

# **COMPARATIVE EVALUATION OF EFFICIENCY OF THE G20, BRICS AND NIC COUNTRIES' PARTICIPATION IN GLOBAL VALUE CHAINS**

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# 1. Methodology

**The aim of this investigation:**

**to perform a comparative analysis of the efficiency  
of G20, BRICS and NIC member countries' participation  
in global value chains (GVC)  
taking into account economic growth, investment activity,  
global competitiveness and labour productivity  
in the period from 2000 to 2009**

# 1. Methodology

Efficiency is estimated by means of **Data Envelopment Analysis (DEA)**

## References:

1. Banker R.D., Charnes A., Cooper W.W. Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis // Management Science. — 1984. — T. 30. — № 9. — P. 1078-1092.
2. Charnes A., Cooper W.W., Rhodes E. Measuring the efficiency of decision-making units // European Journal of Operation Research. — 1978. — T. 2. — № 6.
3. Cooper W., Seiford L., Tone K. Data Envelopment Analysis. A Comprehensive Text with Models, Applications, References and DEA-Solver Software. — Springer, 2nd Edition, 2007. — P. 520.

## DEA-Model: Decision Making Units (DMU<sub>j</sub>), $j = 1, \dots, n$

$$\text{Efficiency}_o = \frac{\text{Virtual Output}}{\text{Virtual Input}} = \frac{u_1 y_{1o} + \dots + u_s y_{so}}{v_1 x_{1o} + \dots + v_m x_{mo}} \rightarrow \max$$

$$\frac{u_1 y_{1j} + \dots + u_s y_{sj}}{v_1 x_{1j} + \dots + v_m x_{mj}} \leq 1 \quad j = 1, \dots, n$$

$$v_1, v_2, \dots, v_m \geq 0; \quad u_1, u_2, \dots, u_s \geq 0$$

$x_{1j}, \dots, x_{mj}$  – input parameters for DMU<sub>j</sub>

$y_{1j}, \dots, y_{sj}$  – output parameters for DMU<sub>j</sub>

$v_1, \dots, v_m$  – weights assigned to input parameters

$u_1, \dots, u_s$  – weights assigned to output parameters

**Output-oriented models: aimed to maximize outputs**

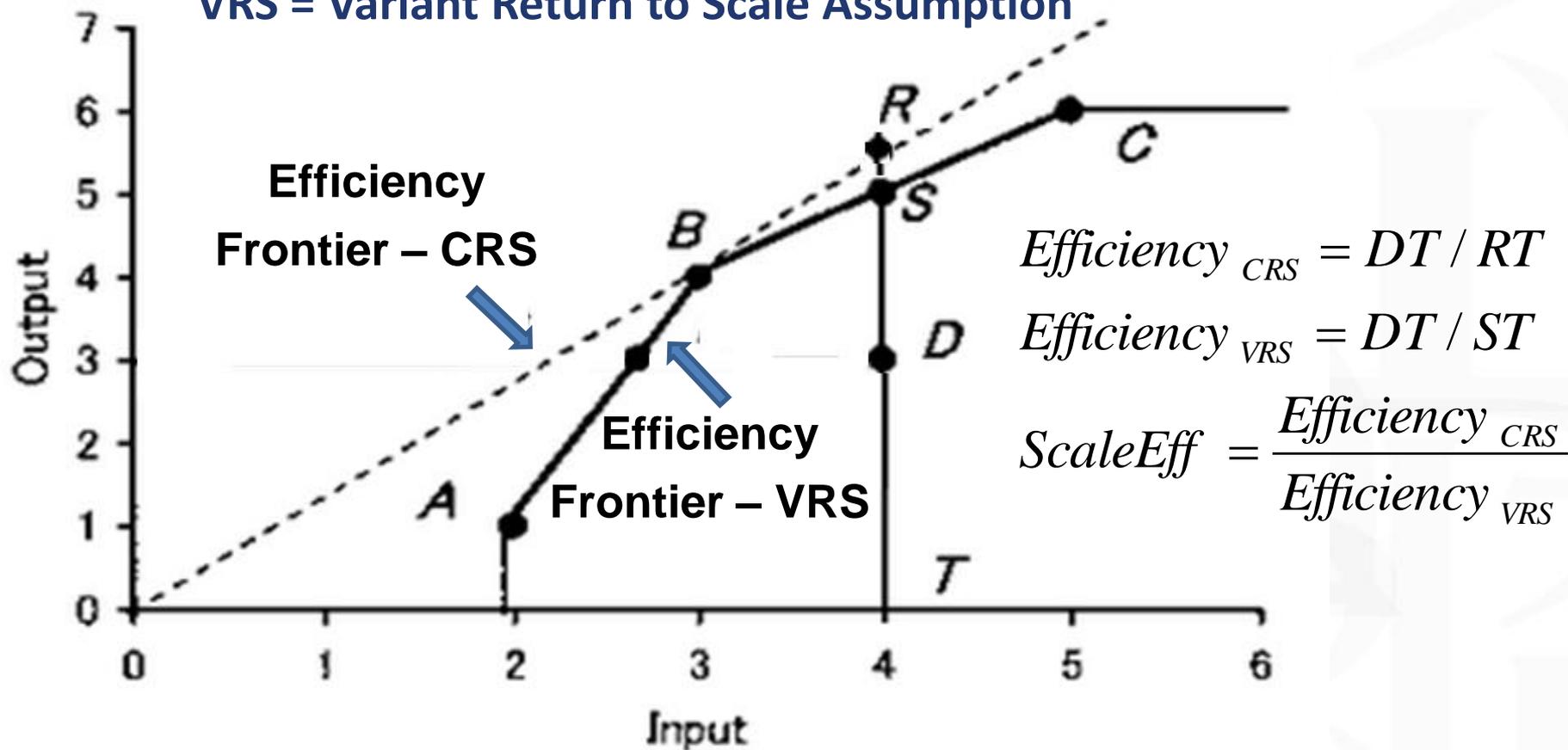
**Input-oriented models: aimed to minimize inputs**

# 1. Methodology

## Example: One Output – One Input

CRS = Constant Return to Scale Assumption

VRS = Variant Return to Scale Assumption



## Output-oriented CRS-model: linear programming

### - Primal problem

$$\begin{aligned} \min_{v,u} \quad & v x_o \\ u y_o &= 1 \\ -vX + uY &\leq 0 \\ v \geq 0; \quad & u \geq 0 \end{aligned}$$



### - Dual problem

$$\begin{aligned} \max_{\eta, \mu} \quad & \eta \\ x_o - X\mu &\geq 0 \\ \eta y_o - Y\mu &\leq 0 \\ \mu &\geq 0 \end{aligned}$$

$X$  –  $(m \times n)$  matrix of inputs

$Y$  –  $(s \times n)$  matrix of outputs

$$x_o = (x_{1o}, \dots, x_{mo}) \geq 0$$

$$y_o = (y_{1o}, \dots, y_{so}) \geq 0$$

$$\mu = (\mu_1, \dots, \mu_n) \geq 0 \text{ – weights}$$

$$\text{Efficiency}_{CRS,o} = 1 / \eta_o$$

Output-oriented VRS-model:  
(convex envelope)

$$\sum \mu_j = 1$$

# 1. Methodology

**DMU = 30 countries**

**Input parameters:**

- Real GDP growth:  $GPD'_{gr,i} = \frac{GDP_{gr,i} - GDP_{gr,\min}}{GDP_{gr,\max} - GDP_{gr,\min}} + 0.01 \quad (i = 1, \dots, n)$
- Foreign direct investment (FDI) inflow
- Global competitiveness index
- Labour productivity: GDP (in constant prices) per employee

**Output parameters:**

- GVC participation index = the share of foreign inputs + domestically produced inputs used in third countries' exports in a country's gross export
- Domestic value added embodied in gross export

**References:** 1) World Bank Database 2) OECD TIVA Database  
3) Global Competitiveness Reports (World Economic Forum)

## 2. Results

### Global Efficiency: CRS Model

Country	2000	2005	2007	2009	Median	Avrg
Russia	0,89	0,66	0,71	0,62	0,71	0,72
Brazil	0,89	0,76	0,88	0,89	0,89	0,88
China	1,00	1,00	1,00	1,00	1,00	1,00
India	0,87	0,95	0,92	1,00	0,92	0,93
S. Africa	0,72	1,00	1,00	0,93	0,97	0,92
USA	1,00	1,00	1,00	1,00	1,00	1,00
Germany	0,82	0,91	0,97	0,95	0,91	0,91
France	0,90	0,88	0,93	0,93	0,91	0,91
UK	0,83	0,93	0,95	0,91	0,92	0,90
Italy	0,95	0,85	0,88	0,80	0,87	0,88
Canada	1,00	1,00	1,00	1,00	1,00	1,00
Japan	0,99	0,90	0,91	0,87	0,92	0,93
S. Korea	0,97	0,90	0,95	0,89	0,92	0,92
Singapore	1,00	1,00	1,00	1,00	1,00	1,00
Indonesia	0,76	0,73	0,76	0,87	0,75	0,76
Mexico	0,90	0,86	0,85	0,81	0,85	0,85

Country	2000	2005	2007	2009	Median	Avrg
Argentina	0,89	0,99	1,00	0,90	0,96	0,94
Turkey	1,00	1,00	0,88	0,78	0,98	0,92
Chile	0,80	0,87	0,79	0,80	0,82	0,84
S. Arabia	0,97	0,91	0,89	1,00	0,92	0,92
Philippines	0,78	0,77	0,75	0,75	0,80	0,82
Hong Kong	1,00	1,00	1,00	1,00	1,00	0,99
Thailand	0,84	0,89	0,89	0,84	0,89	0,89
Malaysia	0,98	0,87	0,88	0,83	0,88	0,89
Australia	0,95	0,90	0,91	1,00	0,97	0,95
Poland	0,75	0,81	0,81	0,87	0,80	0,80
Hungary	0,79	0,84	0,77	0,84	0,83	0,85
Czech Rep.	0,74	0,89	0,84	0,81	0,85	0,85
Slovakia	0,67	0,90	0,97	0,81	0,93	0,90
Slovenia	0,78	0,86	0,88	0,84	0,87	0,87
Average	0,88	0,89	0,90	0,88	0,90	0,90
Median	0,89	0,90	0,90	0,88	0,91	0,91

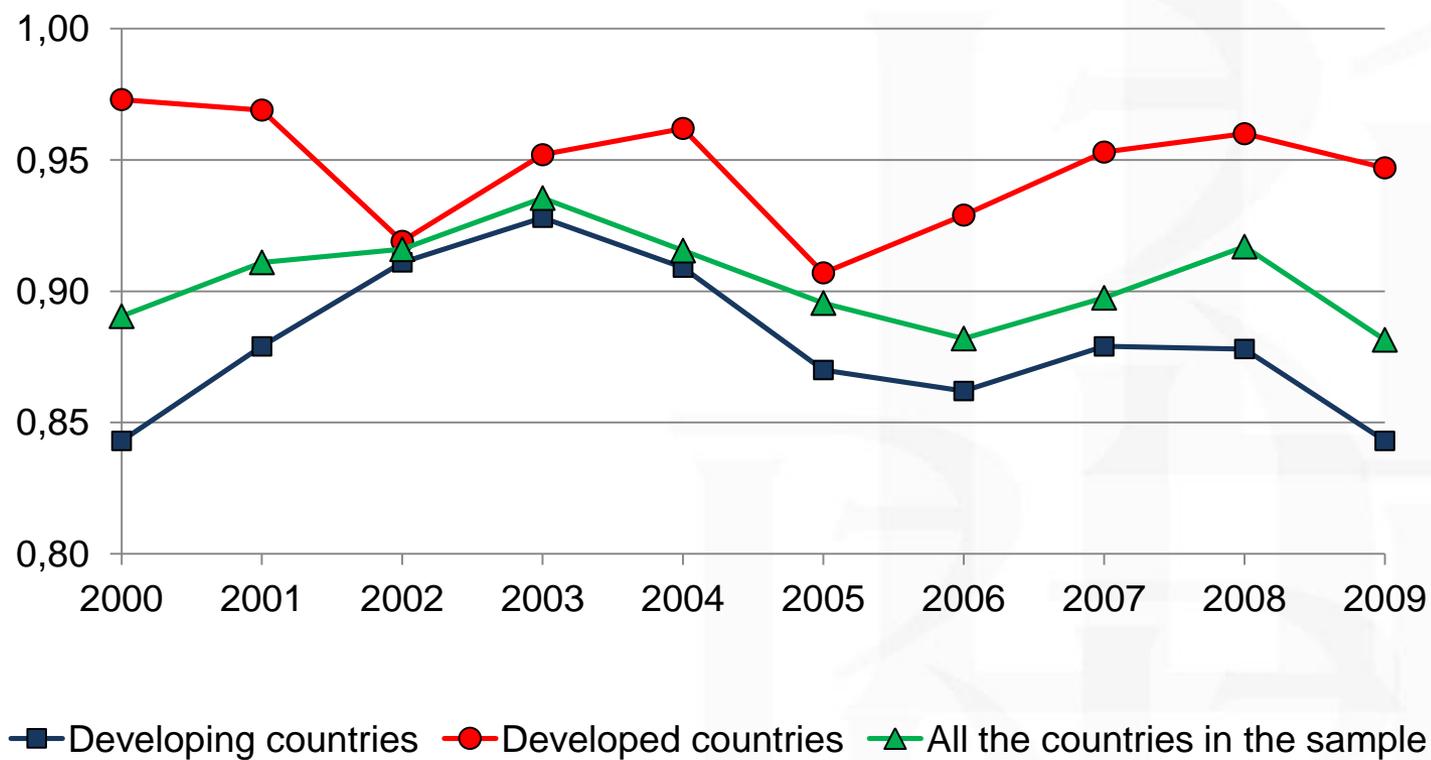
## 2. Results

### Local Efficiency: VRS Model

Country	2000	2005	2007	2009	Median	Avrg	Country	2000	2005	2007	2009	Median	Avrg
Russia	1,00	0,82	0,85	0,74	0,87	0,87	Argentina	1,00	1,00	1,00	1,00	1,00	0,99
Brazil	0,91	0,80	0,88	0,92	0,92	0,92	Turkey	1,00	1,00	0,88	0,78	1,00	0,95
China	1,00	1,00	1,00	1,00	1,00	1,00	Chile	0,89	0,95	0,89	0,88	0,91	0,91
India	1,00	1,00	0,93	1,00	0,99	0,97	S. Arabia	0,98	1,00	0,99	1,00	0,99	0,96
S. Africa	0,82	1,00	1,00	1,00	1,00	0,95	Philippines	0,78	0,80	0,80	0,78	0,83	0,84
USA	1,00	1,00	1,00	1,00	1,00	1,00	Hong Kong	1,00	1,00	1,00	1,00	1,00	0,99
Germany	0,92	0,92	1,00	0,97	0,95	0,95	Thailand	0,85	0,89	0,89	0,85	0,89	0,89
France	0,91	0,88	0,94	0,94	0,94	0,93	Malaysia	0,99	0,90	0,93	0,89	0,92	0,93
UK	0,94	0,94	0,99	0,94	0,94	0,96	Australia	0,95	0,94	0,95	1,00	0,98	0,97
Italy	0,96	0,87	0,88	0,83	0,88	0,90	Poland	0,79	0,83	0,85	0,88	0,82	0,83
Canada	1,00	1,00	1,00	1,00	1,00	1,00	Hungary	0,79	1,00	0,77	1,00	1,00	0,92
Japan	1,00	0,91	0,96	0,96	0,97	0,97	Czech Rep.	0,77	0,92	0,86	0,82	0,88	0,87
S. Korea	0,99	0,91	0,98	0,93	0,95	0,95	Slovakia	0,69	0,91	0,97	1,00	0,97	0,92
Singapore	1,00	1,00	1,00	1,00	1,00	1,00	Slovenia	0,81	0,86	0,89	0,97	0,89	0,89
Indonesia	0,80	0,80	0,84	0,88	0,80	0,82	Average	0,92	0,93	0,93	0,93	0,94	0,94
Mexico	1,00	1,00	1,00	1,00	1,00	1,00	Median	0,95	0,93	0,95	0,96	0,96	0,95

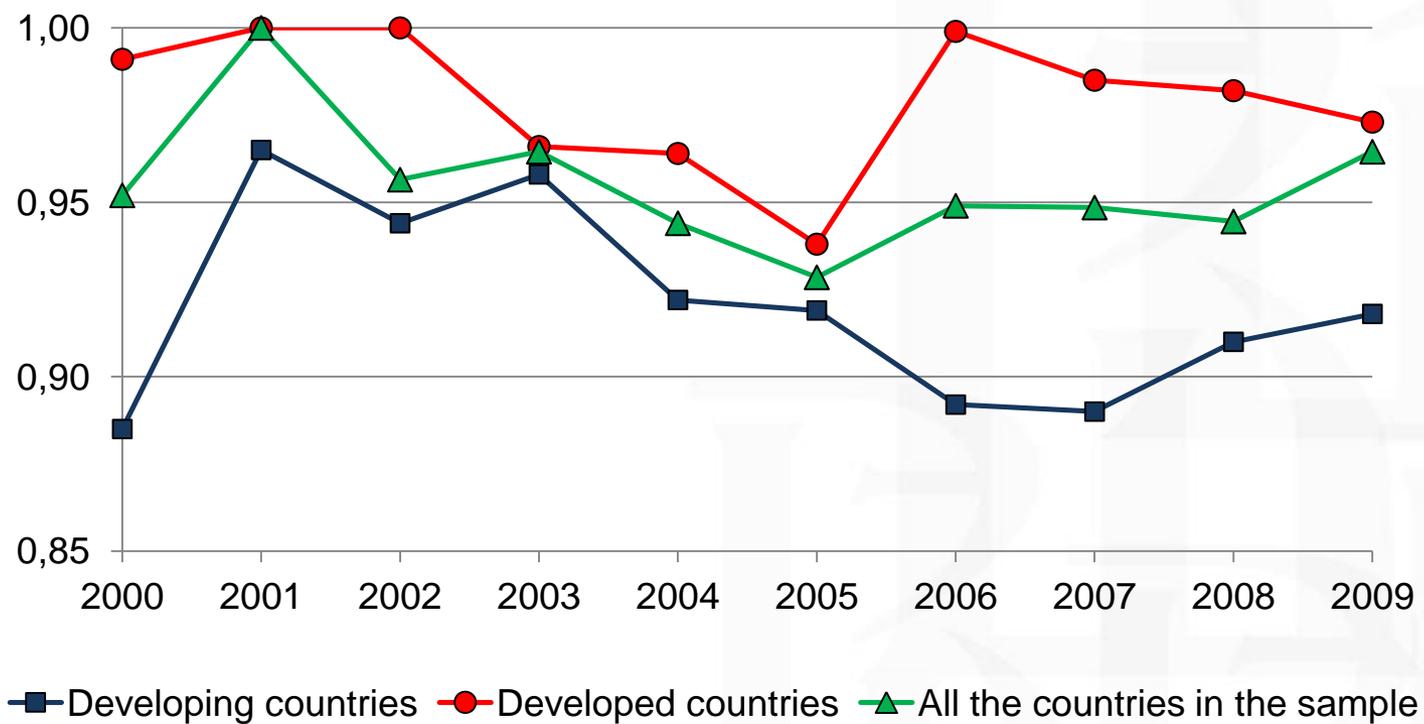
## 2. Results

Global Technical Efficiency Dynamics, 2000-2009, CRS Model



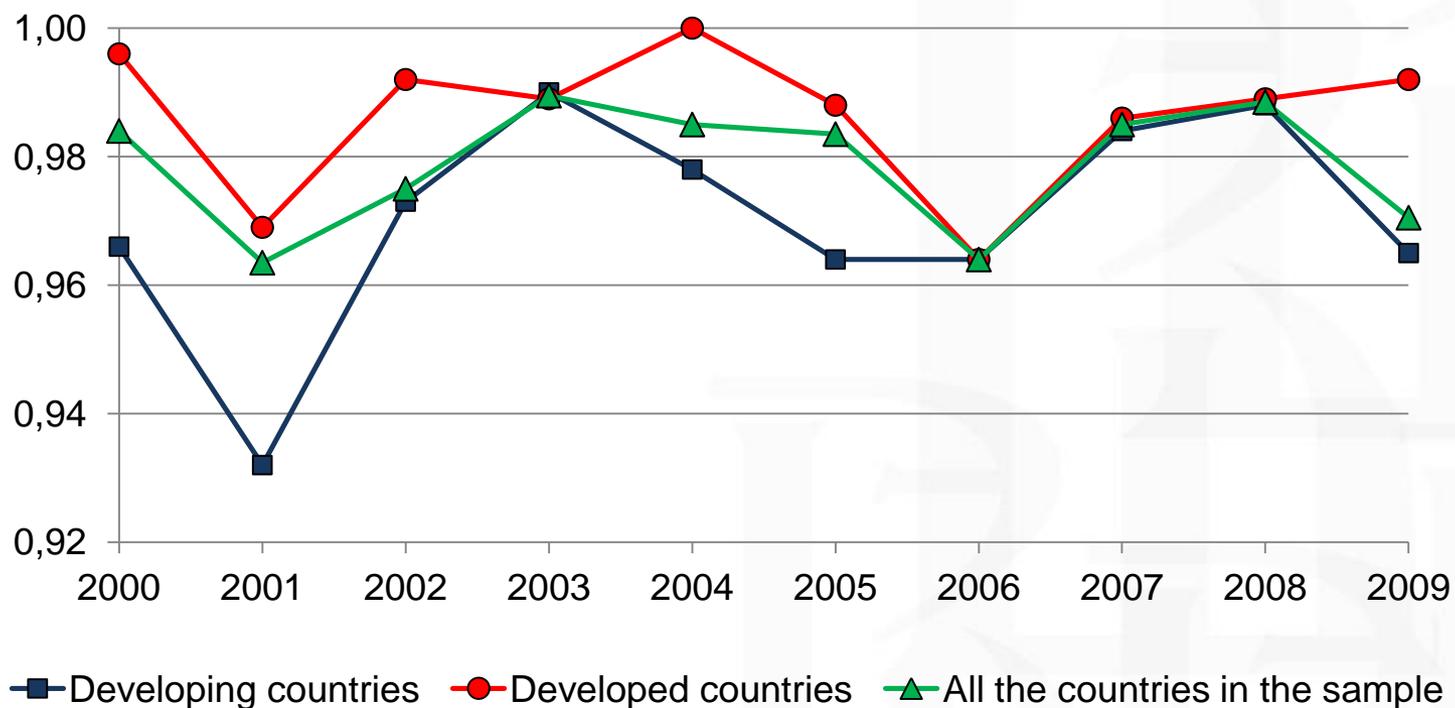
## 2. Results

Local (Pure) Technical Efficiency Dynamics, 2000-2009, VRS Model



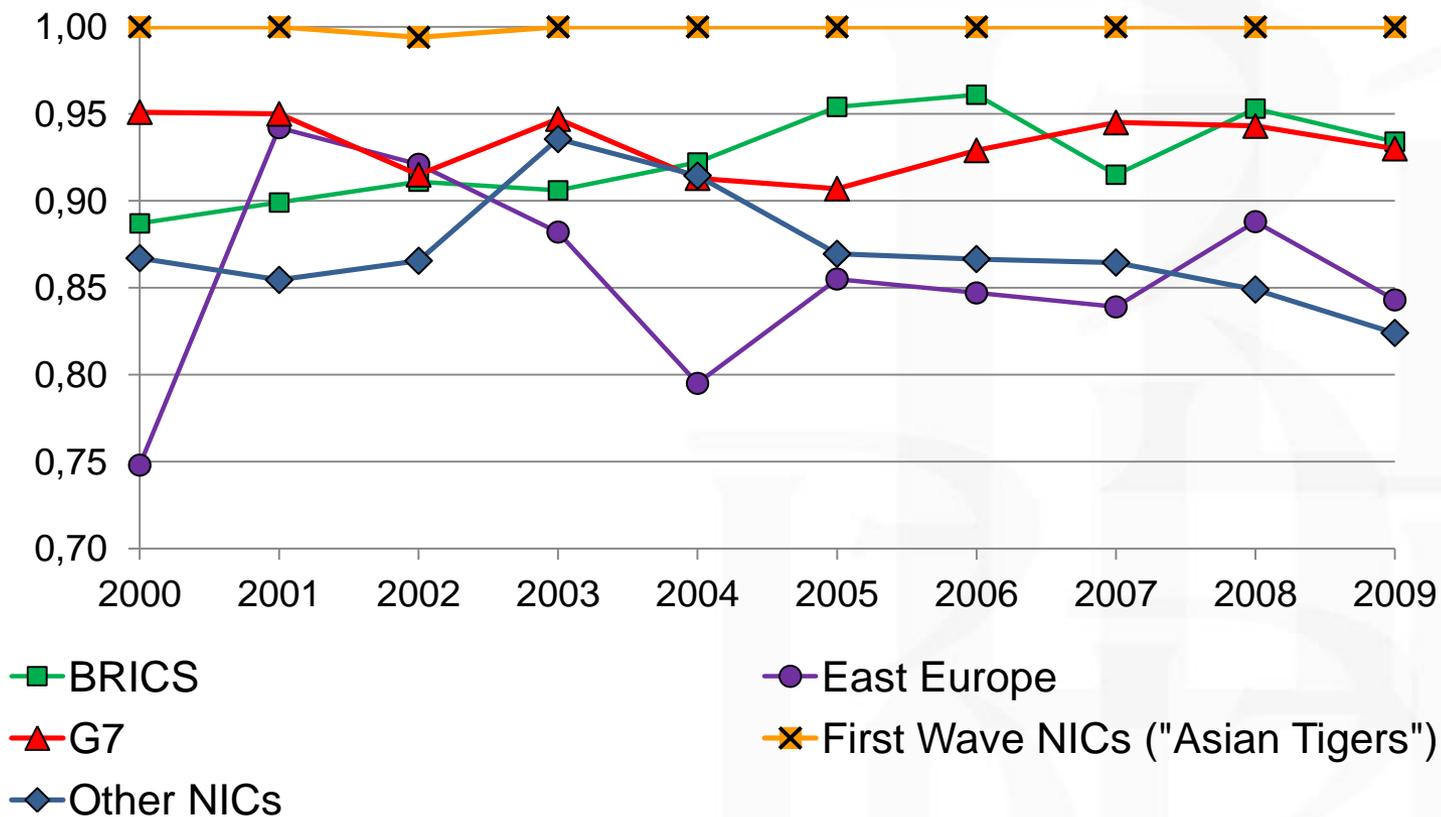
## 2. Results

Scale Efficiency Dynamics, 2000-2009, VRS Model



## 2. Results

Global Technical Efficiency Dynamics, 2000-2009, CRS Model



### Conclusion

1. USA, Canada, Singapore and China are the leaders in using the GVCs' potential.
2. Russia, Indonesia, Chile, Philippines and Poland are the outsiders by global technical efficiency.
3. Developed countries showed higher rates of global and local technical efficiency compared to developing economies.
4. «Asian Tigers» achieved the maximum efficiency, the G7 and BRICS countries followed them.

The lowest levels of efficiency were typical for Eastern Europe.

**Thank you for your attention!**