

Effect of Geopolitical Risk On US Gas Market: with Structural Break Analysis

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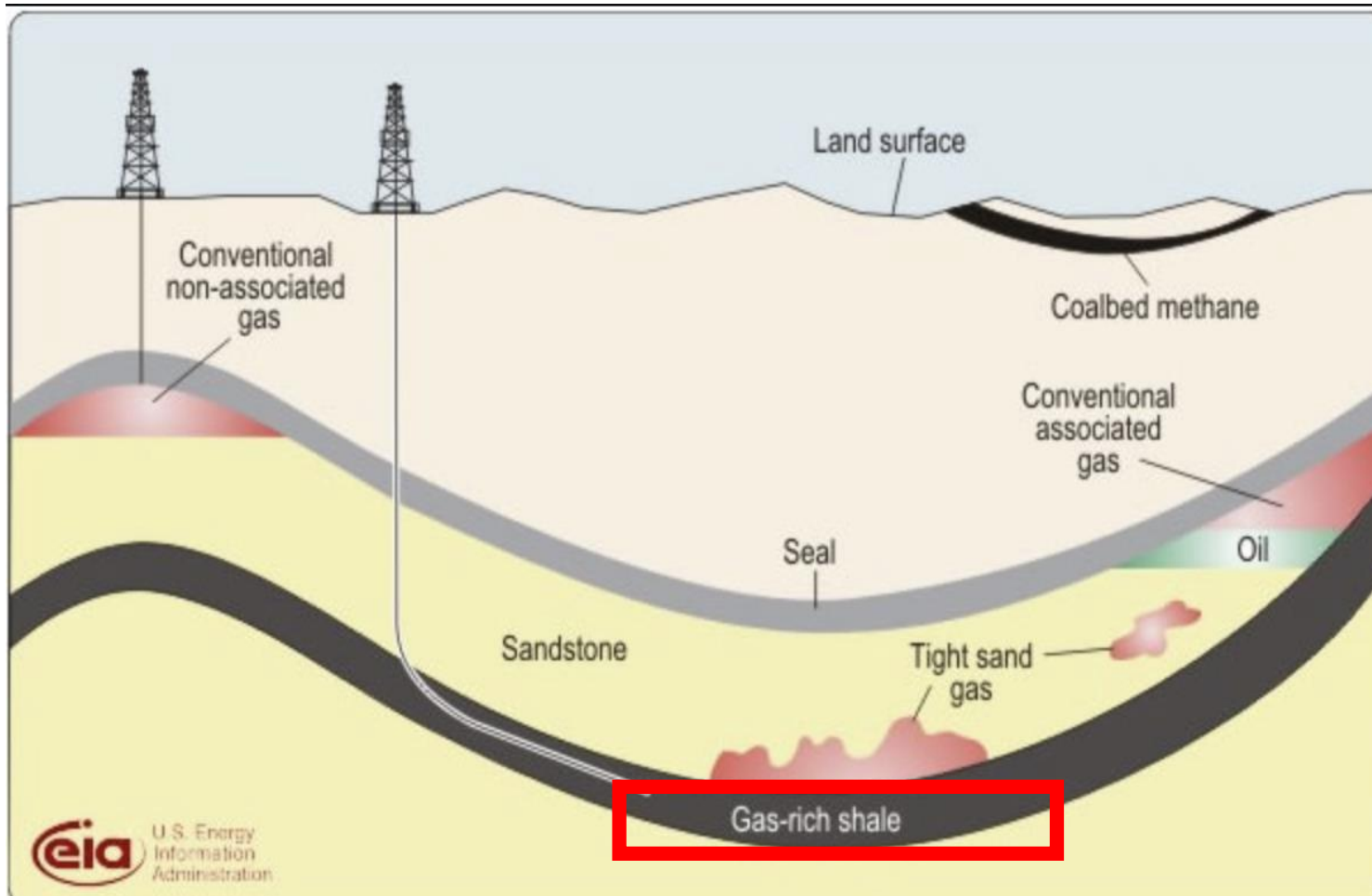
1. Motivation & Research Question

Motivation

- ✓ To escape from energy supply difficulties due to exporter's geopolitical risk, Development of **unconventional drilling** to get natural gas is important .
- ✓ With Shale Gas Revolution, US changed its position from **net importer** to **exporter** of natural gas.
- ✓ In this context, we thought there can be a **structural break** in US gas market and the effect of geopolitical risk changed.

1. Motivation & Research Question

(1) Shale gas revolution

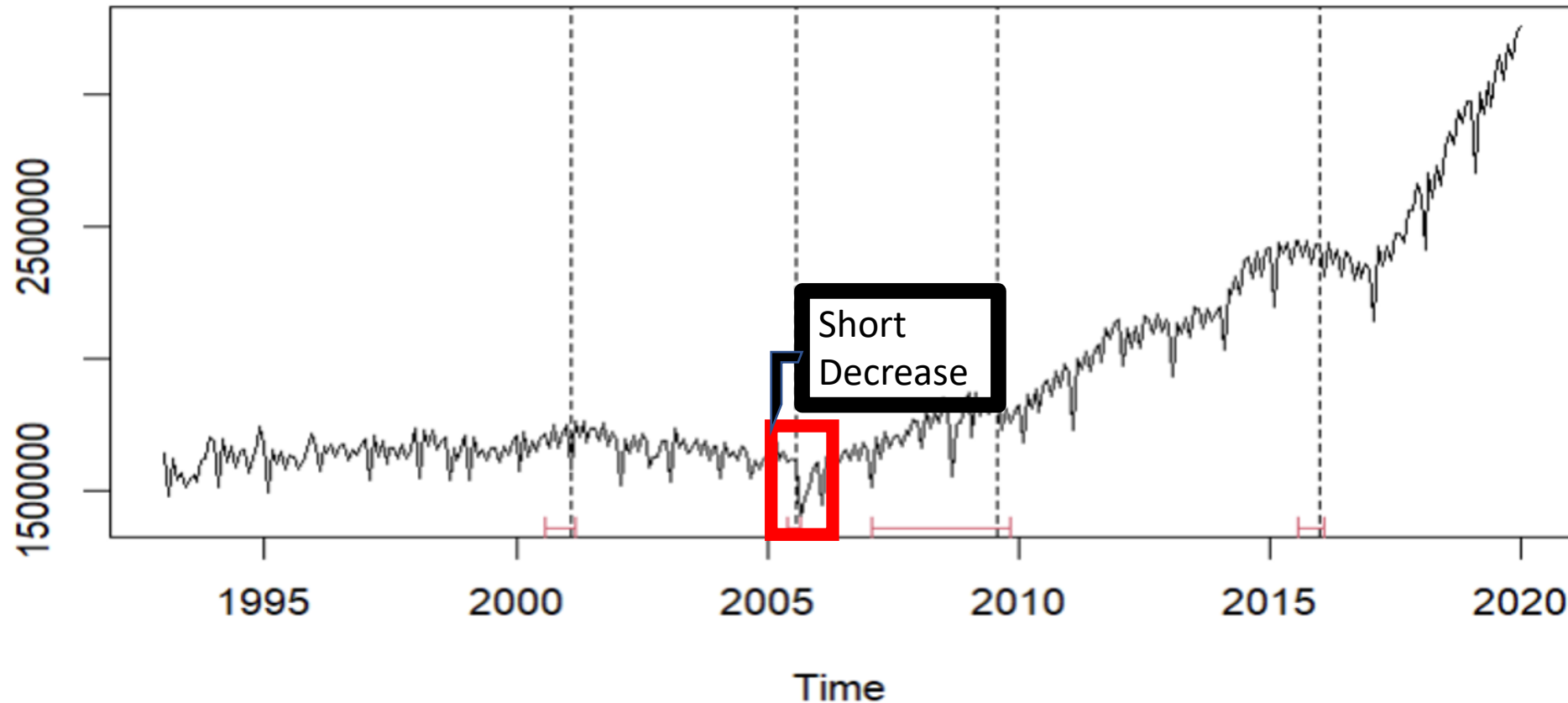


- ✓ Shale gas refers to natural gas that is trapped within shale formations.
- ✓ In the middle of 2000s, Over the past decade, the combination of **horizontal drilling** has allowed access to large volumes of shale gas .
- ✓ US increased **domestic natural gas production** after shale gas revolution.

1. Motivation & Research Question

(2) US Natural gas Production

Time series plot for Natural gas production



1. Motivation & Research Question

- **Research Question**

- Did Shale Gas Revolution trigger **structural break** on US gas market?
- Was there a **decrease** of non-US geopolitical risk's impact on US gas market?

2. Literature Review

- **The US shale gas revolution and its effects on international gas market (Kentaka Aruga, 2016)**
 - found disappearance of market linkage btw US, Europe and Asia gas market after 2006
- **Limitation:** Data period only to 2012.10, Missing to tract the effect of US domestic gas market.

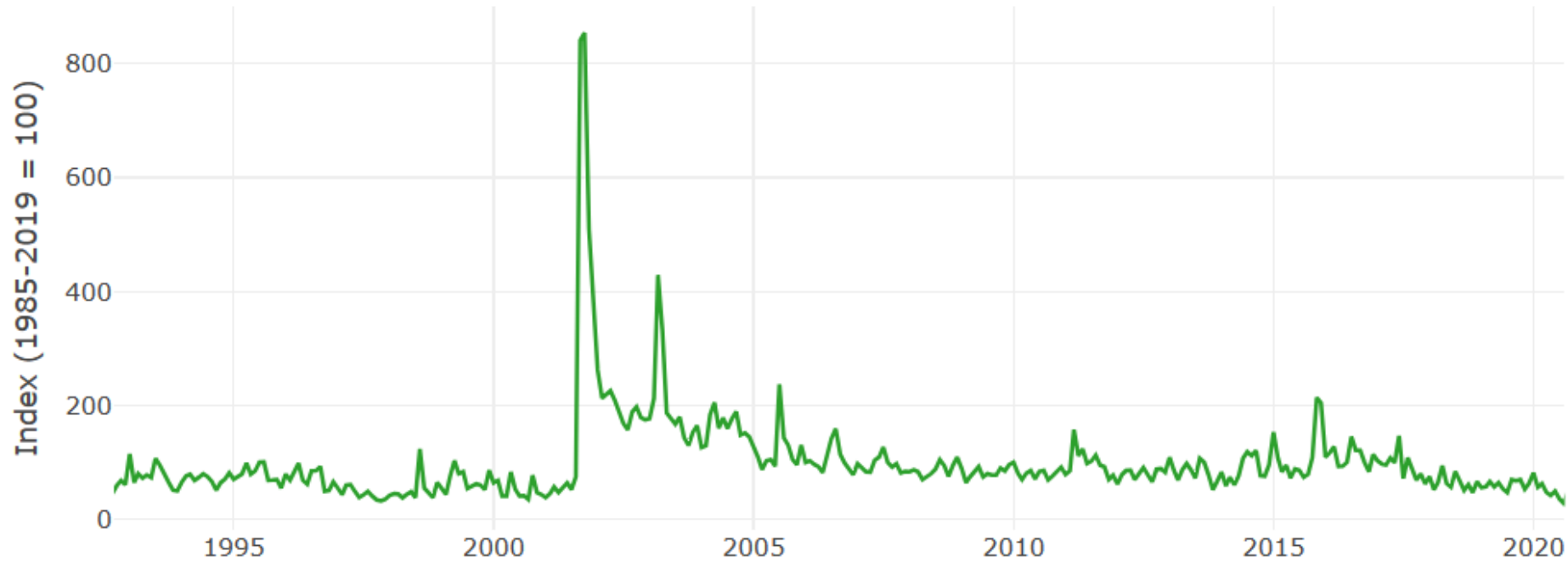
3. Data

- **GPR index (Geopolitical Risk Index by D. Caldara)**
 - ✓ Observe the frequency of articles that include geopolitical tensions and make it as index
 - ✓ We used **GPRA (Geopolitical Risk Action Index)**. GPRA only indexed geopolitical risk about beginning of war, escalation of war, terrorist acts.
 - ✓ GPRA was thought to be the best index to reflect **external US geopolitical risk**.

3. Data

- **GPR index (Geopolitical Risk Index by D. Caldara)**

GPRA Index



3. Data

- **GAS Price**
 - US Henry Hub Spot Price
 - Europe TTF Spot Price
 - Japan and Korea Gas Spot Price (JKM)

→ Deflated by US CPI for real gas price
- **Sample Period**: Jan 1993 ~ Jan 2020

3. Data

Summary Statistics

	Mean	SD	Median
Real US gas price	1.98	1.07	1.59
Real Japan gas price	3.71	1.8	3.04
Real Europe gas price	2.84	1.43	2.26
GPRA	100.3	80.02	83.56

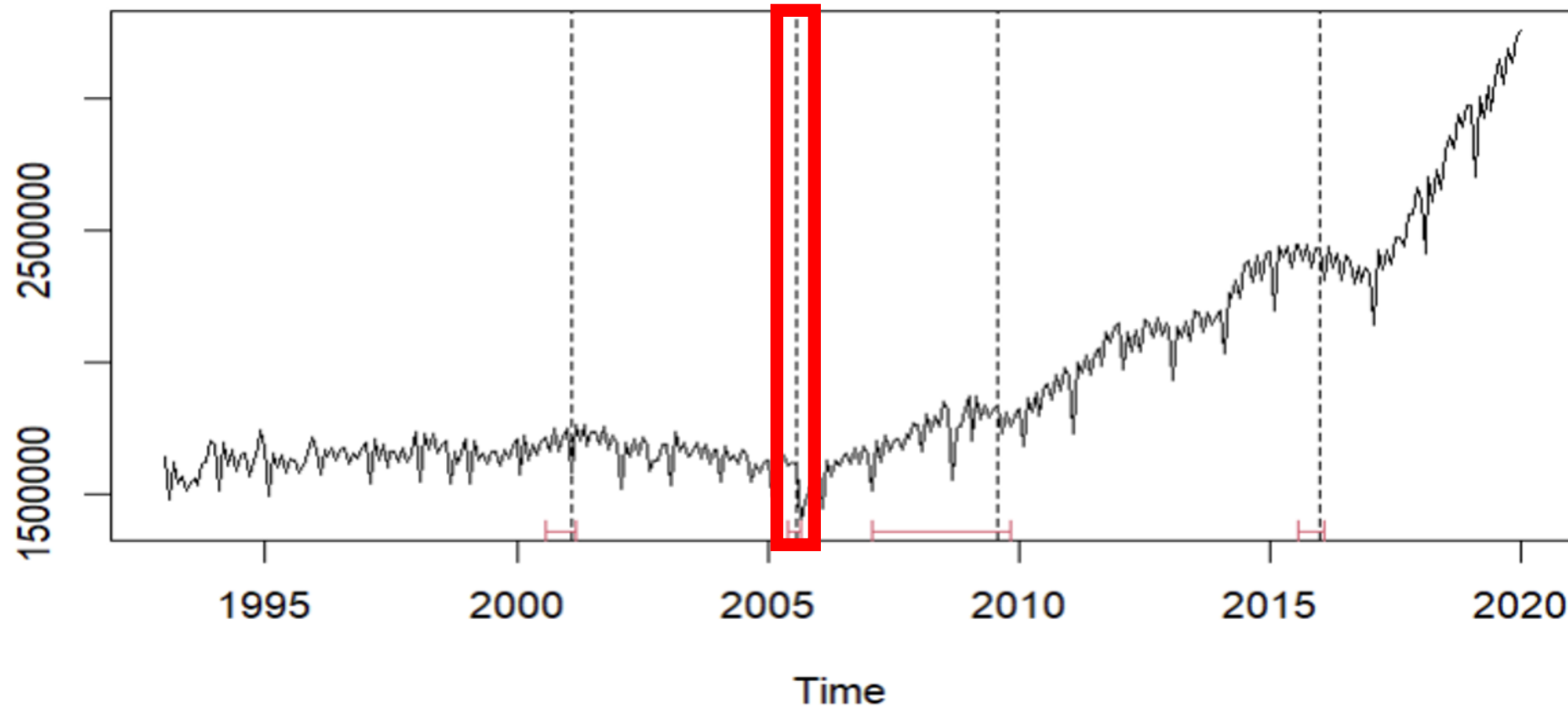
4. Methodology

1. Structural break test – Bai Perron Test
2. Cointegration test among US, Europe and Japan gas market
3. Compare regression results of GPR to US gas market before and after the break

5. Empirical Results

(1) Bai- Perron Test

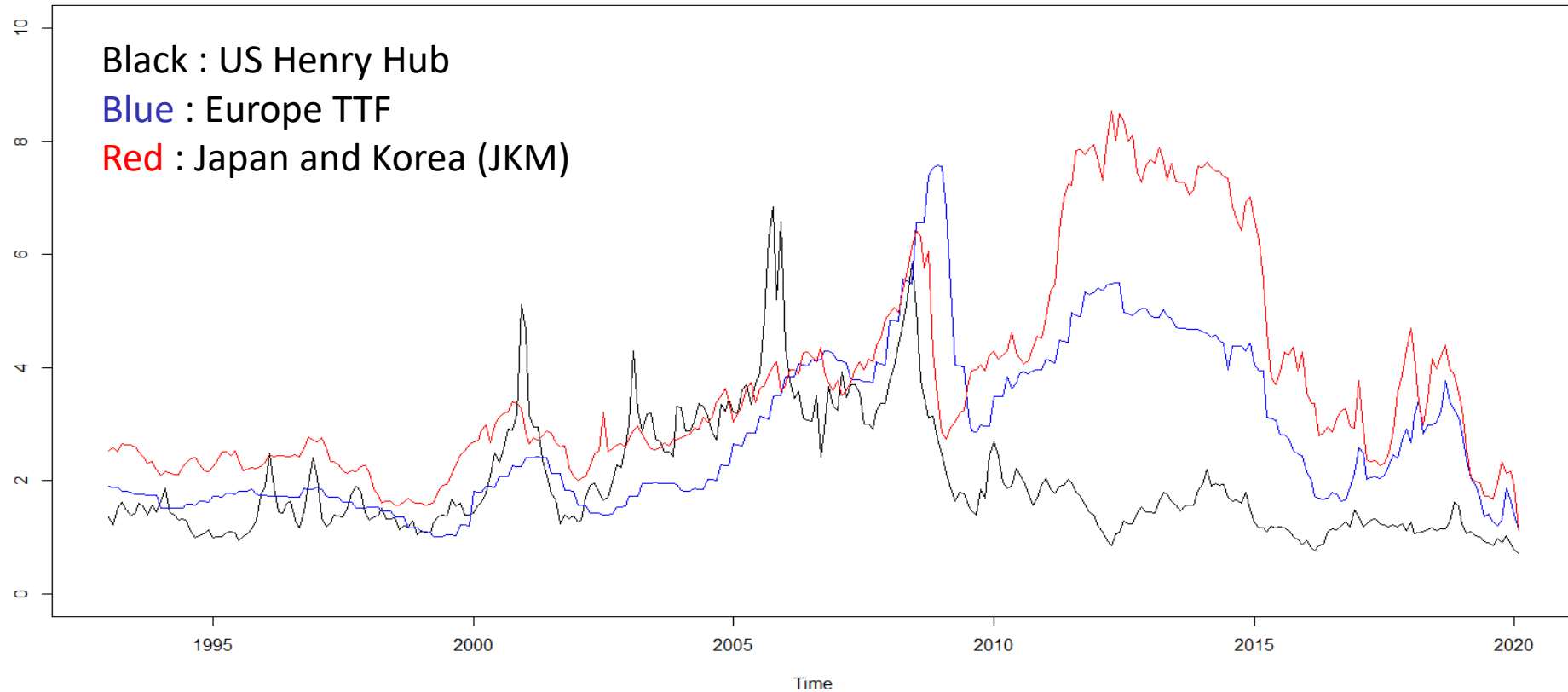
Time series plot for Natural gas production
Structural break point:2006.08



5. Empirical Results

(2) Gas Market Cointegration Test

Time series plot for Gas Prices



5. Empirical Results

(2) Gas Market Cointegration Test

variable	Trace test	Max test
1993.1~2006.8	H0: No Cointegration	
US vs Japan	18.53**	18.53**
US vs Europe	30.47***	28.58***
2006.8~2020.1	H0: No Cointegration	
US vs Japan	6.49	4.43
US vs Europe	14.77	10.60

- **Disappearance of cointegration**

- Before 2006.08

- **All pairs** of Countries has cointegration relationship

- After 2006.08

- **None of the pairs** of Countries has cointegration

- Market linkage between Asia and US and Europe market was **weakened**.

5. Empirical Results

(3) Regression on US Gas Market

Regression Model

$$Gas_{t+1} = \beta_0 + Dummy + \beta_1 GPRA_t * Dummy + \beta_2 IND_t + \beta_3 GASP_t + \beta_4 UNRATE_t + \beta_5 HOUST_t + \epsilon_t$$

GAS : $\log(\text{Real US Gas Price})$

Dummy : 2001.09 ~ 2002.08

IND : $\Delta \log(\text{Industrial Production Index})$

GPRA : $\log(GPRA)$

GASP : $\Delta \log(\text{US Marketed Gas Production})$

UNRATE : $\Delta \text{Unemployment Rate}$

HOUST : $\log(\text{Housing Starts})$

5. Empirical Results

(3) Regression on US Gas Market

Results : Statistical significance of GPRA disappeared in subsample 2

US Henry Hub	Subsample 1	Subsample 2
GPRA	0.1473* (1.874)	0.0725 (0.513)

Subsample 1 : Jan 1993 ~ Jul 2006

Subsample 2 : Aug 2006 ~ Jan 2020

5. Empirical Results

(4) Regression on Other Gas Markets

Regression Model

$$Gas_{t+1} = \beta_0 + \beta_1 GPR_t + \beta_2 IND_t + \beta_3 GASP_t + \beta_4 UNRATE_t + \beta_5 HOUST_t + \epsilon_t$$

GAS : $\log(\text{Real Gas price})$

IND : $\Delta \log(\text{Industrial Production Index})$

GPR : $\log(\text{GPR})$

GASP : $\Delta \log(\text{US Marketed Gas Production})$

UNRATE : $\Delta \text{Unemployment Rate}$

HOUST : $\Delta \log(\text{Housing Starts})$

5. Empirical Results

(4) Regression on Other Gas Markets

Results : Statistical significance of GPR still exists

JKM	Subsample 1	Subsample 2
GPR	0.0818** (2.109)	0.5345** (-2.851)
Europe TTF	Subsample 1	Subsample 2
GPR	0.1375** (2.215)	-0.3459** (-2.018)

Conclusion

1. **Breakpoint still exists** although we extended the sample period compared to Aruga(2016)
2. Cointegration between US, Europe and Japanese gas market **disappeared** after 2006.08
3. Statistical significance of geopolitical risk on US gas price **disappeared** after 2006.08

Reference

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- Caldara, Dario, and Matteo Iacoviello. "Measuring geopolitical risk." *American Economic Review* 112.4 (2022): 1194-1225.

Thank you!