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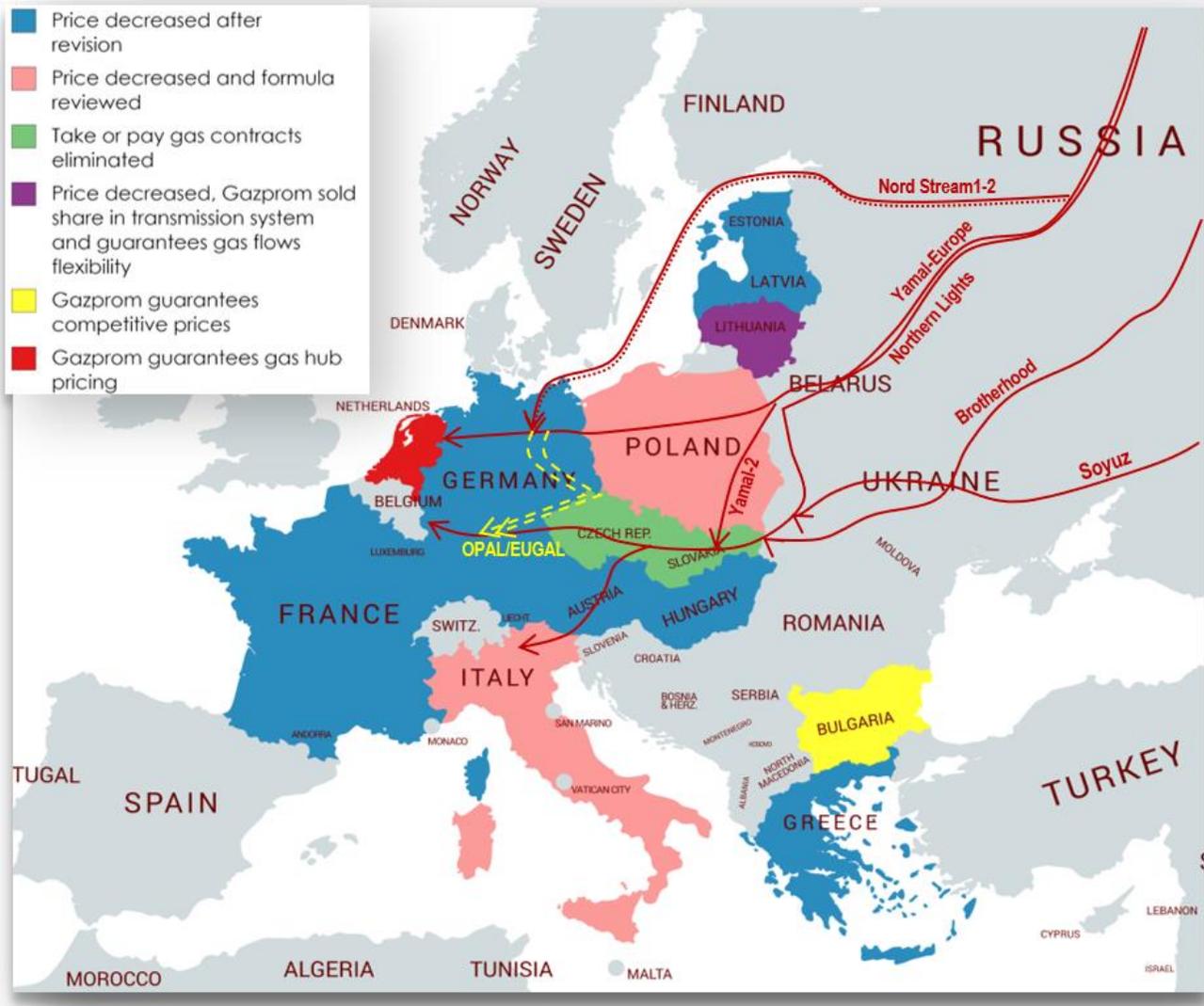
EXPLORING RUSSIAN GAS PRICES TO EUROPE: EMPIRICAL EVIDENCE OF PRICE CONVERGENCE FROM TIME SERIES ANALYSIS

Amina Talipova

Ph.D., Higher School of Economics

Motivation

- Oil and gas are two main export sources for Russia;
- Europe accounts for 90% of gas export;
- Gazprom has exclusive rights to export pipeline gas and the last decade passed under pressure on the company in accusations of competition law violation. It costed company >\$4 bln so far.



Problem Statement

Given the available data in the European gas market, can we prove or refute that after all disputes, Gazprom's prices in Europe are fair and reflect supply-demand motion, as the company states, rather than fuel competition component.

Lower triangle matrix of price pairs to test convergence

$j \rightarrow$	1	2	3	4	5	6	7	8	9
$i \downarrow$	NCG	GPL	TTF	NS	Czech	Latvia	HH	LNG Spain Spot	Brent spot
1	NCG	-							
2	GPL								
3	TTF		-						
4	NS	a_{41}	a_{42}	a_{43}					
5	Czech	a_{51}							
6	Latvia	a_{61}							
7	HH	a_{71}	a_{72}	a_{73}					
8	LNG Spain Spot			a_{83}	a_{84}		a_{87}		
9	Brent spot	a_{91}	a_{92}	a_{93}	a_{94}				

Model specification

Parameter	Other researchers	My specification
Data transformation	Logarithms, first differences, derivatives	Monthly growth expressed as the ratio $p_{it} = \frac{Y_{jt}}{Y_{jt-1}}$
Model	One output for each pair (convergence, non-convergence)	Time dependent convergence function to demonstrate dynamic over time by using time window
Logic function	Zero or one logic function to normalize outputs	Fuzzy-logic function to avoid first and second order errors taking the level of significance

Model specification

Classic

1. Analyzed time series $\longrightarrow p_{i,t} = \frac{Y_{i,t}}{Y_{i,t-1}} = \alpha_i + \beta_{i,t} + \varepsilon_{i,t}$ Where Y are not transformed series

α_i fixed component $\beta_{i,t}$ trend $\varepsilon_{i,t}$ error

2. General definition $\longrightarrow \lim_{k \rightarrow \infty} E(p_{i,t_0+k} - p_{j,t_0+k}) \mid I_{t_0} = \lim_{k \rightarrow \infty} E(p_{i,t_0+k} - p_{j,t_0+k}) \mid I_{t_0+k} = 0$ Where k = one month

Pairwise

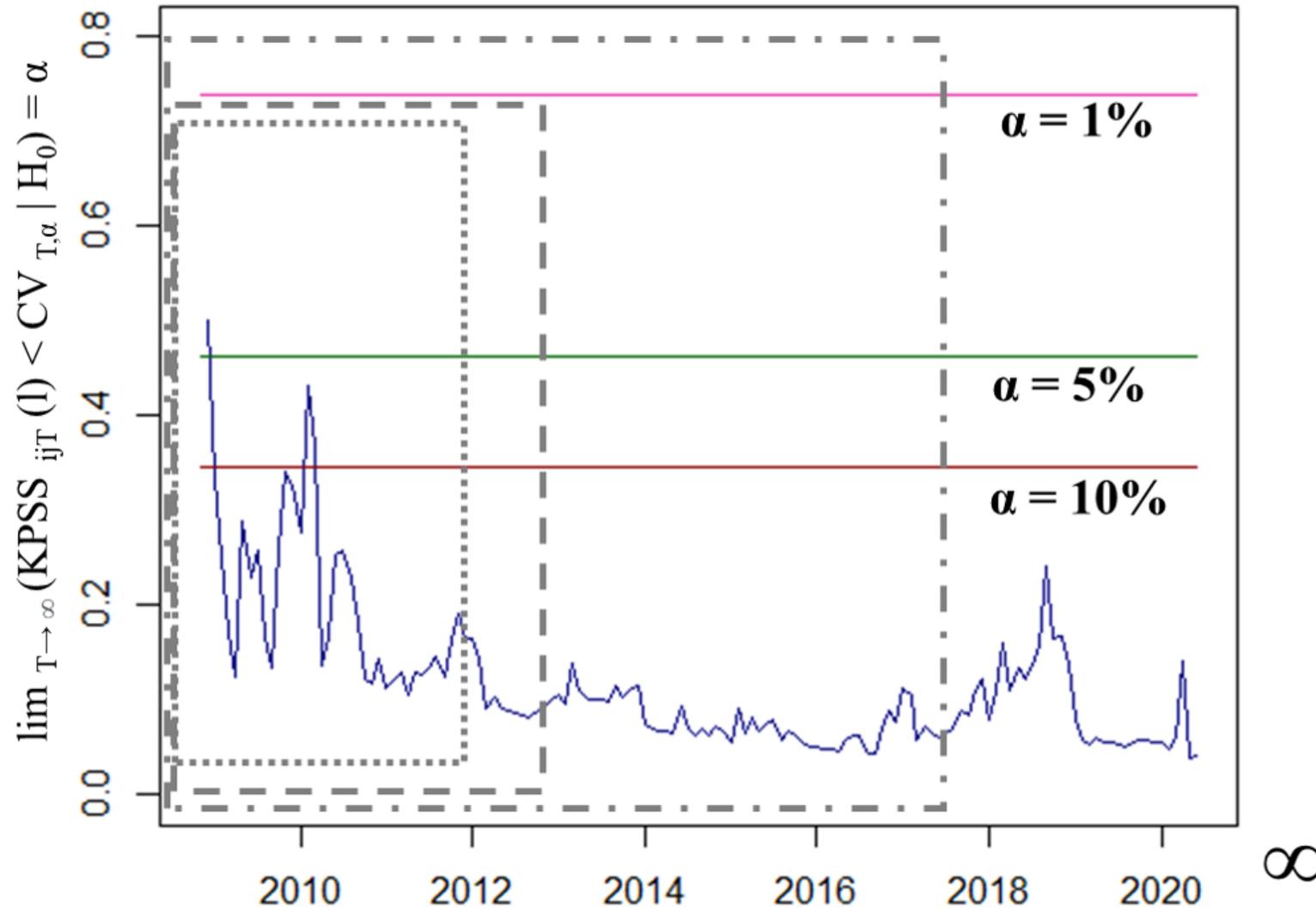
3. Conditional probability pairwise definition $\longrightarrow \lim_{k \rightarrow \infty} E(p_{i,t_0+k} - p_{j,t_0+k}) \mid I_{t_0} = \lim_{k \rightarrow \infty} E(p_{i,t_0+k} - p_{j,t_0+k}) \mid I_{t_0+k} = C$

4. Finally tested condition $\longrightarrow \lim_{T \rightarrow \infty} Pr(UR_{i,j,T} < CV_{T,\alpha} \mid H_0) = \alpha$

for $t = 1, \dots, T$ where UR – the H_0 of pair wise convergence derived from results KPSS tests and its critical value of size α as

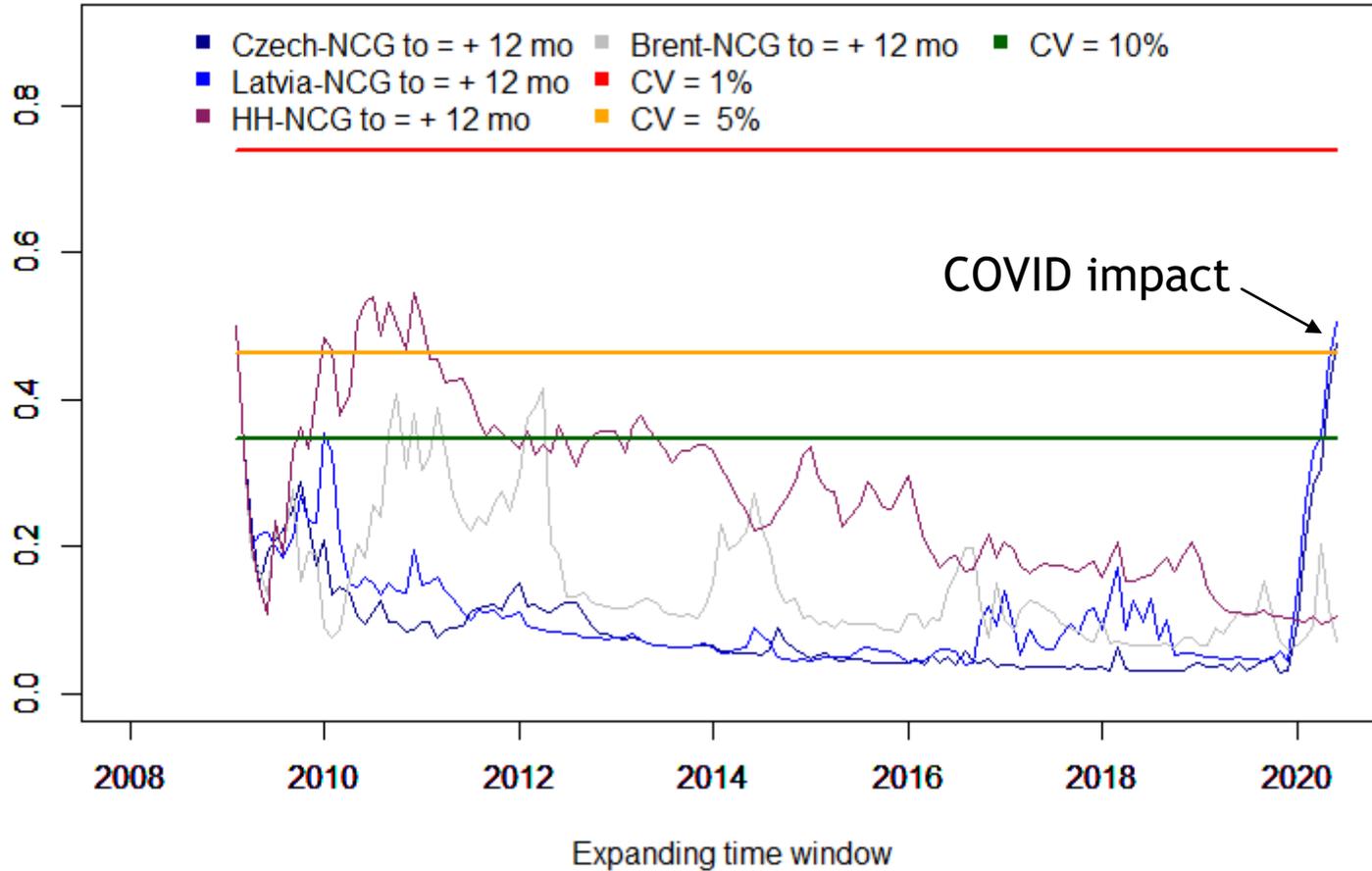
Model specification

For some arbitrary t_0 l_1 l_2 $l_N = i$, where $i = 1, (N-t_0)$



Results

NCG with Czech, Latvia, HH and Brent to = + 12 mo



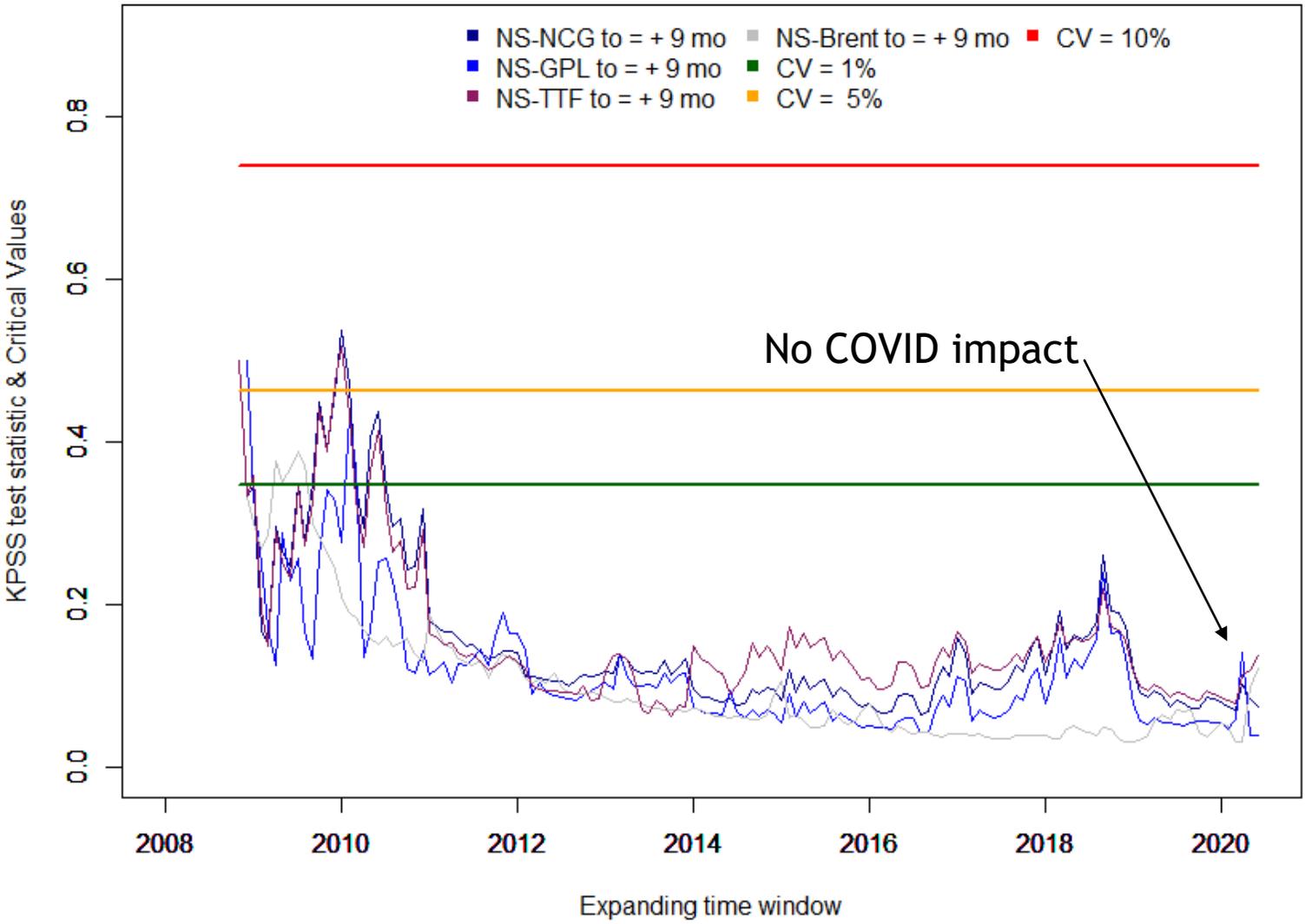
Overall, for all pairs, strict divergence is observed from 2008 to 2014 years.

“Non divergence” is accepted for both Czech and Latvia EU member countries.

“Non divergence” with Brent remains stable.

Results

Nord Stream with NCG, GPL, TTF and Brent for to= + 9 mo



9 months lag shows more convergence and Gazprom indeed uses Brent benchmark for gas pricing.

Non divergence during COVID.

Gazprom uses less power in Central Europe than in Eastern Europe.

Conclusion and future work

1. A strong "non-divergence" is observed between Gazprom and Brent crude oil price with a stable 9 months lag which points out on future potential price revisions or, in a worst scenario, on new antitrust lawsuits. Therefore, it is critical for Russia to review its gas export strategy.
2. This method potentially can be employed for fraud detection by forming this convergence function without human intelligent for energy security purposes.

Thank you for attention!
Happy to answer your questions 😊

Any suggestions are more than welcome:
atalipova@hse.ru
amina.talipova@gmail.com