



Long Term Supply of Natural Gas – LNG vs. (Russian) Pipeline Gas



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Based on joint research with Franziska Holz, Anne Neumann, Ferdinand Pavel, and Sophia Rüter

EPRG Winter Research Seminar

Cambridge, 09 December 2005

Chair of Energy Economics and Public Sector Management at Dresden

EE²

University of Technology

and German Institute of Economic Research (DIW Berlin)



DIW Berlin

German Institute
for Economic Research

Background: EE² / DIW Project

“The Globalization of Natural Gas Markets” (2004-2007)

- **Jointly between Dresden University of Technology, Chair of Energy Economics and Public Sector Management, and DIW Berlin (German Institute for Economic Research)**

<http://www.tu-dresden.de/wwbwleeg/projekte/gg/gg.html>

- **Assessing empirical evidence on gas market internationalization in three modules:**
 - Econometric analysis of energy price developments
 - Institutional economic modeling on governance structures
 - Computational model of the European natural gas market

→ Fundamental research, and advice to European policy makers and the corporate sector

Agenda

- 1. The Issue: Supply Security and International Natural Gas Markets**
- 2. SoS-Economics (Security of Supply)**
- 3. LNG-Economics**
- 4. A Numerical Simulation Model of the European Market (GASMOD)**
- 5. The Case of the UK**
- 6. Conclusions**

Context: The European Natural Gas Sector

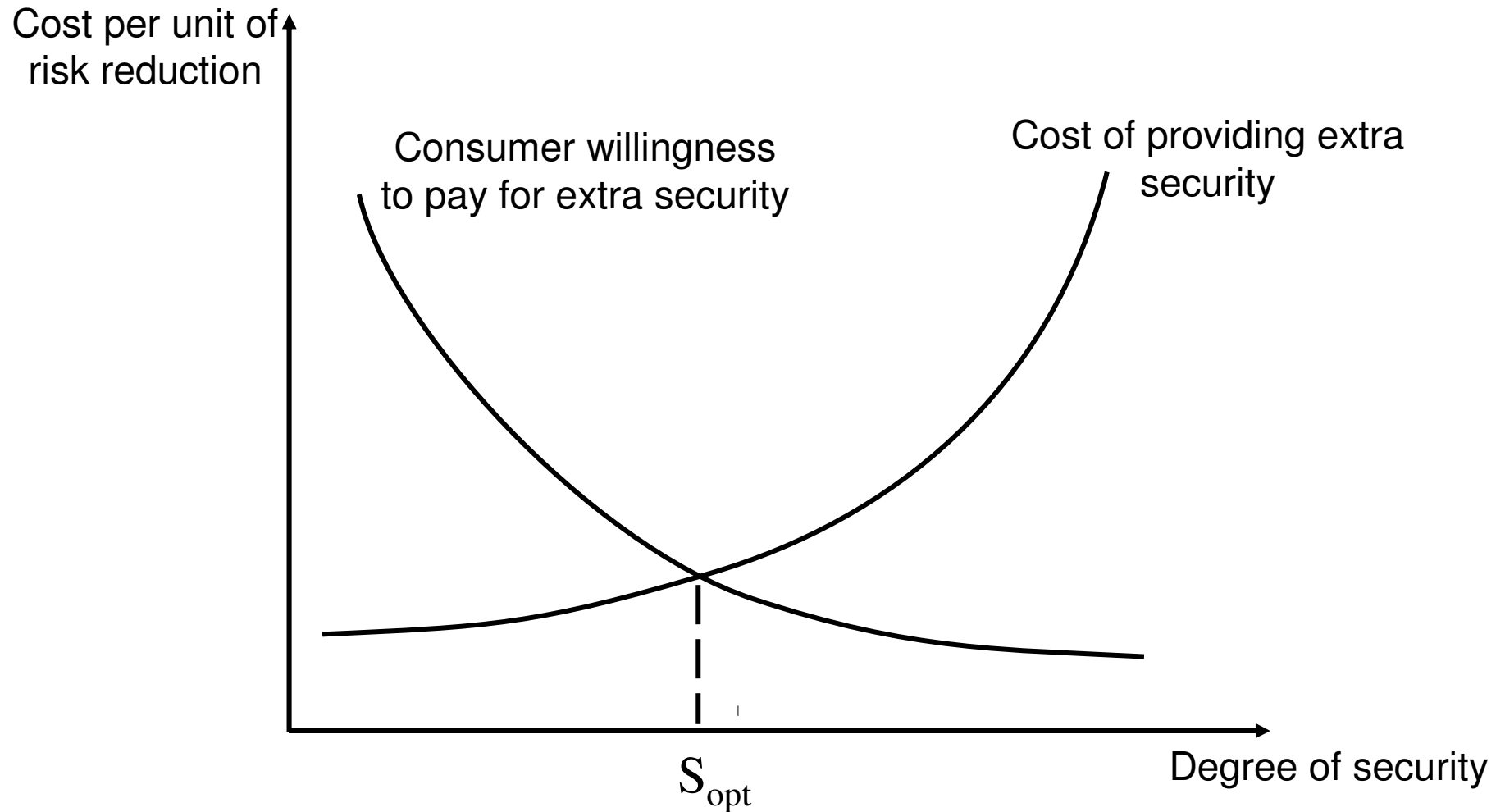
- **Liberalization of European gas markets combined with the growing importance of LNG are likely to modify the structure of European natural gas trade:**
 - Intensification of competition within Europe (end of „destination clause“, national monopolies)
 - Diversification of suppliers: from current triad (Russia, Norway, Algeria) towards a larger number of exporting countries (including Libya, Egypt, overseas LNG, Middle East)
- **Concrete repercussions with competition policy and regulation, Acceleration Directive (2003/55/EC), and further European Commission action (3rd Gas Directive ?), in particular ownership unbundling**
- **Hypothesis: As global natural gas markets emerge, and competition in these markets intensifies, LNG is becoming a crucial source of supply (security), at the expense of Russia, the former dominant supplier to Europe.**
- **But also (consensus of the EMF 23 Group on International Natural Gas Trade): the “honeymoon” for LNG is over, now it has to work its way into the market**

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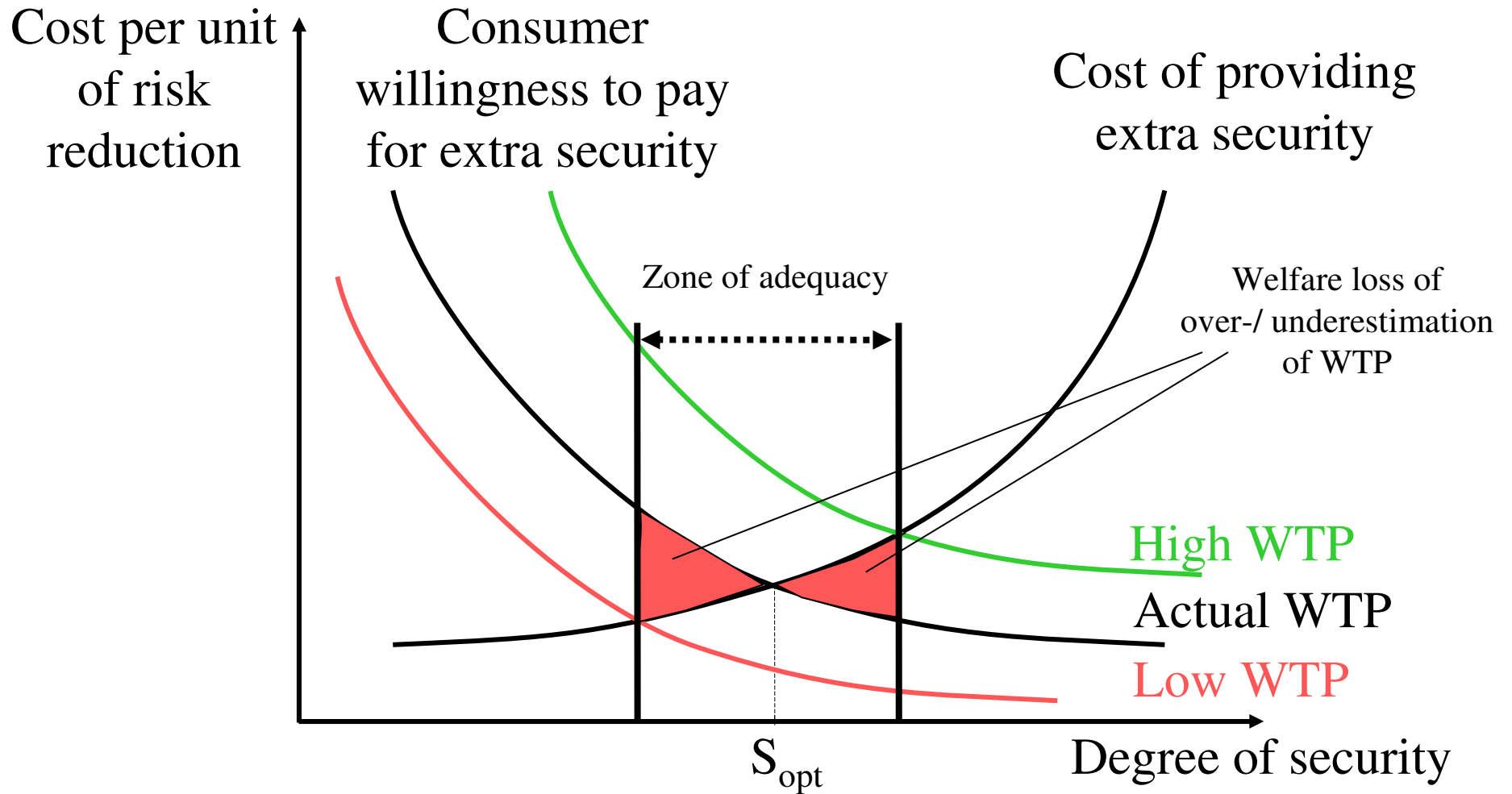
SoS-Economics 201 (Security of Supply)

The optimal Level of Security: A Welfare Perspective



→ Theoretically, the optimal level of security supply can be determined knowing the willingness to pay and the costs of provision

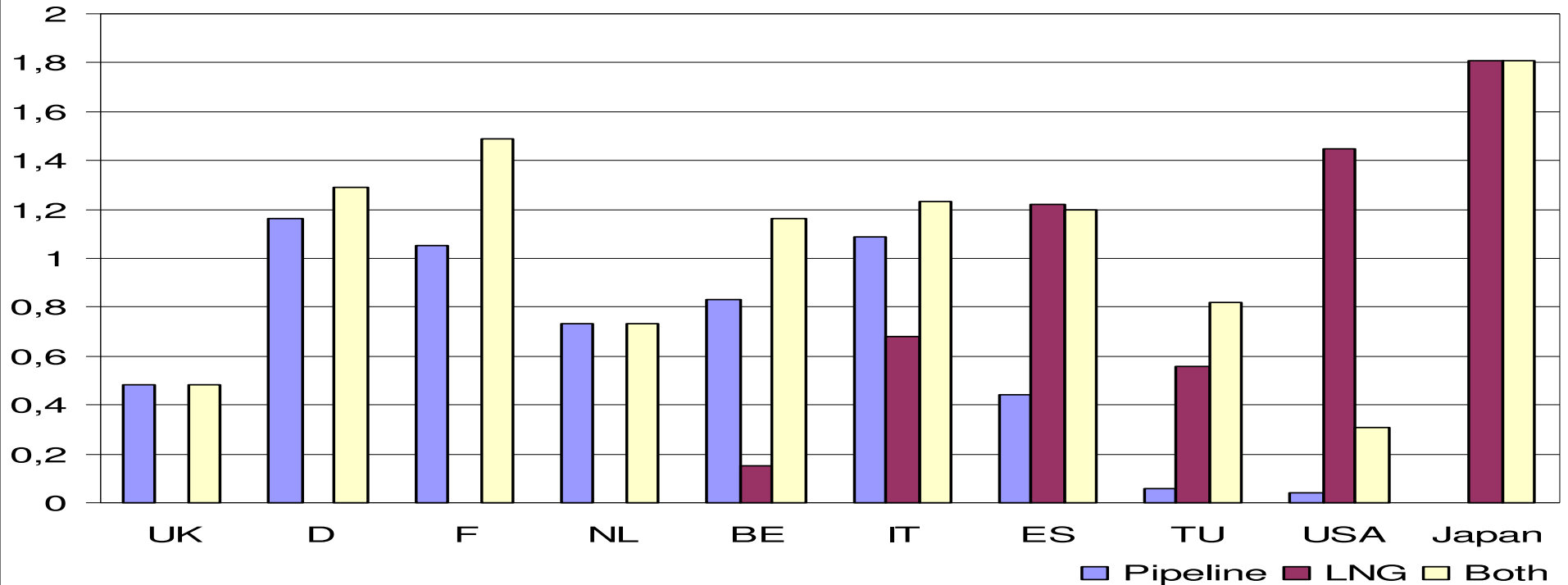
Cost to Society of Misestimations in the Level of Security



➔ An increase in the willingness to pay leads to a higher degree in provision of security

Measures of Supply Diversity I

Shannon Weiner Index, applied to European natural gas (2003)



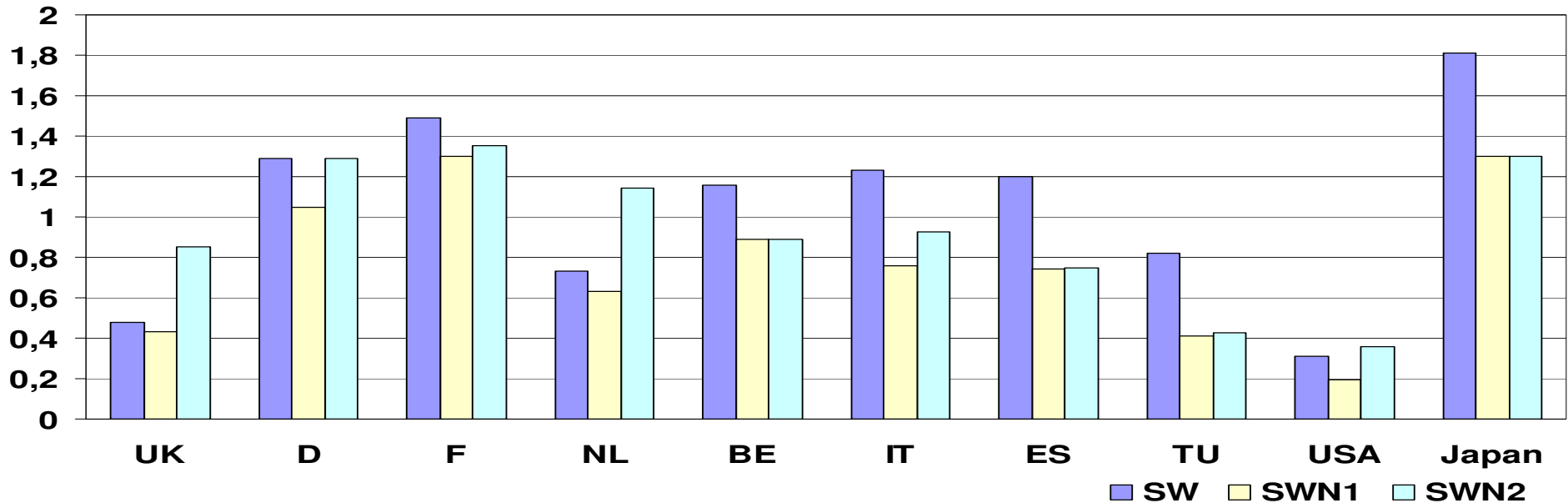
→ $SW = -\sum x_i \ln x_i \quad \forall i \quad x_i = \text{market share of supply country } i$

→ Measure of diversity which places weight on smaller participants ($0 \leq SW \leq 2$)

→ Europe well diversified for pipeline gas; Japan and USA for LNG

Measures of Supply Diversity II

Adjusted “Shannon Weiner-Neumann“ Index



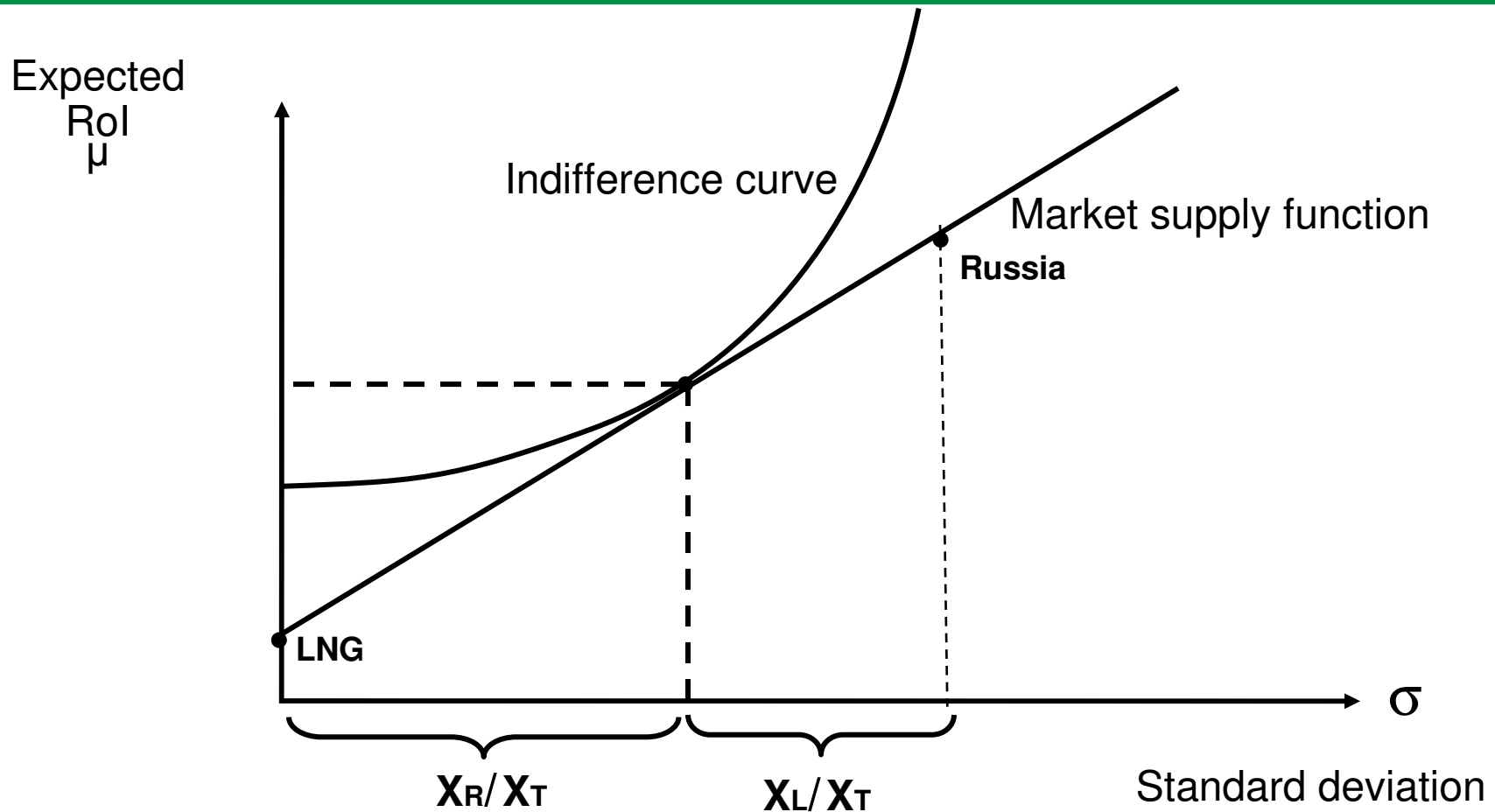
→ $SW1 = -\sum x_i \ln x_i b_i \quad \forall i$

b_i = index of political stability of producing country (PERC Ltd.)

→ $SW2 = (-\sum x_i \ln x_i b_i)(1+g_i) \quad \forall i$ g_i = degree of indigenous production (IEA, 2002)

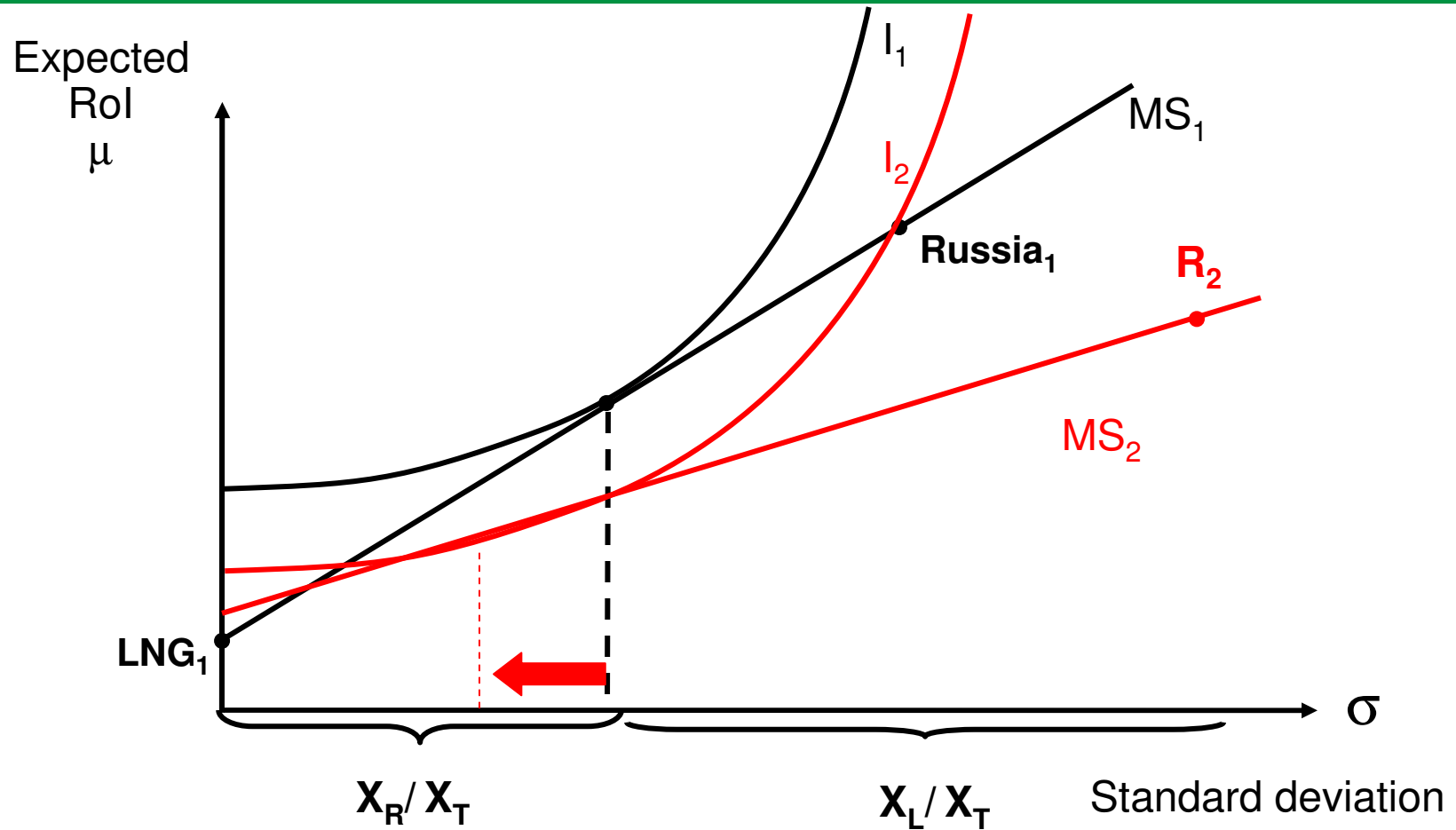
→ The “SWN“- index includes an index of political stability (SWN1) and considers indigenous production (SWN2)

Supply Security and Risk Diversification: The optimal supply portfolio = $f(\text{risk attitude})$



The optimal supply portfolio depends on the degree of trade-off between supply security and expected return on investment (μ - σ -characteristics) of individual supply contracts.

The Optimal Portfolio under Changing Conditions

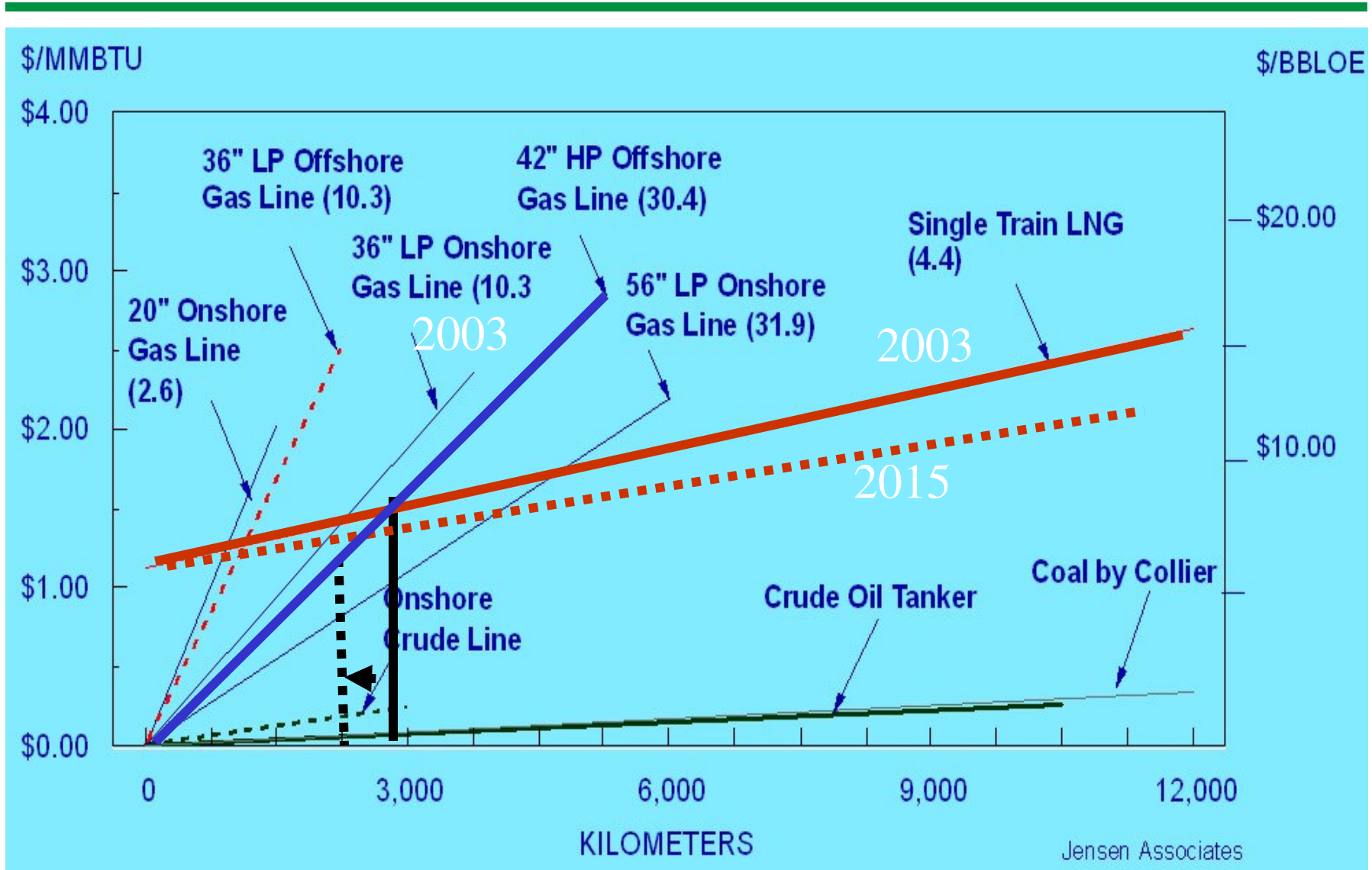


- Shift of market supply function modifies optimal portfolio
- LNG increases market share, at the expense of Russia

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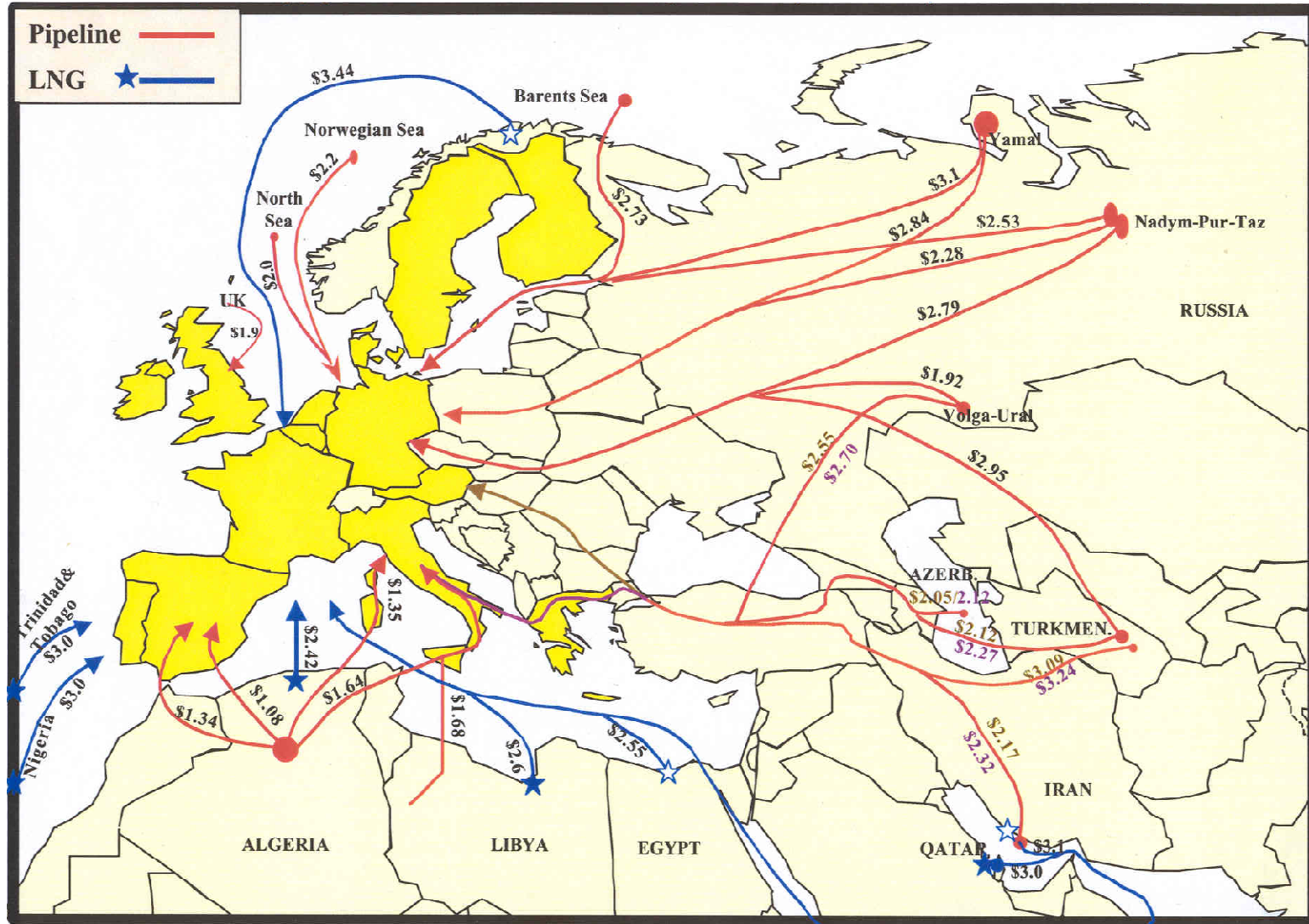
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3.1 LNG vs. Pipeline: Linear Cost Comparison



Source: Jensen, 2005

EU-15 Natural Gas Supply Costs (2010-2020) in \$/MBTU

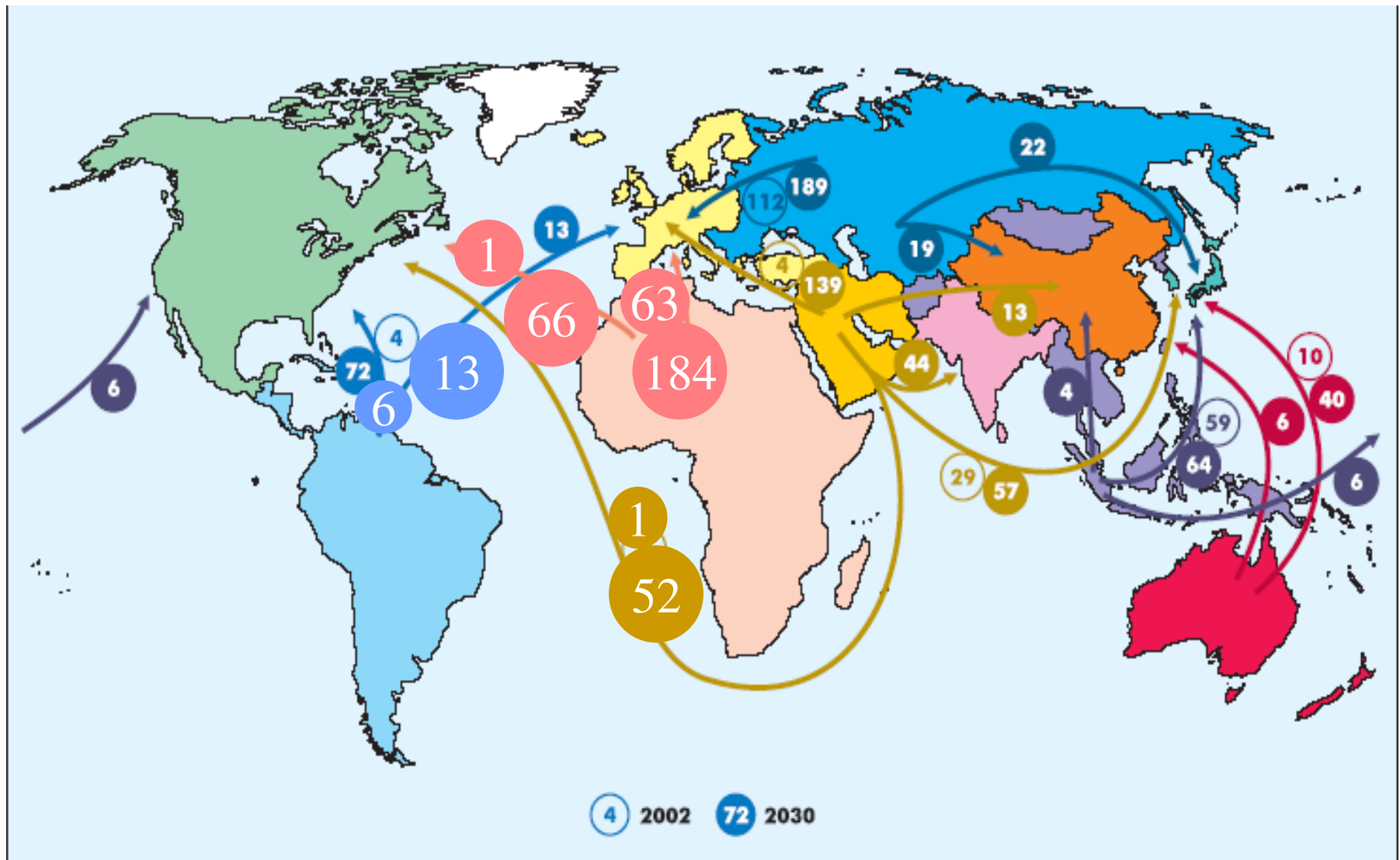


*Long-run marginal production and transport costs, excluding producer country's royalty

3.2 Price competition on globalizing natural gas markets

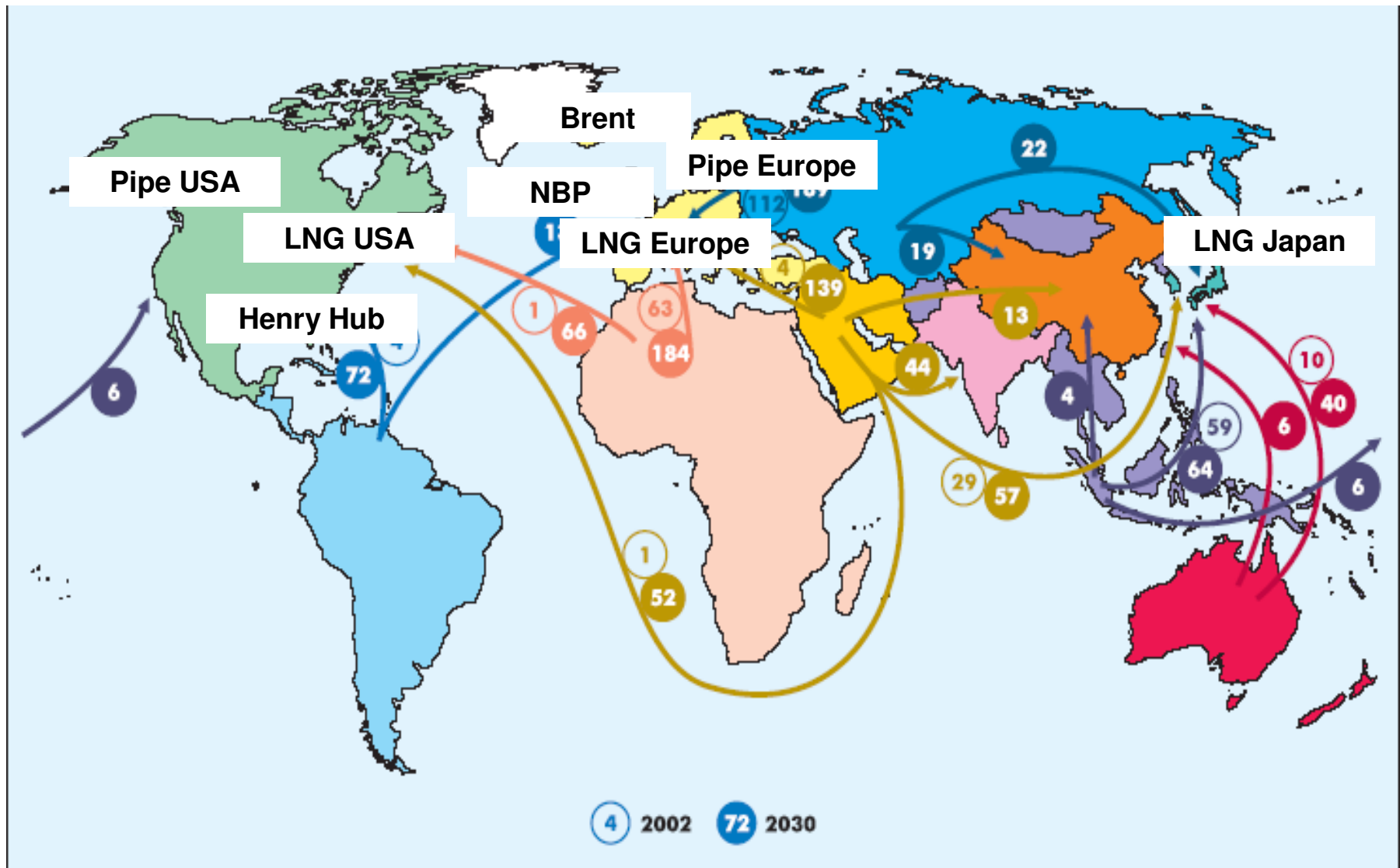
Inter-Regional Natural Gas Trade Flows are Growing Exponentially

(2002 and 2030, in bcm)



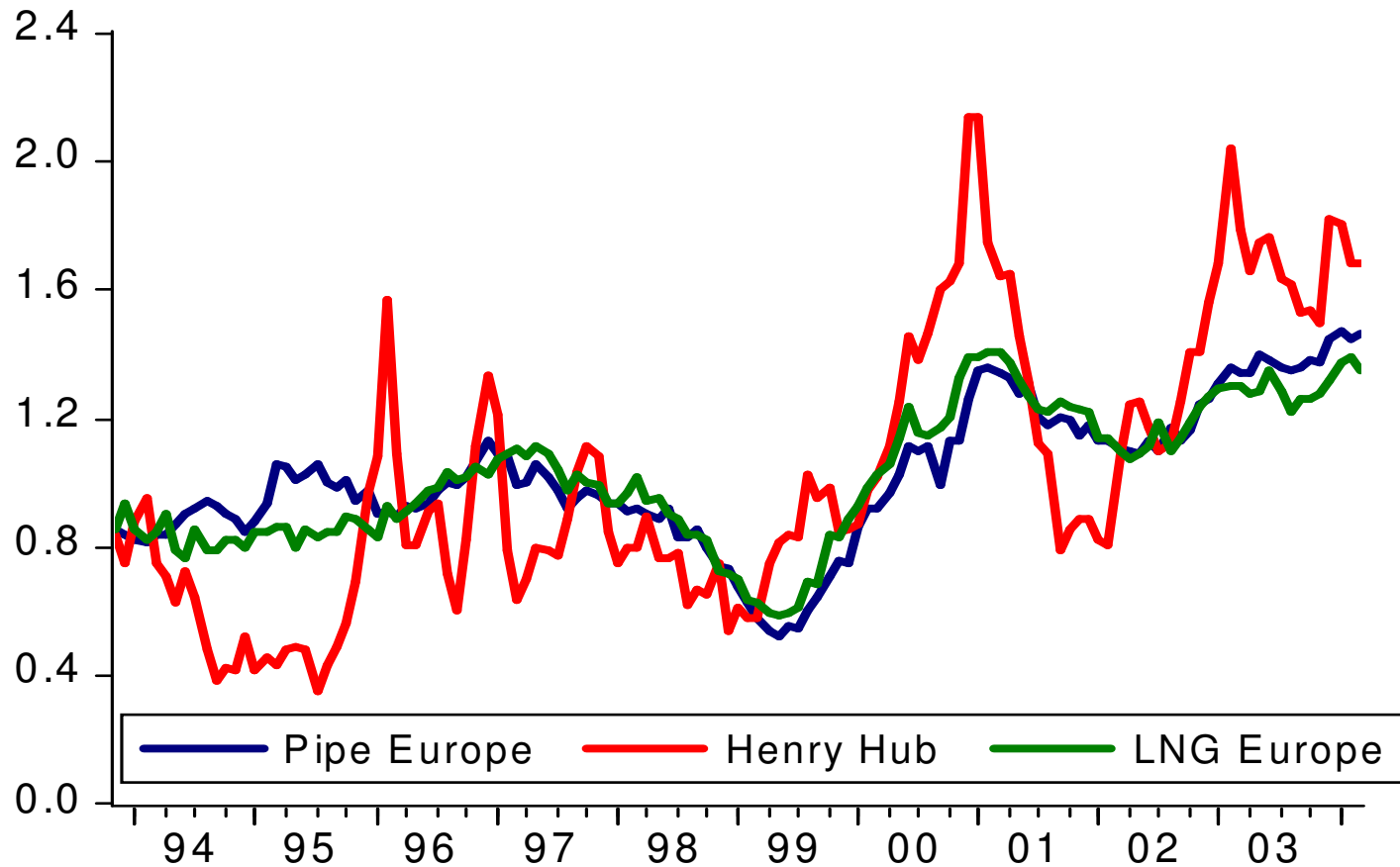
Source: IEA, 2004

Price competition on globalizing natural gas markets

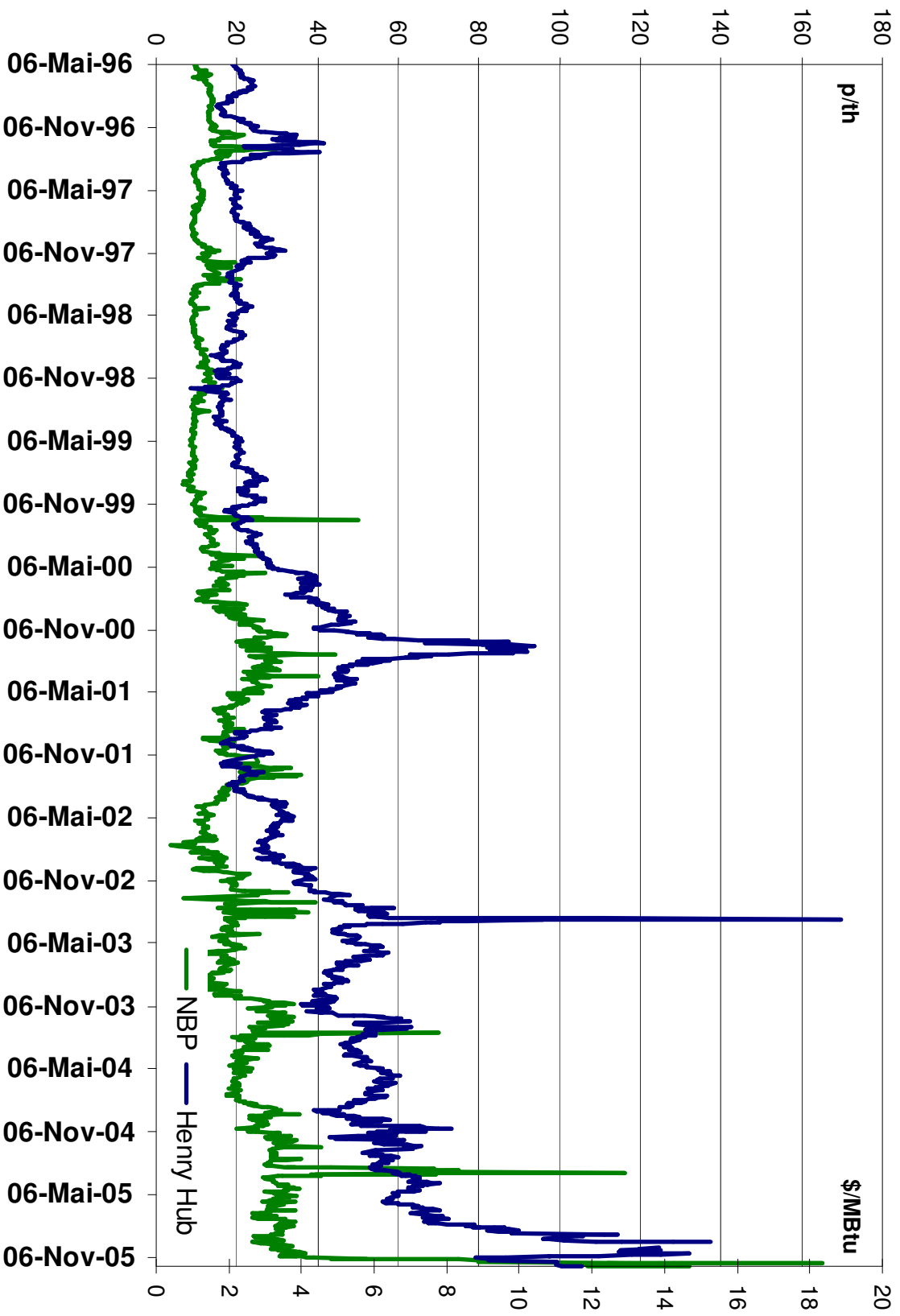


Source: IEA, 2004

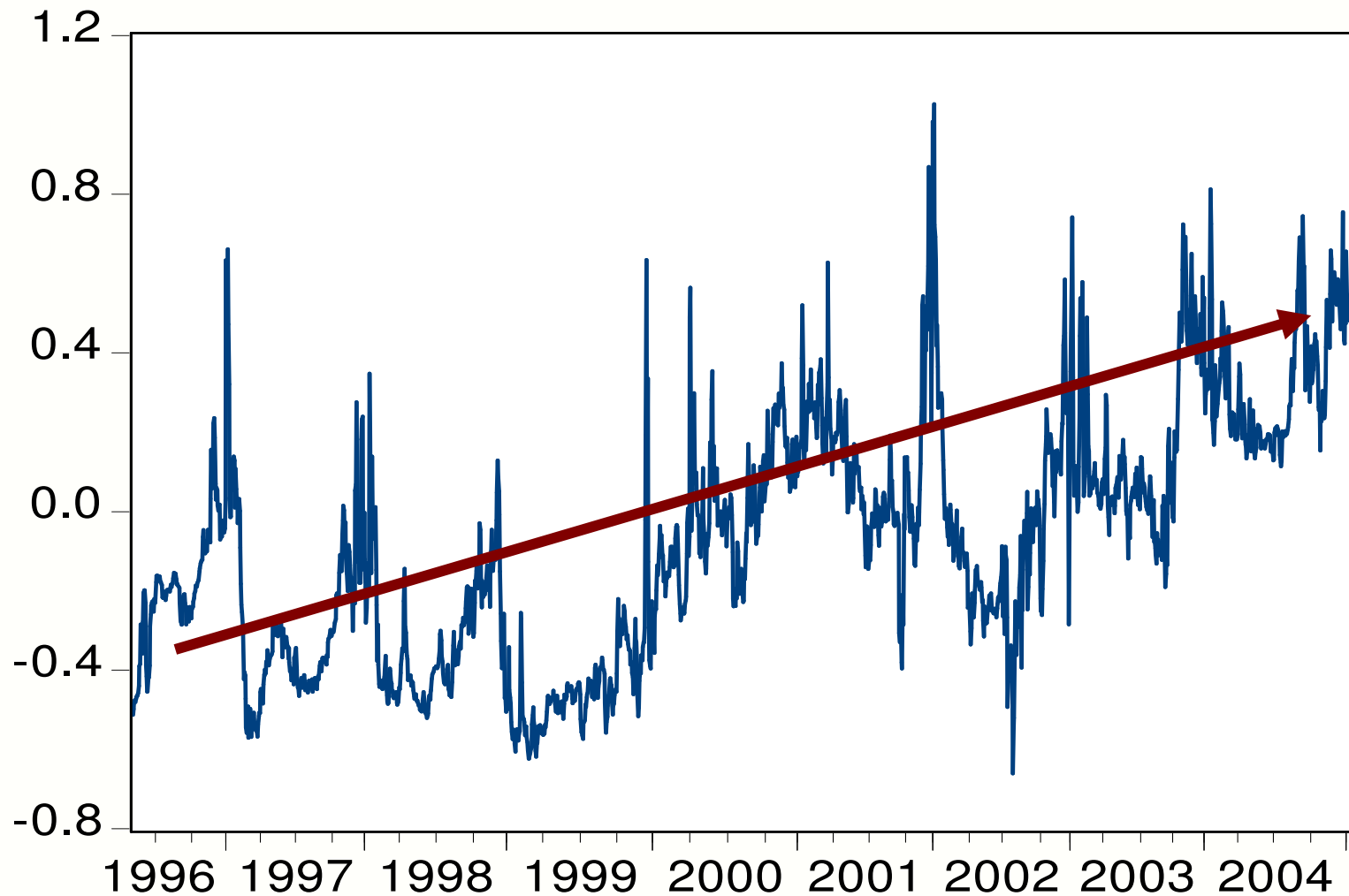
During the 1990s: No Cointegration Between European and North American Natural Gas Prices



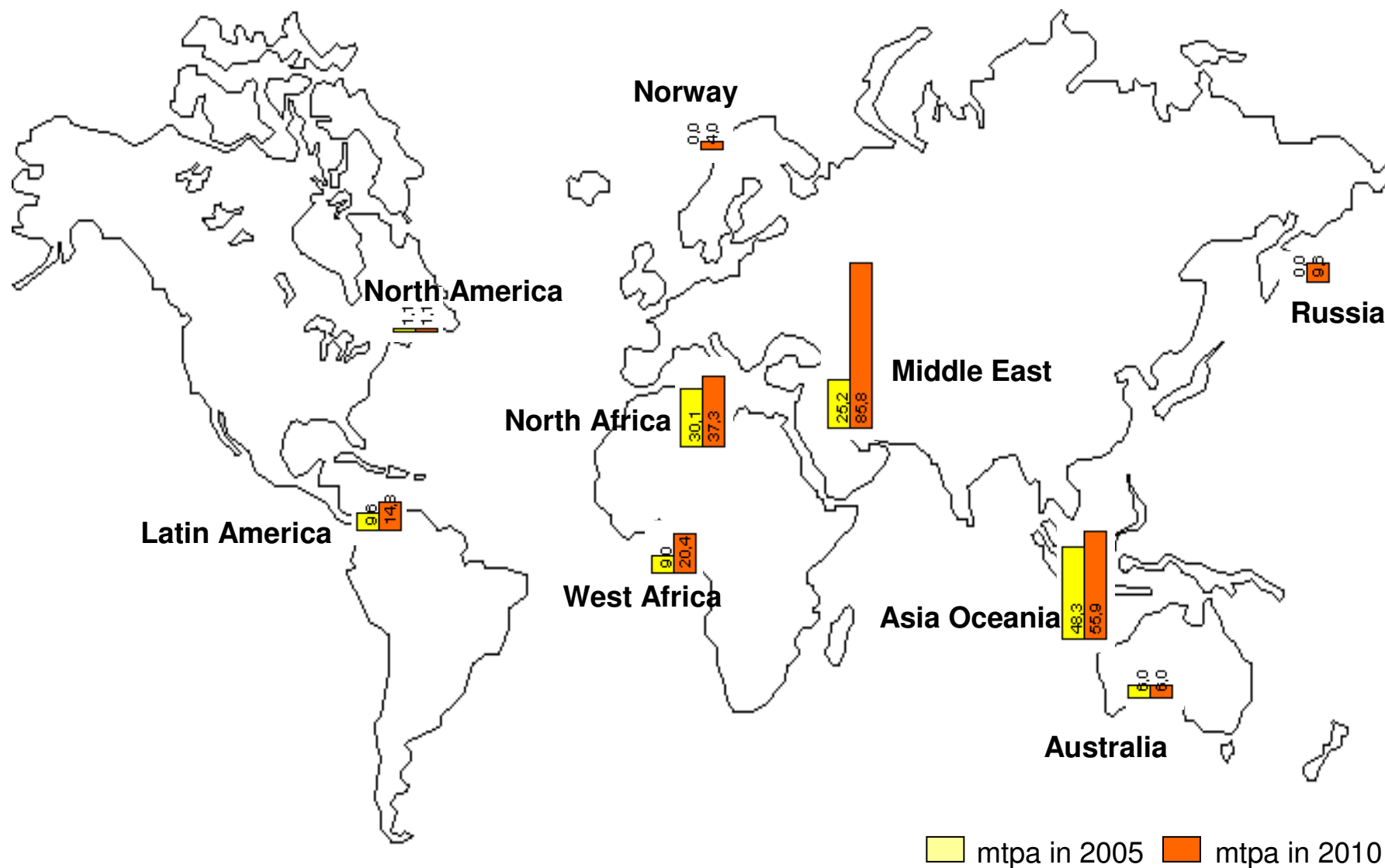
2nd Approach: Convergence of Trans-Atlantic Gas Prices?



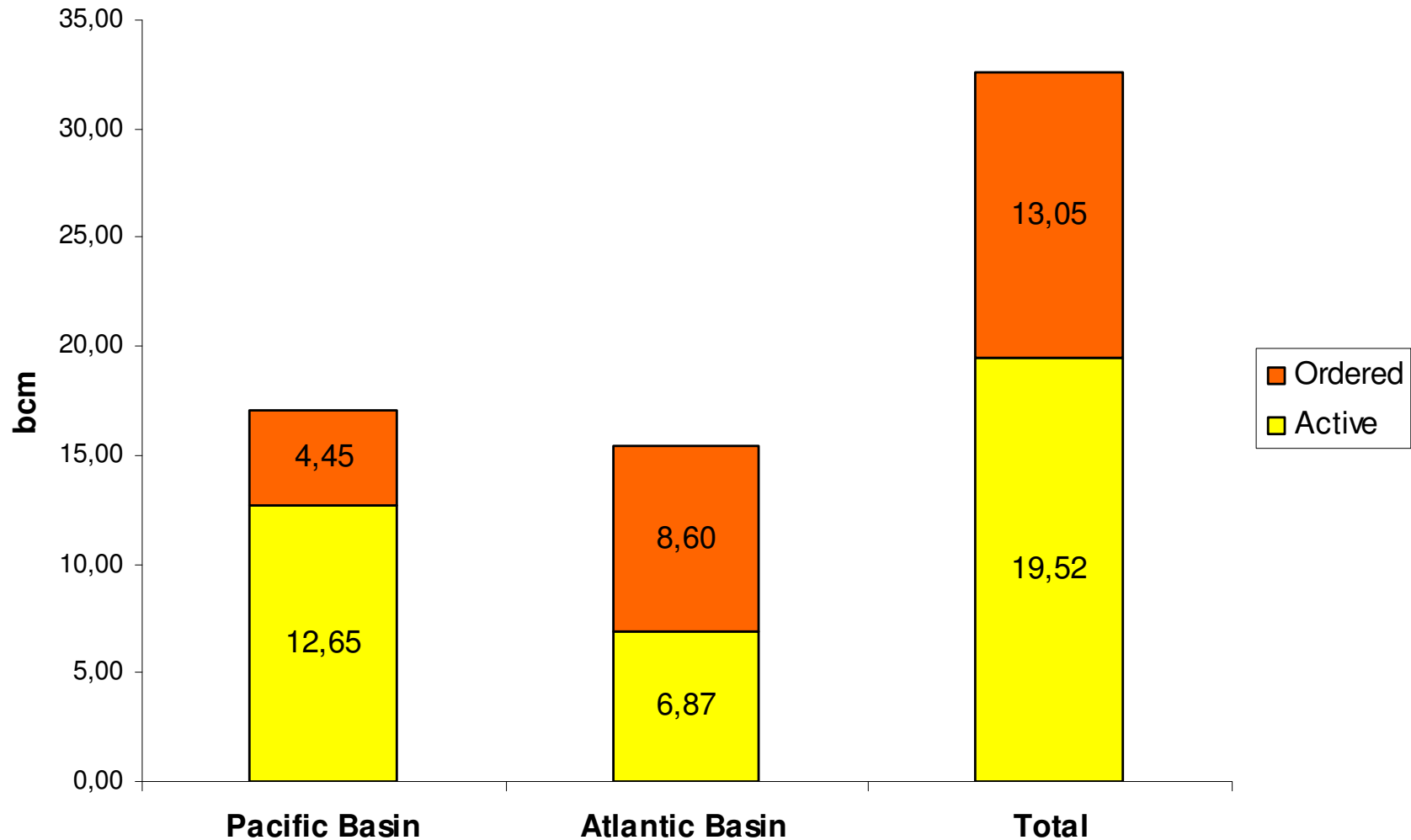
„Sign“ of Convergence of Trans-Atlantic Gas Prices: Increasing β Coefficient!



3.3 Sufficient Supply of LNG? In the Long-Run, Yes Liquefaction Capacities Worldwide (2005 vs. 2010)

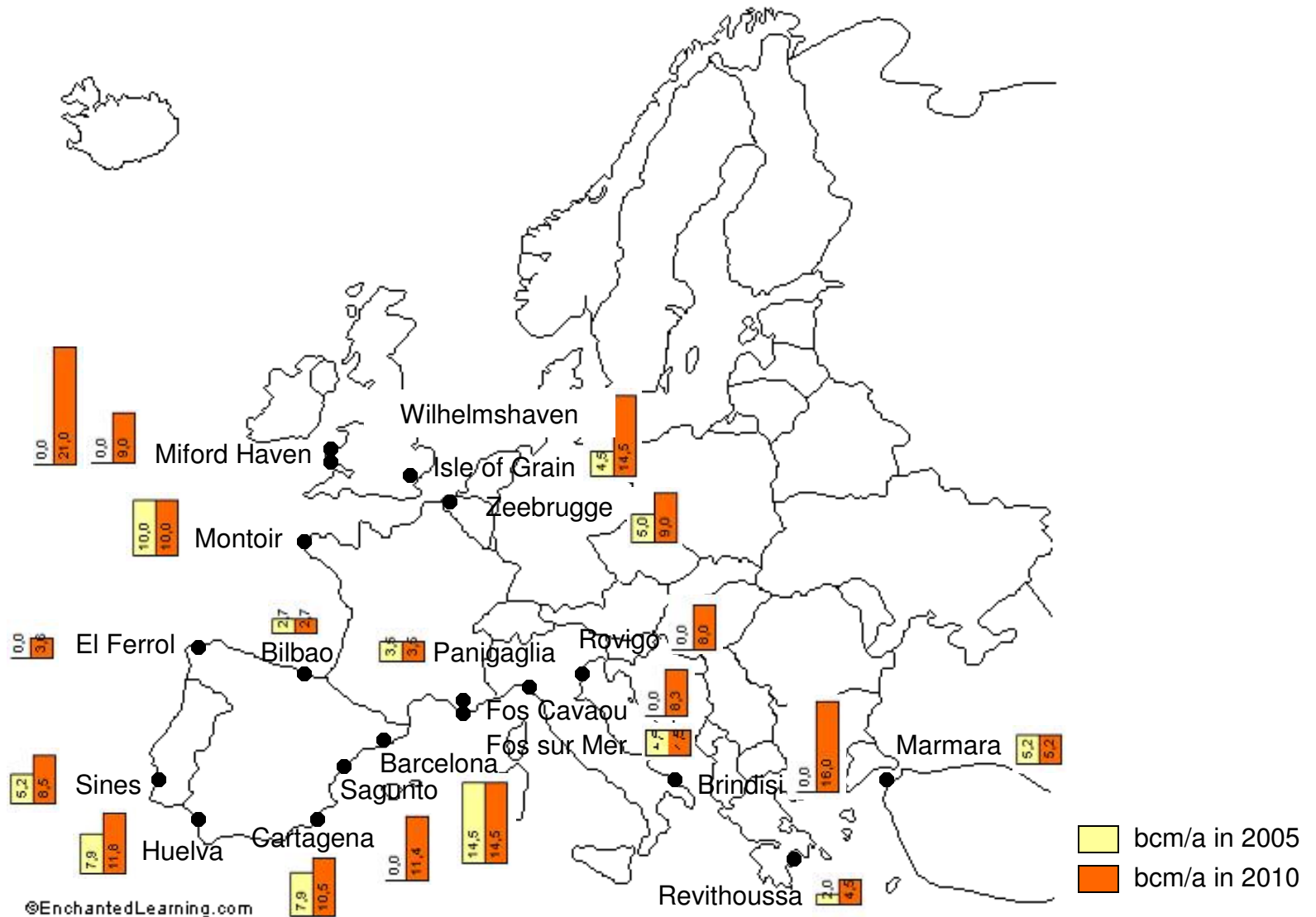


Tanker Fleet Capacities worldwide...



Source: Colton Company

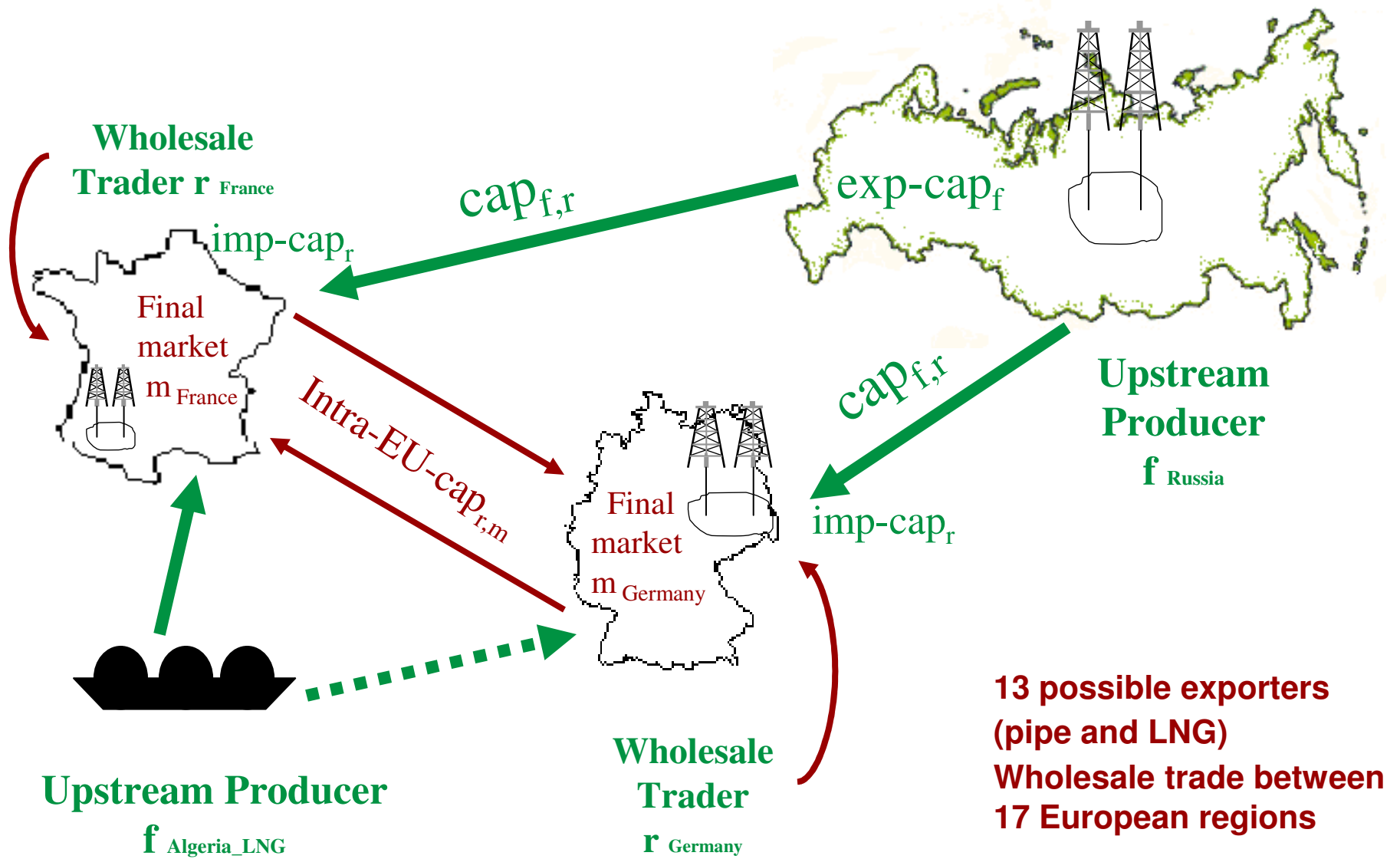
European LNG Regasification Capacities (2005 vs. 2010)



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Model Structure: 2-Levels, Strategic Gamin by Exports and Intra-European Traders



Model Specification

Exporters:

Algeria (LNG and pipe), Libya (LNG and pipe), Egypt, Iraq, Iran (LNG and pipe), Middle East (Qatar, Oman, UAE, Yemen), FSU (LNG and pipe), Norway (LNG and pipe), Netherlands, UK, Nigeria, Trinidad, Venezuela

Importers:

UK, Netherlands, Spain/Portugal, France, Italy/Switzerland, Belgium/ Luxembourg, Germany, Denmark, Sweden/Finland, Austria, Czech/Slovak Rep./Hungary, Balkan, Romania/Bulgaria, Baltic, Greece, Turkey

(Assumption of one exporter / trader and domestic producer per country)

Reference year 2003

Four 5-year steps: 2010, 2015 2020, 2025

Standard data (IEA, BP, OME, some own estimations)

Cournot oligopoly with competitive fringe (Libya, Egypt, Iran, Iraq, Nigeria, Trinidad, Venezuela) on export market

Cournot oligopoly in European markets (except in UK, Denmark, Romania/Bulgaria, Baltic, Turkey)

Price-taking behavior of domestic producers

Model Specification (2)

- Profit maximization program:

$$\text{Max.}_{x_{f,r}} \Pi(x_{f,r}) = (pe_r(X_r) - mc_{f,r}) * x_{f,r}$$

- FOC (assuming Cournot competition):

$$mc_{f,r} = pe_r(X_r) + \frac{\frac{\partial pe(X_r)}{\partial X_r}}{\frac{\partial x_{f,r}}{\partial X_r}} \cdot \frac{\frac{\partial X_r}{\partial X_r}}{\frac{\partial X_r}{\partial X_r}} \cdot \frac{pe_r(X_r)}{pe_r(X_r)} \cdot x_{f,r}$$

- Price elasticity of demand
- Cournot assumption
- Market share

$$mc_{f,r} = pe_r(x_{f,r}) * \left(1 + 1 * \frac{\theta_{f,r}}{\sigma_r} \right)$$

Oligopolistic Mark-up

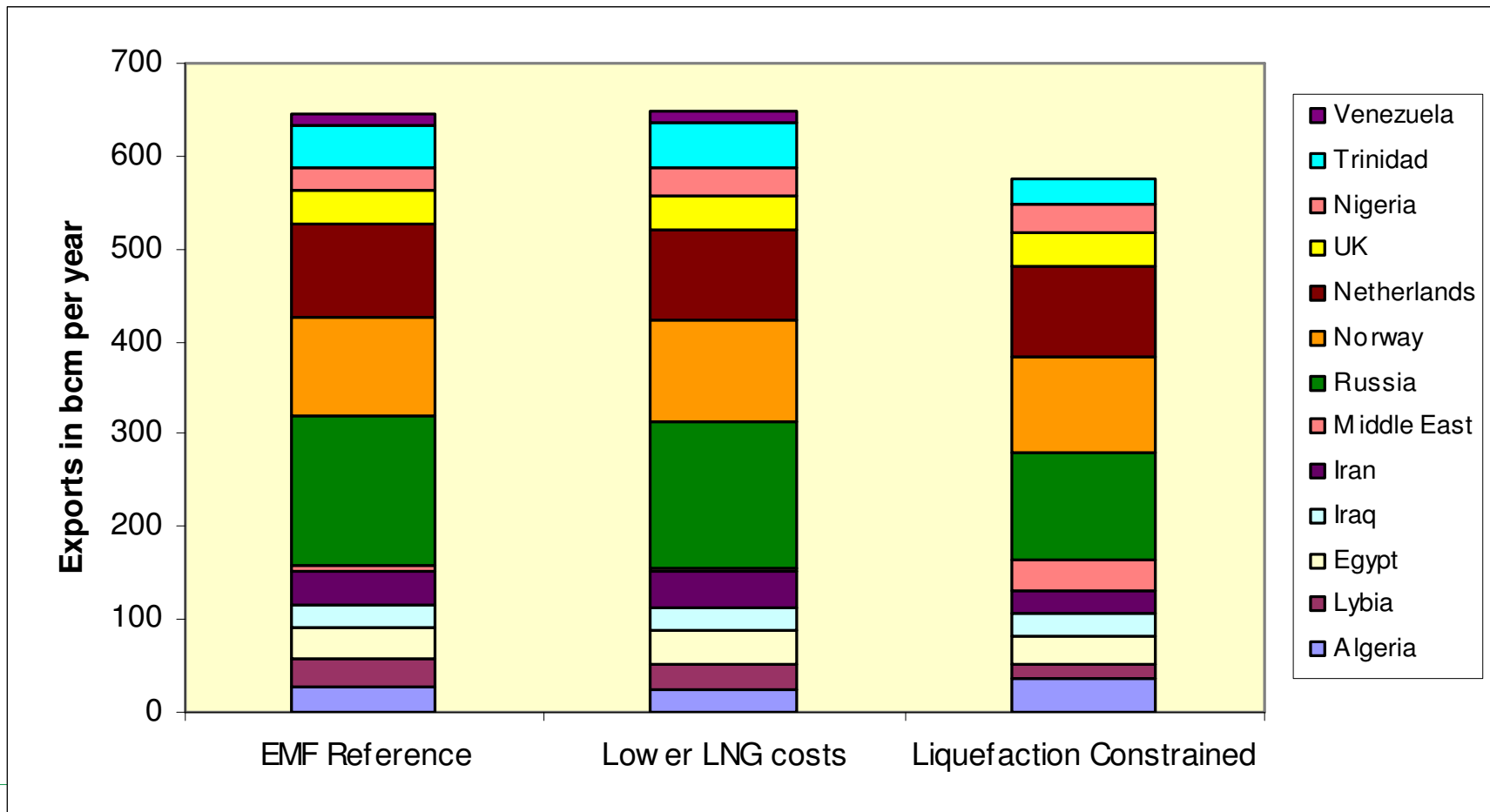
Variables:

- f exporting firm, i.e. upstream producer
- r importing firm, i.e. downstream trader (here: one firm per country)
- m final consumer market, by assumption equivalent to the importing regions
- $mc_{f,r}$ marginal production cost of the producer f (incl. transport costs to trader r)
- pe_r equilibrium import price for the trader r (border price)
- $p0_m$ reference market price on final market m
- $d0_m$ reference demand on final market m
- $\theta_{f,r}$ market share of exporter f with trader r
- σ_r price elasticity of r
- $x_{f,r}$ supply by exporter f to trader r
- $y_{r,m}$ supply by trader r to end-market m
- $domprod_r$ domestic production in European countries

Total Exports 2025

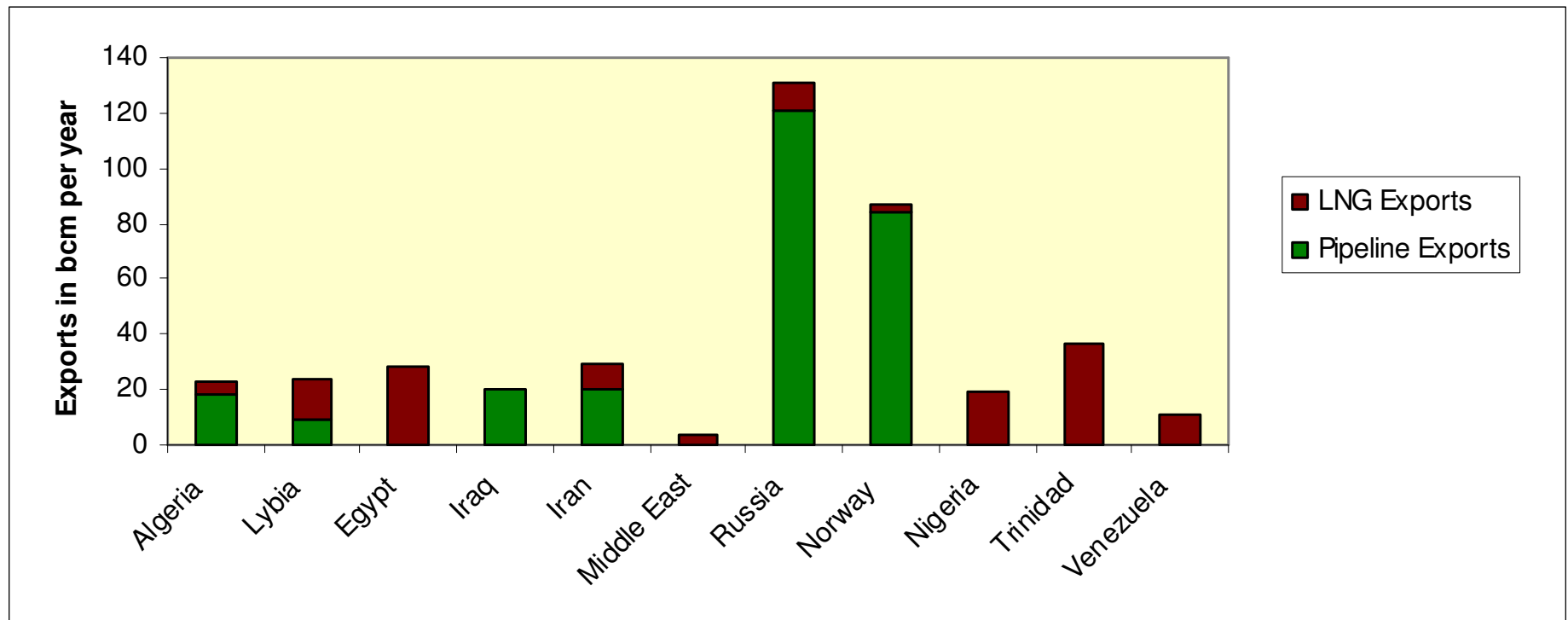
Constraint on liquefaction reduces total exports

Lower LNG costs only have slight influence



Modeling Results: LNG and Pipeline Exports to Europe in 2025

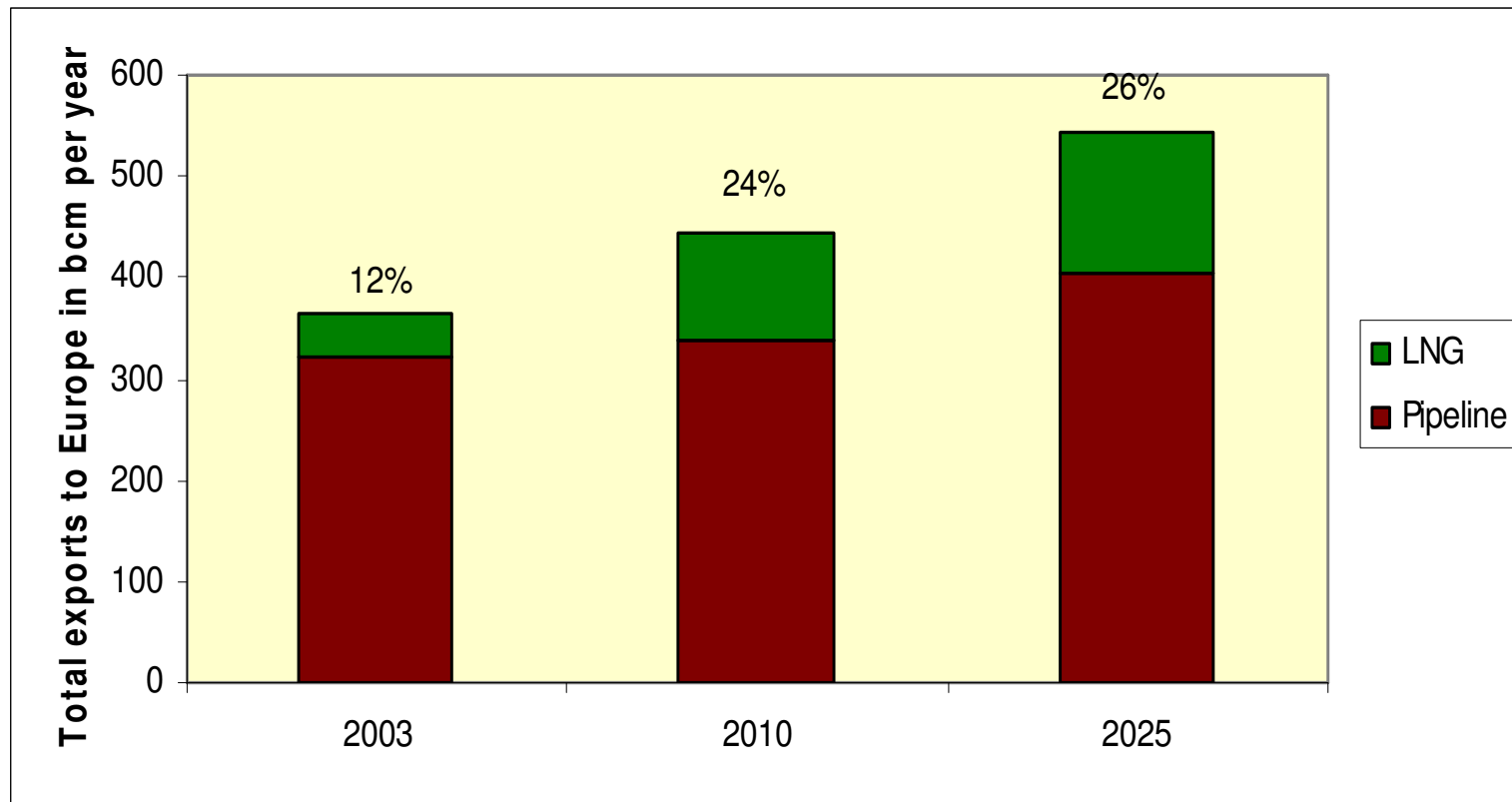
In 2025, most natural gas imports to Europe will still be covered by pipeline gas, but several new LNG suppliers are emerging



LNG and Pipeline Exports to Europe in the Next Decades

... the share of LNG is increasing over time, especially in the next decade.

LNG imports could be limited by the import (regasification) capacity in Europe (conservative modeling assumptions)



Capacity bottlenecks: in LNG import, from Norway and UK, between Fr/Sp, and Ger/NL/Bel/Fr



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Speculation about Long-run Perspectives for the UK

Until very shortly: Role model for continental Europe?

- “Real-time” assessment of the functioning of the Acceleration Directive (TPA exemption): Transco, Milford Haven, Isle of Grain investments
- Increased reliance on natural gas imports: LNG and Russia

Short-term perspective: natural gas shortage ==> high prices

- Soaring prices around the world, repercussions on global gas trade
- Suspicion of strategic capacity withholding; difficult to prove empirically

Long-run perspective: going from net exporter overcapacity to ... import overcapacity? (Stern, 2004, in brackets: additional import bcm)

- Interconnector expansion (2005), BBL 2nd Interconnector (2007): ca. 20 more bcm/a
- Ormen Lange Britpipe: ca. 20 bcm/a
- LNG terminals scheduled (Isle of Grain, 2005, Dragon LNG, 2008, Qatargas 2, 2008): ~ 35 bcm

➔ Many projects are under construction and planned to supply gas to the UK; probably far too many given likely demand (Stern, 2004, conclusion)

➔ (Flexible) LNG imports seem to be at least as strategic (for the UK) as traditional (fixed) pipeline capacities

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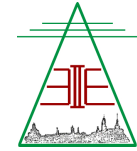
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- **Internationalization of natural gas markets is likely to lead to more diversified supply portfolios, and thus increase supply security**
- **The role of Russia as a strategic natural gas supplier to Europe is often exaggerated; Russia keeps an important position, but ...**
- **... LNG is taking off in Europe, as shown by the large regasification facilities, and, corporate strategies in LNG seem to move towards vertical integration**
- **The European natural gas markets require substantial investments in infrastructure (pipelines, LNG, distribution)**



Research Program

“Globalization of Natural Gas Markets”



- WP-GG-14 Christian von Hirschhausen: Strategies for Energy Security – A Transatlantic Comparison.
- WP-GG-13 Anne Neumann and Christian von Hirschhausen: Long-Term Contracts for Natural Gas - An Empirical Analysis.
- WP-GG-12 Karsten Neuhoff and Christian von Hirschhausen: Long-Term vs. Short-Term Contracts: A European Perspective on Natural Gas.
- WP-GG-11 Anne Neumann and Boriss Siliverstovs: Convergence of European Spot Market Prices for Natural Gas? A Real-Time Analysis of Market Integration using the Kalman Filter.
- WP-GG-10 Georg Meran and Christian von Hirschhausen: Corporate Self-Regulation vs. Ex-Ante Regulation of Network Access – A Model of the German Gas Sector.
- WP-GG-09 Franziska Holz, Christian von Hirschhausen and Claudia Kemfert: A Strategic Model of European Gas Supply (GASMOD).
- WP-GG-08 Christian von Hirschhausen, Berit Meinhart, and Ferdinand Pavel: Transporting Russian Gas to Western Europe - A Simulation Analysis.
- WP-GG-07 Anne Neumann and Christian von Hirschhausen: Less Long-Term Gas to Europe? A Quantitative Analysis of European Long-Term Gas Supply Contracts.
- WP-GG-06 Boriss Siliverstovs, Anne Neumann, Guillaume L'Hégaret, and Christian von Hirschhausen: International Market Integration for Natural Gas? A Cointegration Analysis of Prices in Europe, North America and Japan.
- WP-GG-05 Christian von Hirschhausen and Thorsten Beckers: Reform der Erdgaswirtschaft in der EU: Durch Regulierung zum Wettbewerb?
- WP-GG-04 Ferdinand Pavel, Boris Dodonov and Igor Poltavets: Is the Ukrainian-Russian Gas Consortium in the Economic Interest of Ukraine? Lessons from a European Gas Model.
- WP-GG-03 Christian von Hirschhausen and Anne Neumann: Liberalisierung der europäischen Gaswirtschaft - Neue Regulierungsbehörde soll mehr Wettbewerb schaffen.
- WP-GG-02 Anne Neumann: Security of (Gas) Supply: Conceptual Issues, Contractual Arrangements, and the Current EU Situation
- WP-GG-01 The Globalization of Natural Gas Markets - A Research Agenda.

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