Financing the gas transmission network
Analyzing the effects of duration dependent multipliers

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Agenda

- Motivation & Background
- Research question and methodology
- Preliminary results
Introduction

Motivation

• Decreased demand for long-term transmission capacity
• Increased demand for short-term (e.g. daily) transmission capacity

Consequence

• Efficient pricing of short-term vs. long-term transmission capacities gets more relevant

Implication

Energy transition

Indicative German gas demand for 2050

Electrification scenario – dena EL95

Current German gas demand

GWh/d

Jan | Apr | Jul | Oct | Dec

0 | 0 | 0 | 0 | 0

6000 | 5000 | 4000 | 3000 | 2000 | 1000 | 0

Jan | Apr | Jul | Oct | Dec

0 | 0 | 0 | 0 | 0

6000 | 5000 | 4000 | 3000 | 2000 | 1000 | 0

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Introduction

Background

Financing the gas transmission network

Who: Gas traders who transfer gas using the gas transmission network

What: Entering and exiting a transmission grid market area (entry-/exit-tariffs)

How: Traders need to buy the transmission capacity they require in explicit auctions

How is transmission capacity priced?

- Duration dependent tariff (reserve price)
- Auction premium

Effect of multipliers

- Multipliers increase the relative price of short-term capacities in comparison to long-term capacities
- Impact on 1) short-term efficiency, 2) long-term efficiency and 3) allocation of costs

EU TAR 2017

- Multipliers
  - 1 - 1.5 for quarterly and monthly capacity
  - 1 - 3.0 for daily and intraday capacity

Impact on transport, storage, gas prices ...
**Introduction**

**Research question**

What are the adequate multipliers to balance between

1. facilitating short-term gas trade,
2. providing long-term signals for efficient investment in the transmission network,
3. enhancing cost reflectiveness of transmission network charges?

This question is discussed currently EU-wide within an a consultation (NC TAR 2017 (Article 28))

**Question analyzed in this research**

What are the effects of multipliers on the gas dispatch?

Intuitive hypotheses:

1. Multipliers increase long-term capacity bookings.
3. Multipliers increase storage utilization.
4. Multipliers increase price differences between market zones in most situations.
5. Multipliers increase total costs in the short-term and hence reduce efficiency.
Literature review

Hallack and Vazquez (2013) – European Union regulation of gas transmission services: Challenges in allocation of network resources through entry/exit schemes

• Inefficient offers of network services in entry/exit regulations

Bermudez et al. (2016) – Gas transmission networks in Europe: Connections between different entry–exit tariff methodologies

• Comparison of capacity-weighted distance vs least squares approaches for computing tariffs
• Weighted computation methodologies more suitable for including transmission network features

Bonbright et al. (1961) – Principles of public utility rates

• Rates based on long–term marginal costs incentivize efficient investments
• Rates based on short–term marginal costs incentivize efficient short–term utilization

Borenstein (2016) – The economics of fixed cost recovery by utilities

• Rates based on short–term marginal costs incentivize efficient short–term utilization


• High resolution gas infrastructure and dispatch model
• Pipeline gas flow, storage and LNG simulations

Harald Hecking (2015) – Two new tariff models to foster competition and security of supply in the EU gas market

• Recommends differentiating tariff structures between intra EU, domestic exits and EU borders
• Proposed schemes bring with them different distributional effects

Our contribution

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Methodology

The TIGER model

Geocoded Database
Coverage: Europe > 600 nodes

> 900 pipeline sections
  - Based on TSO maps
  - Capacity/ pressure/ diameter
  - Entry- and Exit-Points

> 200 Storages
  - Storage type
  - Maximum injection/ withdrawal capacity
  - Working gas volume

> 30 LNG import terminals
  - Max. hourly/ annual capacity
  - LNG storage capacity

Implicit assumptions
Perfect information (no uncertainty)

Input
Gas Supply
Gas Demand
Gas Infrastructure

Linear Optimization
Objective function: Cost–minimal demand satisfaction, restricted by available capacities

Output
Natural gas trade
Infrastructure utilization
Import costs/ HUB prices

Gas Supply
Gas Demand
Gas Infrastructure
## Methodology

### Model extension

**Equation 1 - Modification of cost minimization function**

\[
\text{minimize } \text{TOTAL}\_\text{COSTS} = \text{CB}\_\text{COSTS}_{t,n,n_1,p} + \text{STORAGE}\_\text{COSTS} + ... \tag{1}
\]

**Equation 2 - Definition of capacity booking costs**

\[
\text{CB}\_\text{COSTS}_{t,n,n_1,p} = \text{CB}_{t,n,n_1,p} \cdot \text{tariff}_{n,n_1} \cdot \text{multiplier}_p \tag{2}
\]

**Equation 3/4 - Defining required capacity booking**

\[
\text{CB}_{t,n,n_1,p} \geq \text{TRANSPORT}\_\text{CB}_{t,n,n_1,p} \quad \forall (n,n_1) \tag{3}
\]

\[
\text{CB}_{t,n,n_1,p} = \text{CB}^{MAP}_{n,n_1,p} \tag{4}
\]

**Equation 5 - Assigning transported volumes to corresponding capacity products**

\[
\text{TRANSPORT}_{t,n,n_1} = \sum_p \text{TRANSPORT}\_\text{CB}_{t,n,n_1,p} \tag{5}
\]

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**Legend**

- \(t \in T\) points in time
- \(n, n_1 \in N\) nodes in the pipeline network
- \(p \in P\) capacity products (defined by duration, start and end date)
- \(i(n,n_1)\) subset of pipeline connections where entry/exit tariffs are applied
Hypotheses testing

*Indicative model results*

**Hypotheses 1/2:**

Multipliers increase long-term capacity bookings. Multipliers decrease seasonality and short-term volatility of gas transports.

**Capacity booking/transport (NCG – Switzerland)**

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**Model results**

Both hypotheses are supported by our model results.
Hypotheses testing

**Indicative model results**

**Hypotheses 3:**
Multipliers increase storage utilization.

**Model results**
When multipliers are in place storages are utilized more.
Hypotheses 4: Multipliers increase price differences between market zones in most situations.

**Price Spread (NCG – Gaspool)**

- Price difference differ with and without multipliers
- On average price differences are higher with multipliers
- When there is capacity which is booked but used (only the case in scenario with multipliers) price differences are zero

**Model results** Hypothesis is supported by our model results.
Outlook

- Analysis regarding the implications on short-term efficiency (Hypothesis 5)
  - based on the model framework
  - in a theoretical framework

- Analyzing the impact of uncertainty
Hypotheses testing

Indicative model results

Hypotheses 2:
Multipliers decrease seasonality and short-term volatility of gas transports.

Cross market area transports

Without multipliers

With multipliers

Model results

Multipliers reduce volatility as assumed and reduce congestion.
**Hypotheses testing**

**Indicative model results**

**Hypotheses 3:**

Multipliers increase storage utilization.

**Model results**

Storages are utilized more when multipliers are in place.
Equation 1 - Modification of cost minimization function

\[
\text{minimize } \text{TOTAL.COSTS} = CB.COSTS_{t,n,n_1,p} + \text{STORAGE.COSTS} + \ldots
\]