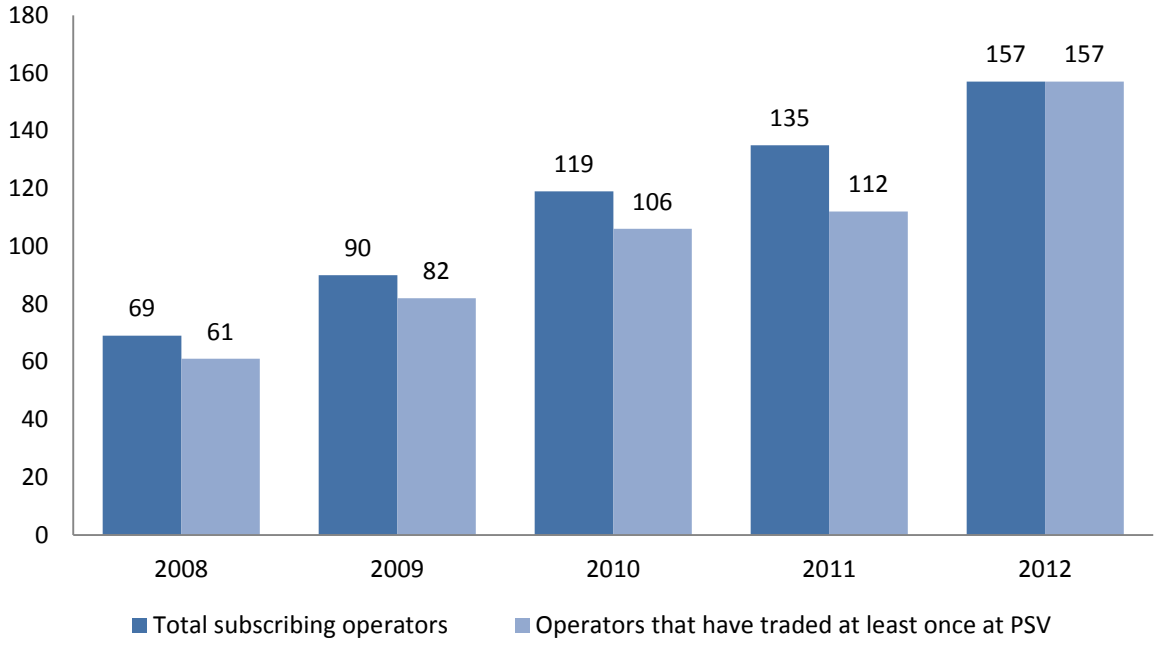


Indicators: liquidity

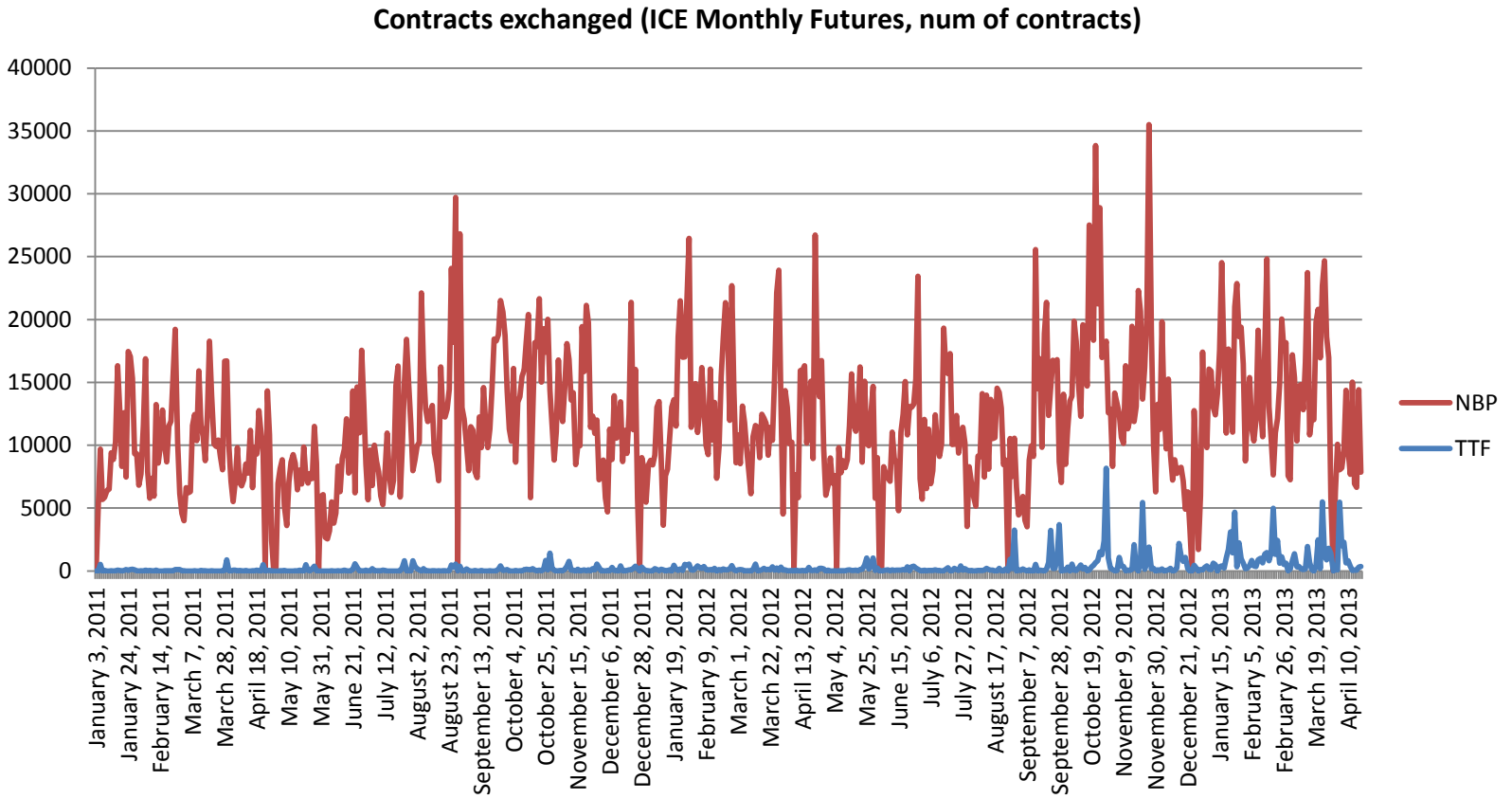




Indicators: liquidity



Indicators: financial market



Conclusions

- Wholesale gas trading consequence of market liberalization.
- Natural endowment/importance of upstream long term contracts matter.
- Appropriate rules may help enhancing market liquidity:
  - Adoption of an entry/exit system;
  - Transparency;
  - Adoption of a market-based balancing system → e.g. UK, Netherlands;
  - Reduction of market areas → e.g. Germany;
  - Start with balancing platform → counterfactual: Italy;
- Wholesale gas trade in each national gas system, financial transaction in a single market venue: U.K.

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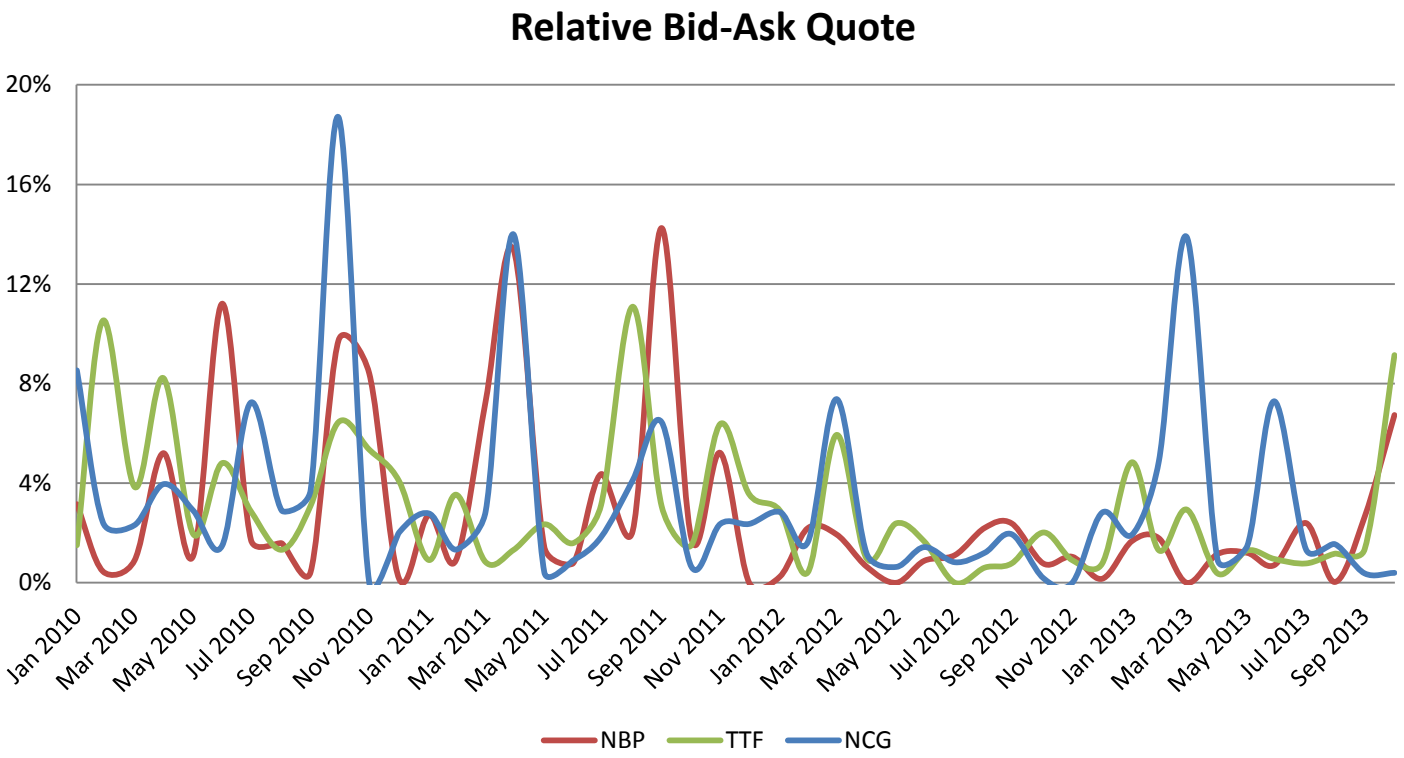
Thank you.

Back-up slides

Indicators: liquidity



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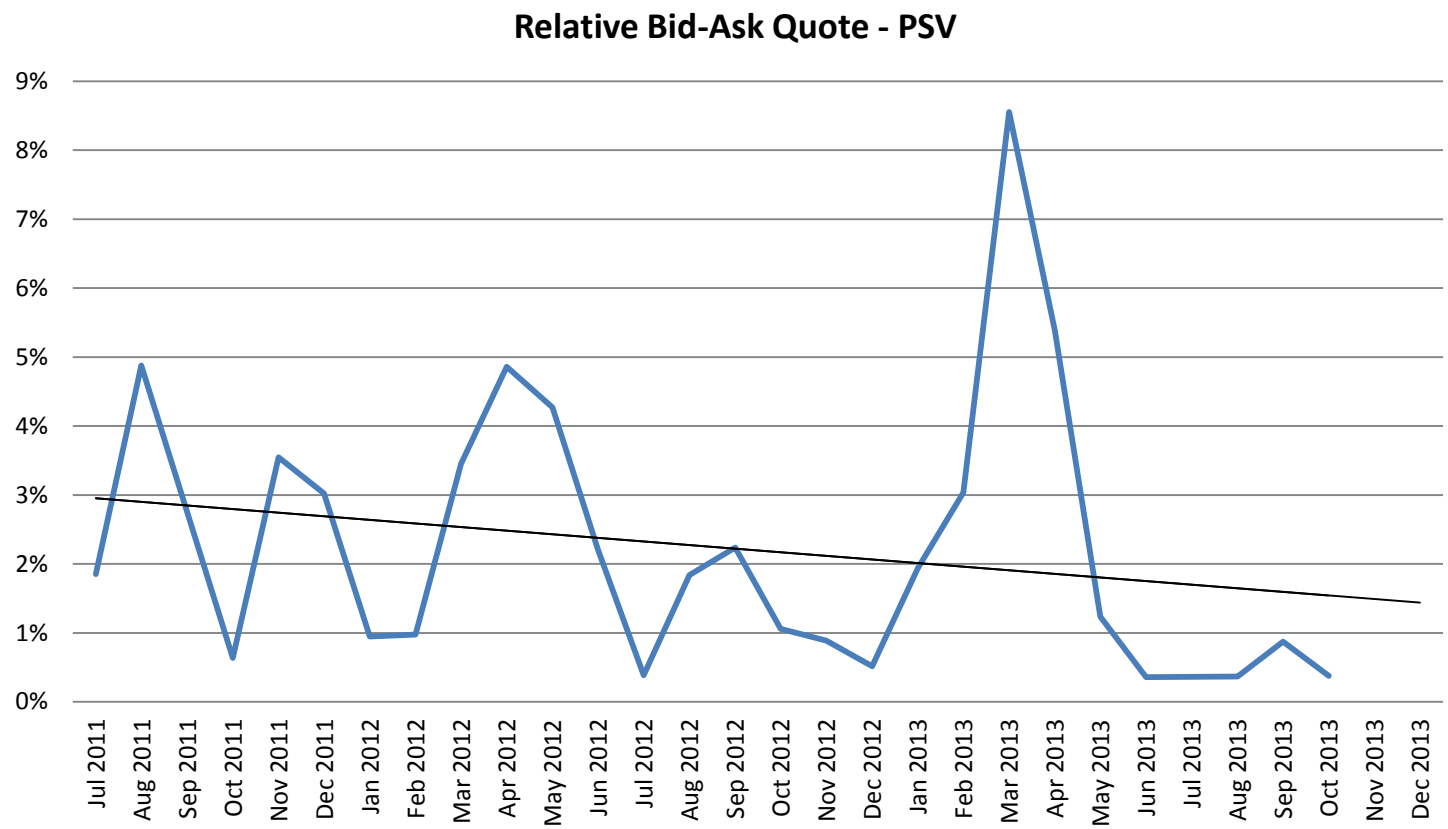
Indicators: liquidity



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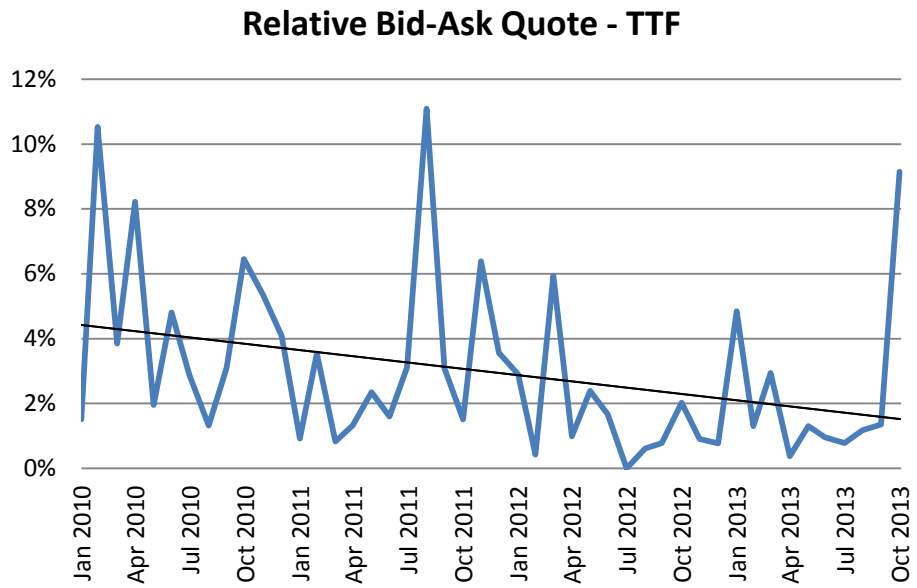
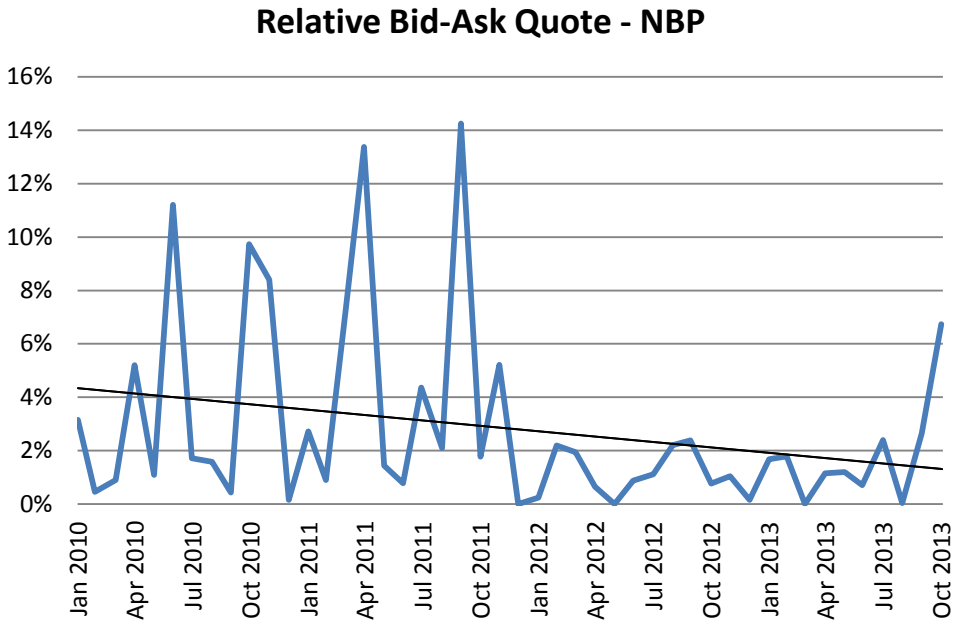
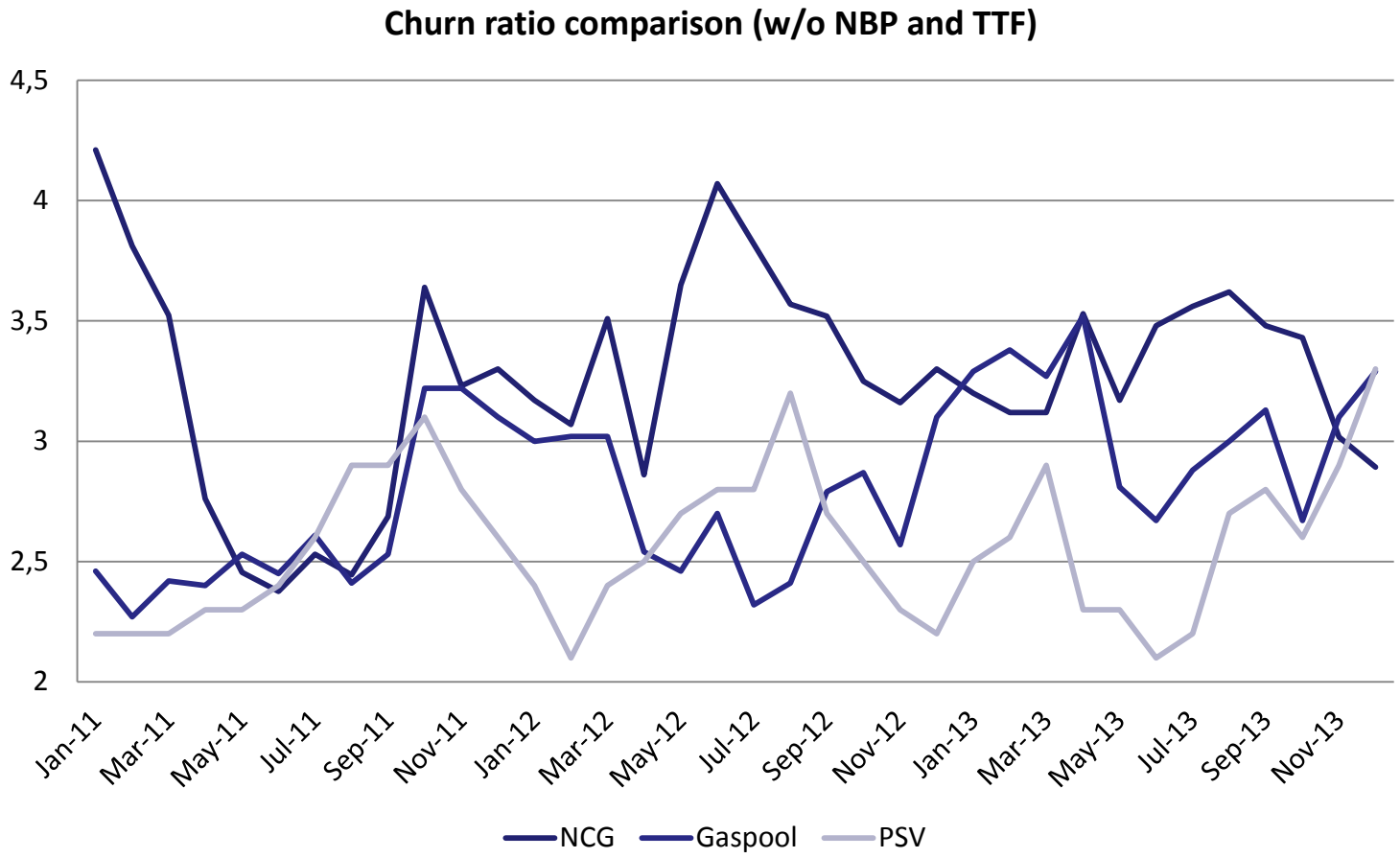




Indicators: liquidity



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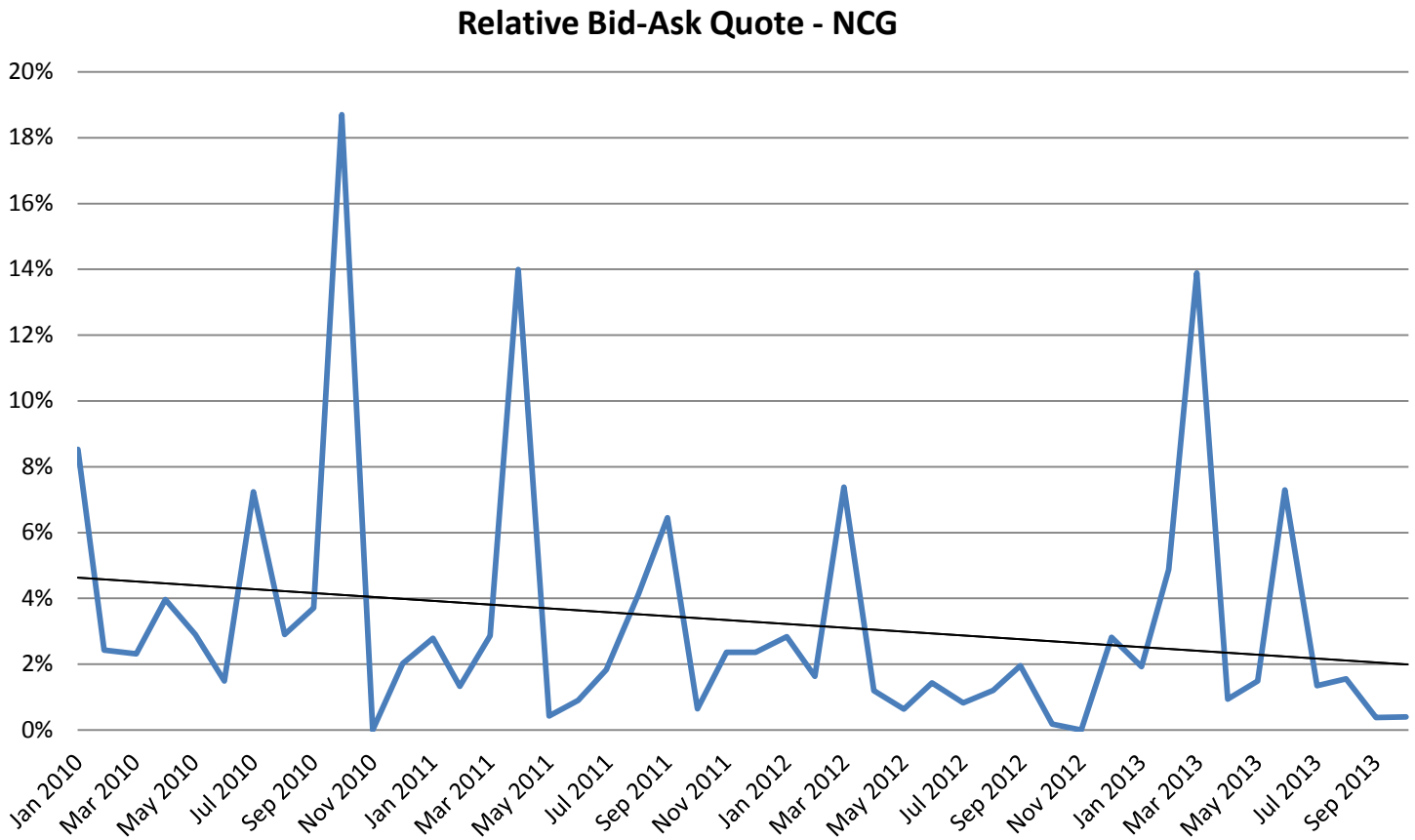

Regulation: UK

- First EU country to liberalize gas market.
- '90s: creation of *Flexibility mechanism* for balancing, heavily relying on the physical flexibility tools available.
- 1999: *New Gas Trading Arrangements* (NGTA): more reliance on market-based tools for balancing, in order to improve price signals and to reduce the cost of balancing.
- Operators have incentives to clear their positions, with the TSO (National Grid) balancing only residually the system at a price related to the System Average Price (SAP).
- The price set on the OCM is used as a reference for the SAP; subsequently, the System Marginal Buy Price (SMBP) and the System Marginal Sell Price (SMSP) are computed.
- The main market instrument to acquire the resources for balancing is the On-the-day Commodity Market (OCM).

Regulation: the Netherlands

- 2004: GTS (Gas Transport Services) introduced an entry-exit capacity system and the virtual trading point TTF.
- 2005: ownership unbundling of Gasunie into GasTerra, as trading company, and Gasunie as transportation company.
- 2007-2009: rules to improve transparency, quality conversion and balancing regime.
- 2011: *Nieuw marktmodel* introduced. TTF becomes the central trading point for all natural gas in the Dutch transmission system.

Regulation: Germany

- 2002: creation of the Bunde-Oude hub on the Dutch/German border.
- 2005: Energiewirtschaftsgesetz (EWG), entry-exit system; 19 entry-exit zones, called “Marktgebiete”.
- 2008: reduction of the zones to 12.
- 2010: Gas Network Access Ordinance (GasNZV) required TSOs to reduce the market areas for L-gas to one and for H-gas to two by 2011.
- 2013: Further steps into balancing market reform.

Regulation: Italy

- 2006: creation of the PSV hub.
- 2010: creation of the P-GAS, in order to exchange quotas of imported gas.
- 2011: creation of the PB-GAS for balancing purposes (similar to old UK flexibility mechanism).
- 2014: enlargement of the flexibility tools allowed for balancing.