# Trade sanctions & international spatial integration:

# What is the impact of sanctioning Iran?

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## INTRODUCTION

- **Politically-motivated trade sanctions** usually generate fierce discussions
  - sanctions are decided by a small group of nations to restrict a country's access to international trade
  - they hardly turn into complete trade blockades (i.e., an embargo)

- What are the sanctions?
  - a series of measures aimed at **raising the export cost for the targeted country**

- What impacts?
  - For the coerced country (e.g., macroeconomic impacts…)
  - For other countries ?
    - If the coerced country is a large exporter,

**Do the sanctions affect the degree of spatial price integration among importing nations?**

## INTRODUCTION

- How can the coerced country react to the sanctions?

  - Organize a trade deflection toward non-sanctioning countries (Haidar, 2017)

  - Engage in smuggling activities

# 1: BACKGROUND

## BACKGROUND


Source: U.T. Austin

- **Iran**
  - A ressource-rich nation…
  - … that faces a number of issues when attempting to monetize its natural resources

- Iran's big push on petrochemicals

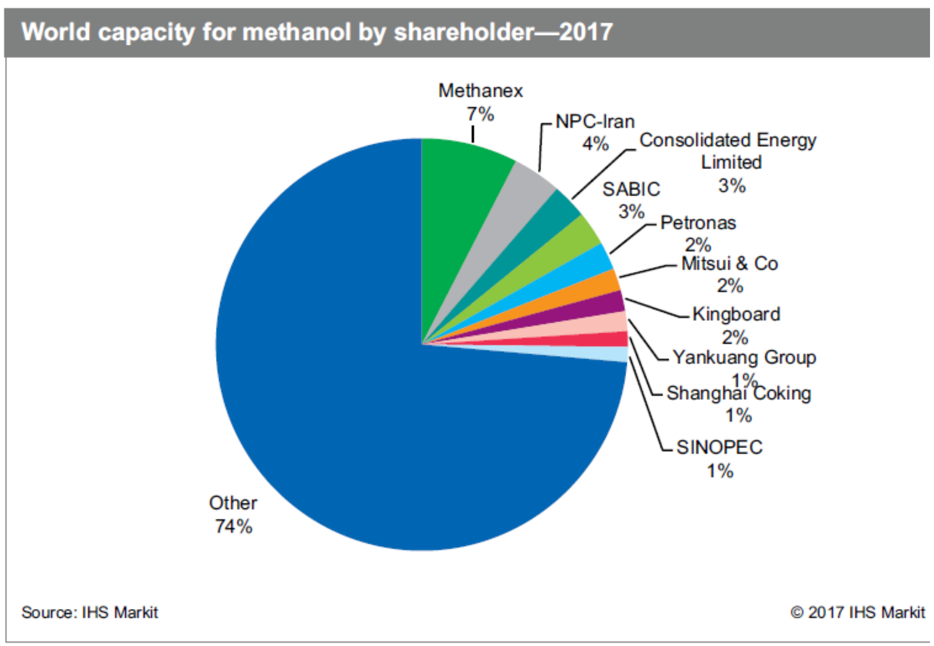
During the 2000s, Teheran strongly encouraged the deployment of state-controlled, export-oriented, gas-based industries

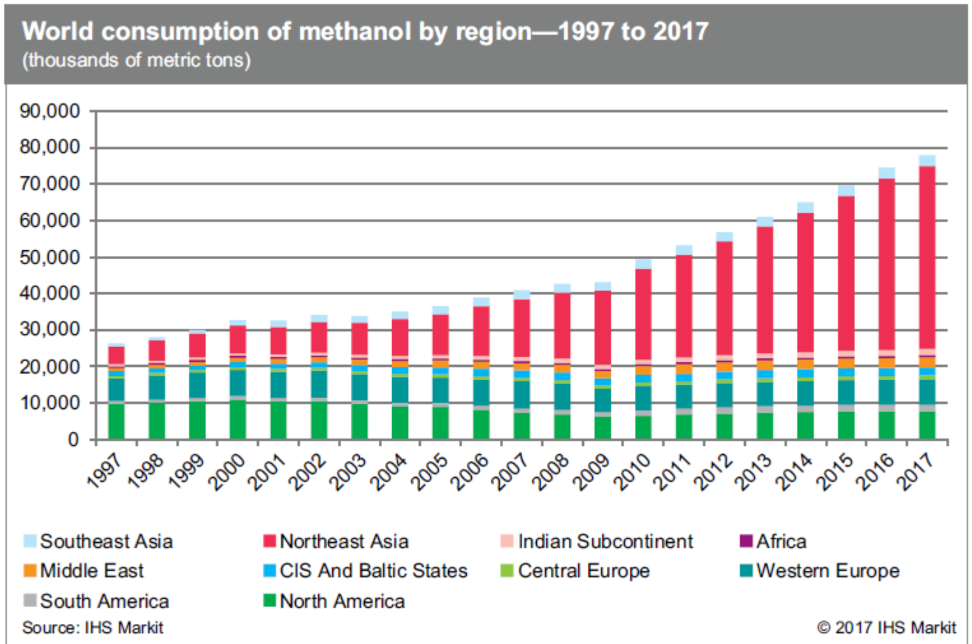
| IRAN | 1990 | 2010 |
|---|---|---|
| petrochemical exports revenues (MM$) | 141.0 | 2,970.0 |

Source: U.N. Comtrade

# BACKGROUND

- **Methanol**
  - a basic petrochemical mainly produced from natural gas,
    - Can be converted into formaldehyde (a raw material used in particle board, plywood, paints, foams, rubbers, adhesive, coatings, resin plastic, explosives, pharmaceuticals, and pesticides), acetic acid, olefins (ethylene, propylene) or gasoline additives. In China, methanol is also consumed as a motor fuel (Su et al., 2013).
  - a globally traded commodity, **traded at destination markets** (in USD/ton)
  - a **homogenous** good (no regional variations in quality standards).



# BACKGROUND

- The National Petrochemical Company (NPC) is now **the world's second largest producer of methanol**.

  4 arguments explain the appeal of methanol processing to the NPC

  1 - This is a **profitable option** (Massol and Banal-Estañol, 2014)

  2 - Compared to LNG, MeOH processing is **less capital intensive** and involves simpler processing technologies.

  3 – Its **logistics is less vulnerable to foreign sanctions** than those of natural gas.

  4 – The main markets are located in Asia.

- The NPC is reputed to operate as a "**swing supplier**" (IHS, 2017)

  - It has limited downstream integration

  - It acts primarily as a merchant seller that **shifts methanol to destination markets** in Asia that offer the highest netback price.

## The 2012-2016 sanctions against Iran

- An unprecedented wave of U.N., U.S. & E.U. sanctions focused on the Iranian exports of oil, gas and petrochemicals (Cordesman et al., 2014).
  - prohibited access to
    - western-controlled shipping-related services (e.g., ship insurance, banking system),
    - to lines of credit for moving cargo.
    - to fuel supplies for Iranian ships.
- Were these sanctions bypassed?

# 2: MODEL

# Iran as a swing supplier

We consider **M>2** export markets where

- the excess demand in market ***i*** and in period ***t*** is $q_{it} = D(P_{it})$.
- $s_{it}^{k}$ is the quantity shipped to market ***i*** by producer ***k***

Assuming perfect competition, the producer's behavior is

$$\underset{s_{it}^{k}}{Max} \quad \Pi_k\left(s_{it}^{k}\right) = \sum_{i=1}^{M} P_{it}\, s_{it}^{k} - C_k\left(\sum_{i=1}^{M} s_{it}^{k}\right) - \sum_{i=1}^{M} \tau_i^{k} s_{it}^{k}$$

$$\text{s.t.} \quad \sum_{i=1}^{M} s_{it}^{k} \le K_k \qquad \left(\gamma_k\right)$$

# A SWING SUPPLIER

- We derive the F.O.C. of optimality for two markets ***i*** & ***j***
- If producer ***k*** serves these two markets:

$$\begin{cases} P_{it} - MC_k - \tau_i^k - \gamma_k = 0 \\ P_{jt} - MC_k - \tau_j^k - \gamma_k = 0 \end{cases}$$

and thus $\boxed{P_{it} - P_{jt} = \tau_i^k - \tau_j^k}$

The behavior of the swing supplier contributes to the economic integration of the two markets.

The local prices are said to verify
**Marshall's Law Of One Price (LOOP)**

# METHODOLOGY: A PBM APPROACH

- A **Parity Bounds Model** (PBM):
  - Arbitrageurs assumed to be profit-maximizing
  - Spreads examined with "switching regime" specification, estimating probability of observing each of a series of trade regimes
- Sexton et al. (1991) considers three regimes:

(I) "arbitrage": $P_{it} - P_{jt} - T_t = 0$

(II) "outside the parity bounds": $P_{it} - P_{jt} - T_t > 0$

(III) "inside the parity bounds": $P_{it} - P_{jt} - T_t < 0$

# Methodology: A standard PBM

If one models the arbitrage cost as: $T_t = \alpha + Z_t \beta + \varepsilon_t$ with $\varepsilon_t \sim N\left(0, \sigma_\varepsilon^2\right)$

The PBM to be estimated is:

Regime I: $P_{it} - P_{jt} = \alpha + Z_t \beta + \varepsilon_t$ ,

Regime II: $P_{it} - P_{jt} = \alpha + Z_t \beta + \varepsilon_t + \eta_t$ ,

Regime III: $P_{it} - P_{jt} = \alpha + Z_t \beta + \varepsilon_t - \eta_t$ ,

where $\eta_t \sim N^+\left(0, \sigma_\eta^2\right)$

The ambition is to estimate: $\left(\lambda_I, \lambda_{II}, 1 - \lambda_I - \lambda_{II}\right)$ the probabilities to observe these regimes and $\left(\alpha, \beta, \sigma_\varepsilon, \sigma_\eta\right)$ the parameters .

# THE DENSITY FUNCTIONS

- We let $\pi_t = P_{it} - P_{jt} - \alpha - Z_t \beta$

**Table 1. The density functions of the three regimes.**

| | | |
|---|---|---|
| Regime I: | $f_t^{I}(\pi_t)$ | $= \frac{1}{\sigma_\varepsilon}\phi\left(\frac{\pi_t}{\sigma_\varepsilon}\right).$ |
| Regime II: | $f_t^{II}(\pi_t)$ | $= \left[\frac{2}{\sqrt{\sigma_\varepsilon^2+\sigma_\eta^2}}\right]\phi\left(\frac{\pi_t}{\sqrt{\sigma_\varepsilon^2+\sigma_\eta^2}}\right)\left[1-\Phi\left(\frac{-\pi_t\sigma_\eta}{\sigma_\varepsilon\sqrt{\sigma_\varepsilon^2+\sigma_\eta^2}}\right)\right].$ |
| Regime III: | $f_t^{III}(\pi_t)$ | $= \left[\frac{2}{\sqrt{\sigma_\varepsilon^2+\sigma_\eta^2}}\right]\phi\left(\frac{\pi_t}{\sqrt{\sigma_\varepsilon^2+\sigma_\eta^2}}\right)\left[1-\Phi\left(\frac{\pi_t\sigma_\eta}{\sigma_\varepsilon\sqrt{\sigma_\varepsilon^2+\sigma_\eta^2}}\right)\right].$ |

Note: Here, $\phi$ denotes the standard normal density function, and $\Phi$ is the standard normal cumulative distribution function. The density function of Regime I is that of a normal variable. The one of regimes II and III are the density of the sum of a normal random variable and a truncated normal random variable derived in Weinstein (1964).

# Estimation

- The joint density function for $\pi_t$ over all trading regimes is

$$f_t(\pi_t) = \lambda_I f_t^I(\pi_t) + \lambda_{II} f_t^{II}(\pi_t) + [1 - \lambda_I - \lambda_{II}] f_t^{III}(\pi_t)$$

- Estimation

$$\underset{(\alpha,\beta,\sigma_\varepsilon,\sigma_\eta,\lambda_I,\lambda_{II})}{\text{Max}} \quad \text{Log(L)} = \sum_{t=1}^{N} \log\left(f_t(\pi_t)\right)$$

s.t. Probabilities are in [0,1]

std. dev. >0

# METHODOLOGY:
## CORRECTING FOR SERIAL CORRELATION

The PBM to be estimated is:

Regime I: $P_{it} - P_{jt} = \alpha + Z_t \beta + \mu_t$ , where $\mu_t = \rho \mu_{t-1} + \varepsilon_t$ .

Regime II: $P_{it} - P_{jt} = \alpha + Z_t \beta + \mu_t$ , where $\mu_t = \rho \mu_{t-1} + \varepsilon_t + \eta_t$ .

Regime III: $P_{it} - P_{jt} = \alpha + Z_t \beta + \mu_t$ , where $\mu_t = \rho \mu_{t-1} + \varepsilon_t - \eta_t$ .

where $\rho$ is the first-order autocorrelation parameter

## THE EXTENDED PBM

- **Negassa and Myers (2007):** the probability of being in regime ***r*** at time ***t*** is allowed to change under the sanctions:

$$\lambda_r\left(1-D_t\right)+\delta_r D_t$$

The joint density function for the observation at time ***t*** is

$$\begin{aligned} f_t\left(\pi_t\right) \;=\; & \left[\lambda_I\left(1-D_t\right)+\delta_I D_t\right] f_t^I\left(\pi_t\right) \\ & +\left[\lambda_{II}\left(1-D_t\right)+\delta_{II} D_t\right] f_t^{II}\left(\pi_t\right) \\ & +\left[\left(1-\lambda_I-\lambda_{II}\right)\left(1-D_t\right)+\left(1-\delta_I-\delta_{II}\right) D_t\right] f_t^{III}\left(\pi_t\right) \end{aligned}$$

# 3: Application

# DATA

- **Monthly transaction price** data for MeOH delivered in China, India, South-Korea and South-Eastern Asia (Source: Argus)

  Altogether, these countries accounted for 66% of global consumption (IHS, 2017).

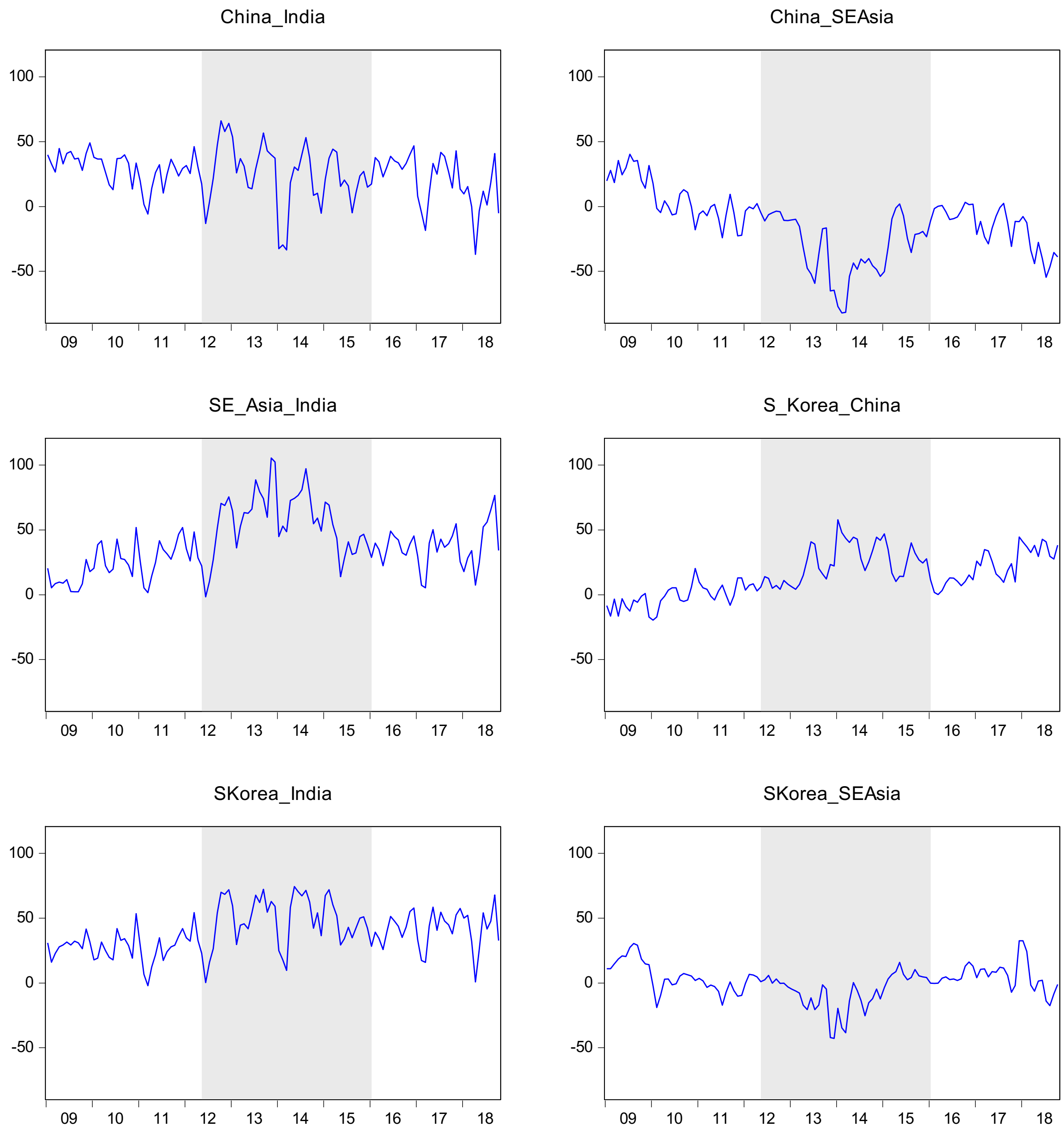
- Sample period: **Jan. 2009 - Oct. 2018** (118 obs.)

  Sanctions: May 2012 – Jan. 2016 ( 45 obs.)

**Table 2. Average prices at destination (in $/ton).**

| | China | India | SE Asia | S. Korea |
|---|---|---|---|---|
| Entire sample period | | | | |
| Mean price | 324.46 | 299.78 | 339.07 | 339.12 |
| Subperiod I: before the sanctions | | | | |
| Mean price | 309.49 | 280.13 | 303.53 | 307.88 |
| Subperiod II: under the sanctions | | | | |
| Mean price | 345.29 | 321.28 | 376.50 | 369.19 |
| *Variation* | *+11.6%* | *+14.7%* | *+24.0%* | *+19.9%* |
| Subperiod III: after the sanctions | | | | |
| Mean price | 314.19 | 294.30 | 331.10 | 335.97 |
| *Variation* | *-9.0%* | *-8.4%* | *-12.1%* | *-9.0%* |

# The Spatial price spreads



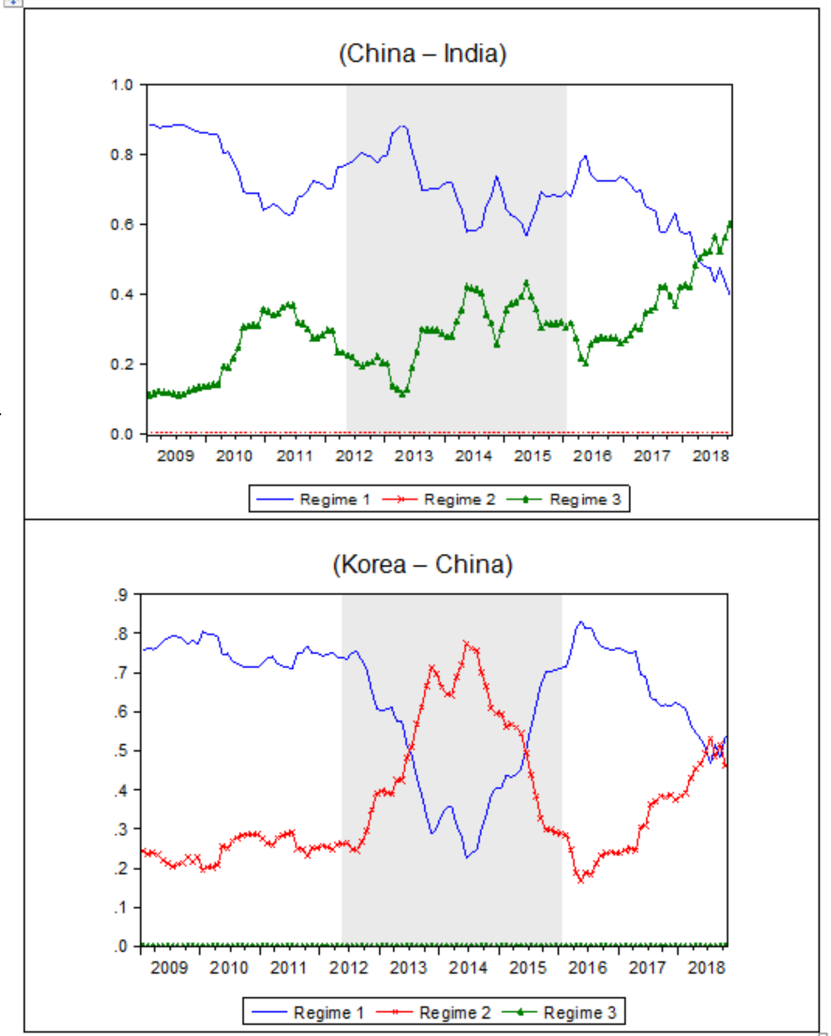

Not stationary

# INSIGHTS FROM A SIMPLE PBM

- Estimate a simple PBM and use the estimates to evaluate (Kiefer, 1980):

$$\text{Proba}_t^r = \frac{\hat{\lambda}_r f_t^r(\pi_t)}{\hat{\lambda}_I f_t^I(\pi_t) + \hat{\lambda}_{II} f_t^{II}(\pi_t) + \left[1 - \hat{\lambda}_I - \hat{\lambda}_{II}\right] f_t^{III}(\pi_t)}$$

**Figure 2. Fifteen month centered moving average estimates of regime probabilities for (China – India) and (Korea – China)**



# IS THE CHANGE IN PROBALITIES SUPPORTED BY THE DATA?

**Table 5. Likelihood ratio tests**

| | Log-likelihood | | LR test | | |
|---|---|---|---|---|---|
| | Restricted Model | Unrestricted Model | $\chi^2(2)$ statistics | | (*p*-value) |
| China – India | -474.802 | -473.988 | 1.628 | | *(0.443)* |
| SE Asia – India | -492.797 | -477.619 | 30.356 | *** | *(0.000)* |
| S. Korea – China | -426.280 | -416.020 | 20.520 | *** | *(0.000)* |
| S. Korea – India | -468.940 | -460.909 | 16.063 | *** | *(0.000)* |
| S. Korea – SE Asia | -411.784 | -408.880 | 5.808 | * | *(0.055)* |

Note: Asterisks indicate rejection of the null hypothesis at the $0.1^{*}$, $0.05^{**}$ and $0.01^{***}$ significance levels, respectively.

**Table 6. Estimation results for the price differential between China and India**

| | China – India |
|---|---|
| Mean parameters | |
| $\alpha$ | 44.126 *** |
| | *(4.922)* |
| $\rho$ | 0.565 *** |
| | *(0.061)* |
| Standard deviations | |
| $\sigma_{\varepsilon}$ | 8.701 *** |
| | *(1.033)* |
| $\sigma_{\mu+}$ | 26.599 *** |
| | *(4.767)* |
| Probabilities (in %) | |
| $\lambda_I$ | 70.762 *** |
| | *(10.659)* |
| $\lambda_{II}$ | 0.000 |
| | *(0.031)* |
| $1-\lambda_I-\lambda_{II}$ | 29.238 *** |
| | *(10.659)* |
| Log likelihood | -474.802 |

Note: Estimates for the monthly dummies are not reported for brevity. Numbers in parentheses are standard errors. Significance tests are based on asymptotic standard errors that have been computed using the Hessian matrix of the log-likelihood function. Asterisks indicate significance at 0.1*, 0.05** and 0.01*** levels, respectively.

| | SE Asia – India | | S. Korea – China | | S. Korea – India | | S. Korea – SE Asia | |
|---|---|---|---|---|---|---|---|---|
| Probabilities (in %) | | | | | | | | |
| $\lambda_I$ | 100.000 | | 75.659 | *** | 100.000 | | 58.705 | *** |
| | – | | *(11.446)* | | | | *(16.102)* | |
| $\lambda_{II}$ | 0.000 | | 24.341 | ** | 0.000 | | 27.925 | * |
| | – | | *(11.446)* | | – | | *(15.284)* | |
| $1-\lambda_I-\lambda_{II}$ | 0.000 | | 0.000 | | 0.000 | | 13.369 | * |
| | – | | *(0.047)* | | – | | *(7.203)* | |
| Probabilities (in %) | | | | | | | | |
| $\delta_I$ | 0.008 | | 0.000 | | 0.719 | | 50.556 | *** |
| | *(0.451)* | | – | | *(28.651)* | | *(17.384)* | |
| $\delta_{II}$ | 95.978 | *** | 100.000 | | 89.677 | *** | 0.000 | |
| | *(4.370)* | | | | *(28.853)* | | – | |
| $1-\delta_I-\delta_{II}$ | 4.014 | | 0.000 | | 9.604 | | 49.444 | *** |
| | *(4.350)* | | – | | *(9.591)* | | *(17.384)* | |
| Log likelihood | -477.619 | | -416.020 | | -460.909 | | -408.880 | |

# CONCLUSIONS

- **Absent any sanctions**, a high degree of market integration is achieved among Asian markets.

- **Under the sanctions**, we observe signs of **balkanization**
  - they form two distinct market areas respectively (China & India) and (Korea & Southeast Asia).
  - the degree of market integration achieved within each of these two areas remain very high.

- Overall, our findings are consistent with market commentaries arguing that the sanctions only imperfectly prevented the exportation of Iranian methanol to China and India
  - These two countries are reputed to have offered alternative insurance and transportation schemes to Iran.

**Thank you!**