

# Innovation and Competitiveness

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# What is competitiveness?

- Countries and firms
- Growth and trade – the external constraint
- Explaining competitiveness; cost competitiveness versus "non-price factors" – the "Kaldor paradox"
- "non-price factors" cannot be taken for granted, but needs to be explained
- Innovation and competitiveness?

# A simple Schumpeterian growth model

(1) Assume that the GDP of a country ( $Y$ ) is a function of its technological knowledge ( $Q$ ), its capacity for exploiting the benefits of knowledge ( $C$ ), and a constant ( $A_1$ ):

$$Y = A_1 Q^\alpha C^\beta \quad (\alpha, \beta > 0)$$

(2) Its technological knowledge is a function of knowledge diffused to the region from outside ( $D$ ) and knowledge (or innovation) created in the country ( $N$ ) and, again, a constant ( $A_2$ ):

$$Q = A_2 D^\gamma N^\lambda \quad (\gamma, \lambda > 0)$$

(3) The diffusion of external knowledge follows a logistic curve, where  $T_*$  and  $T$ , represent the frontier country and the country under consideration

$$d = \phi - \phi \frac{T}{T_*} \quad (\phi > 0)$$

# Why do growth rates differ?

(4) By differentiating (2) and substituting (3) into it we obtain the growth of a country's technological knowledge:

$$q = \gamma\phi - \gamma\phi\frac{T}{T_*} + \lambda n$$

By differentiating (1) and substituting (4) into it we get the country's rate of growth:

$$y = \alpha\gamma\phi - \alpha\gamma\phi\frac{T}{T_*} + \alpha\lambda n + \beta c$$

Which can be expressed in relative terms to show why growth rates differ:

$$y_{rel} = y - w = -\alpha\gamma\phi\frac{T - T_w}{T_*} + \alpha\lambda(n - n_w) + \beta(c - c_w)$$

# Hence, the rate of growth may be seen as the outcome of three sets of factors:

- The potential for exploiting knowledge developed elsewhere.
- Creation of new knowledge in the country (innovation).
- Growth in the capacity to exploit the potential entailed by knowledge (independently of where it is created).
- Model applied to cross country samples by Fagerberg (1987) and Fagerberg and Verspagen (2002), both in Research Policy: All three factors matter, but imitation becomes harder through time, and importance of innovation increases

# Including international trade . . .

Assume a country's market share for exports depends on three factors: its technological competitiveness, its capacity to exploit technology commercially, and its price (P) competitiveness:

$$S_x = A_3 \left( \frac{Q}{Q_W} \right)^\rho \left( \frac{C}{C_W} \right)^\mu \left( \frac{P}{P_W} \right)^{-\pi}$$

Exports

$$S_M = A_4 \left( \frac{Q_W}{Q} \right)^{\bar{\rho}} \left( \frac{C_W}{C} \right)^{\bar{\mu}} \left( \frac{P_W}{P} \right)^{-\bar{\pi}}$$

Imports

Differentiating these equations and substituting (4) into them, we arrive at the dynamic expressions for the growth in market shares:

$$s_x = -\rho\gamma\phi \frac{T - T_W}{T_*} + \rho\lambda(n - n_W) + \mu(c - c_W) - \pi(p - p_W)$$

$$s_M = -\bar{\rho}\gamma\phi \frac{T_W - T}{T_*} + \bar{\rho}\lambda(n_W - n) + \bar{\mu}(c_W - c) - \bar{\pi}(p_W - p)$$

# The growth of market share depends on four factors:

- The potential for exploiting knowledge developed elsewhere, which depends on the country's level of technological development relative to the world average.
- Creation of new knowledge (technology) in the country (innovation) relative to that of competitors.
- Growth in the capacity exploit knowledge, independently of where it is created, relative to that of competitors.
- Change in relative prices in common currency
- And specialization and demand? (Thirlwall – Kaldor)

# The external constraint

If we assume that trade is in balance, we get:

$$y = (s_X - s_M) + (p - p_W) + w$$

Substituting the dynamic market share equations into this equation and rearranging gives us the reduced form of the model:

$$y_{rel} = -(\rho + \bar{\rho})\gamma\phi\frac{T - T_W}{T_*} + (\rho + \bar{\rho})\lambda(n - n_W) + (\mu + \bar{\mu})(c - c_W) + [1 - (\pi + \bar{\pi})](p - p_W)$$

And by including demand into the market share equations we arrive at:

$$y_{rel} = -\frac{(\rho + \bar{\rho})}{\bar{\tau}}\gamma\phi\frac{T - T_W}{T_*} + \frac{(\rho + \bar{\rho})}{\bar{\tau}}\lambda(n - n_W) + \frac{(\mu + \bar{\mu})}{\bar{\tau}}(c - c_W) + \frac{1 - (\pi + \bar{\pi})}{\bar{\tau}}(p - p_W) + \frac{\tau - \bar{\tau}}{\bar{\tau}}w$$

Which captures the 4 aspects of competitiveness:

# Conclusions from the reduced model

- Growth: Catch-up potential + competitiveness
  - Four aspects of competitiveness
    - Technology competitiveness
    - Capacity competitiveness
    - Price competitiveness
    - Demand competitiveness

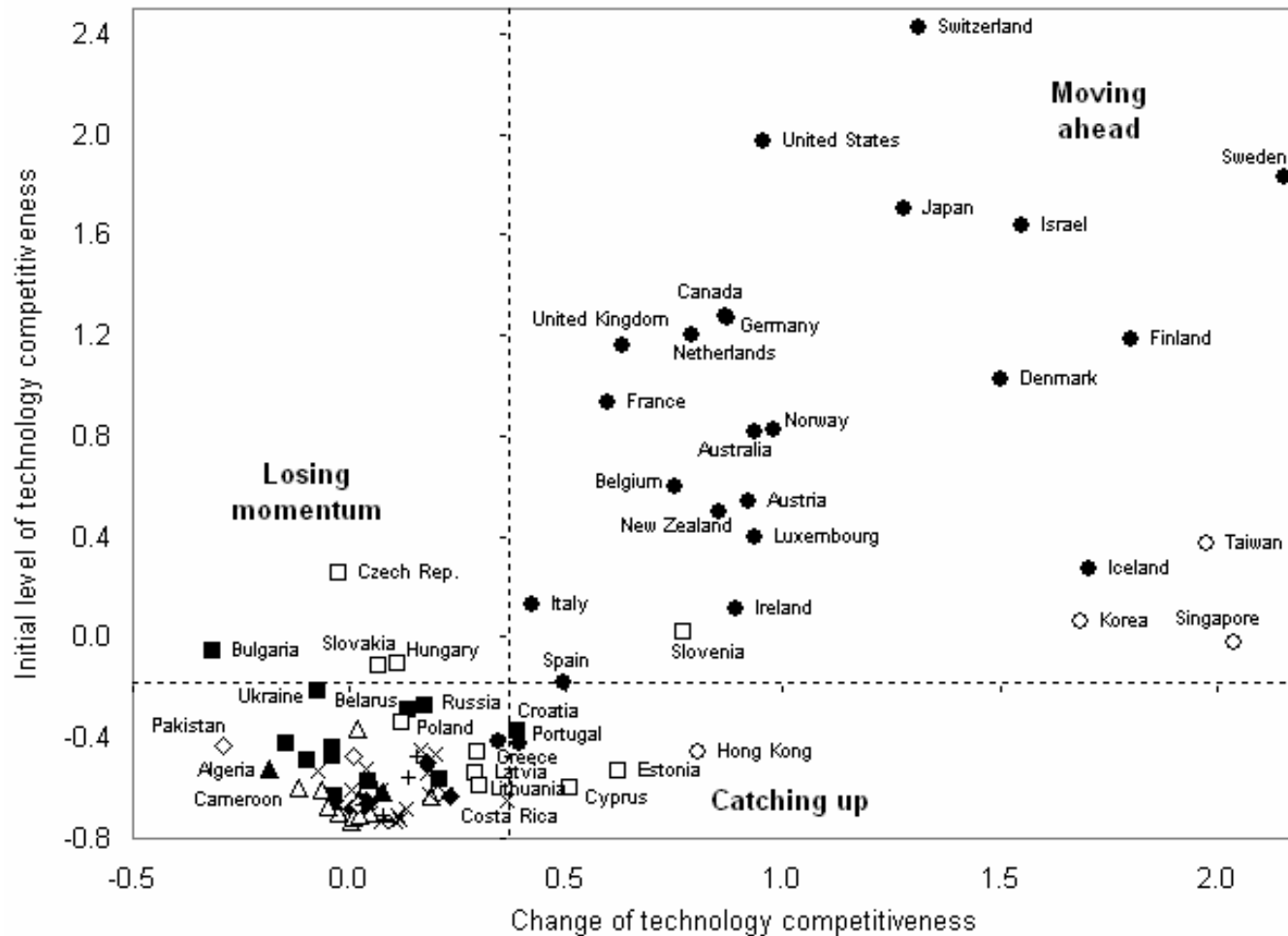
# Data/indicators

- Overall/GAP: GDP per capita
- Technology: R&D, patents, publications and ICT infrastructure
- Capacity: Education, governance, financial system
- Price: Growth in unit labour cost
- Demand: Growth of world demand

# Convergence or divergence in GDP per capita?



# Technology Competitiveness

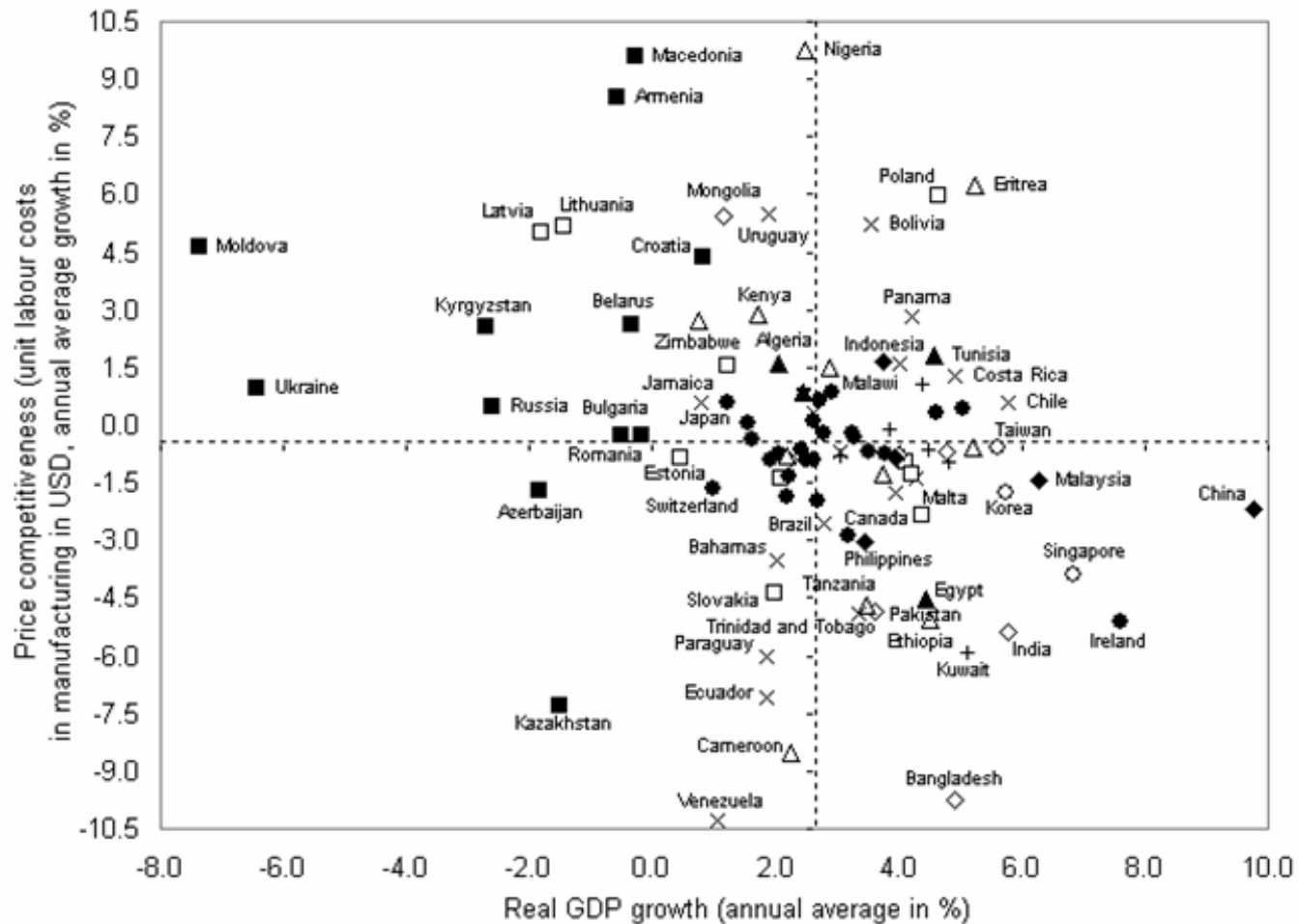


- Developed Countries    ○ Asian Tigers    □ New EU Members    ■ East Europe & CIS
- × Latin America    + West Asia    ◇ Central Asia    ◆ East Asia
- ▲ North Africa    △ Sub-Sahara Africa

# Capacity Competitiveness

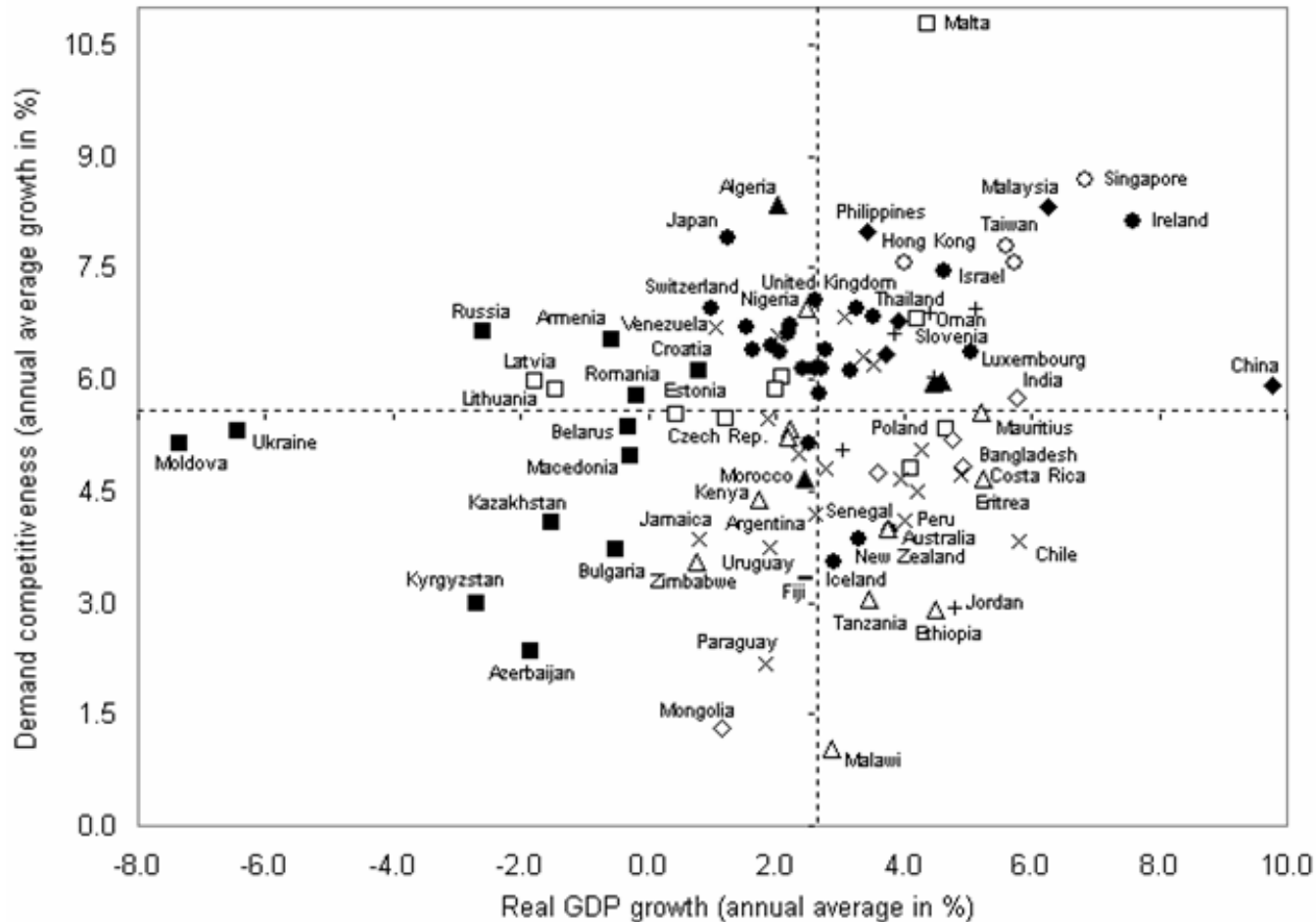


# Price Competitiveness



- Developed Countries
- Asian Tigers
- New EU Members
- East Europe & CIS
- × Latin America
- + West Asia
- ◇ Central Asia
- ◆ East Asia
- ▲ North Africa
- △ Sub-Sahara Africa

# Demand Competitiveness



- Developed Countries
- Asian Tigers
- New EU Members
- East Europe & CIS
- × Latin America
- + West Asia
- ◇ Central Asia
- ◆ East Asia
- ▲ North Africa
- △ Sub-Saharan Africa

# Analyzing the dynamics

- High explanatory power, robust results
- Potential for diffusion important, but conditional on:
  - Technology and capacity competitiveness
  - Price competitiveness
  - Demand competitiveness

# Regression results

	<i>Simple OLS</i>	<i>Iteratively re-weighted least squares</i>	<i>Simple OLS excluding outliers</i>	<i>Least median squares</i>
Constant	..	0.11	0.00	0.08
	..	(1.54)	(1.05)	(1.30)
Log of the initial GDP per capita	-0.46***	-0.38***	-0.43***	-0.43***
	(4.36)	(3.69)	(5.44)	(5.26)
Technology	0.39***	0.27***	0.38***	0.36***
	(3.86)	(2.83)	(4.47)	(4.68)
Capacity	0.24***	0.26***	0.21**	0.23***
	(3.12)	(3.51)	(2.46)	(3.98)
Price	-0.24***	-0.13*	-0.31***	-0.15***
	(2.69)	(1.78)	(3.62)	(2.76)
Demand	0.23***	0.21**	0.27***	0.21***
	(3.05)	(2.52)	(2.85)	(3.15)
F-test	9.67	7.06	15.63	..
R <sup>2</sup>	0.28	..	0.33	..
Pseudo R2	..	..	..	0.19
Observations	100	100	93	100

Note: Absolute value of robust t-statistics in parentheses. \*, \*\*, \*\*\* denote significance at the 10, 5 and 1 percent levels. DFITS used to exclude outliers with a cut-off point at  $\text{abs}(\text{DFITS}) > 2 \cdot \sqrt{k/n}$ .

# Regression results with fixed factors

	<i>Simple OLS</i>	<i>Iteratively reweighted least squares</i>	<i>Simple OLS excluding outliers</i>	<i>The best model (excl. outliers)</i>	<i>The best model (reweighted)</i>
Constant	..	0.02	0.00	0.00	0.02
	..	(0.40)	(0.42)	(0.46)	(0.40)
Log of the initial GDP per capita	-0.30*	-0.32**	-0.34**	-0.32***	-0.33***
	(1.88)	(2.60)	(2.42)	(3.62)	(3.56)
Technology	0.23**	0.23**	0.15	0.15*	0.20**
	(2.03)	(2.14)	(1.56)	(1.88)	(2.37)
Capacity	0.23**	0.15**	0.17**	0.14**	0.13**
	(2.53)	(2.11)	(2.12)	(2.01)	(2.09)
Price	-0.11	-0.08	-0.15*	-0.17**	-0.11*
	(1.25)	(1.11)	(1.94)	(2.48)	(1.73)
Demand	0.19**	0.14**	0.21**	0.24***	0.19***
	(2.39)	(1.67)	(2.45)	(3.14)	(2.72)
F-test	6.94	7.08	14.33	20.95	11.83
R <sup>2</sup>	0.55	..	0.69	0.68	..
Observations	100	100	93	93	100

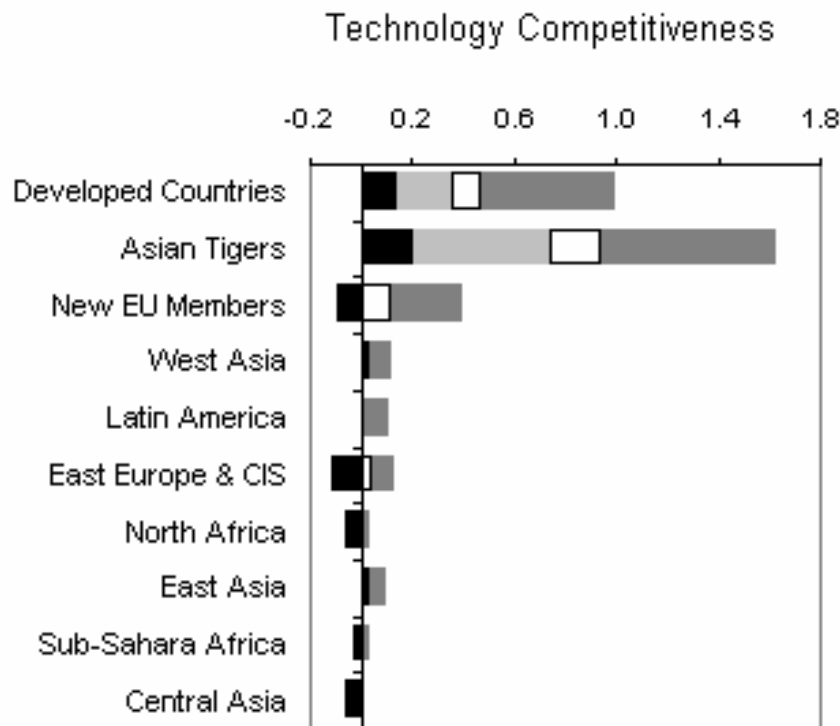
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# Why Growth Rates Differ?

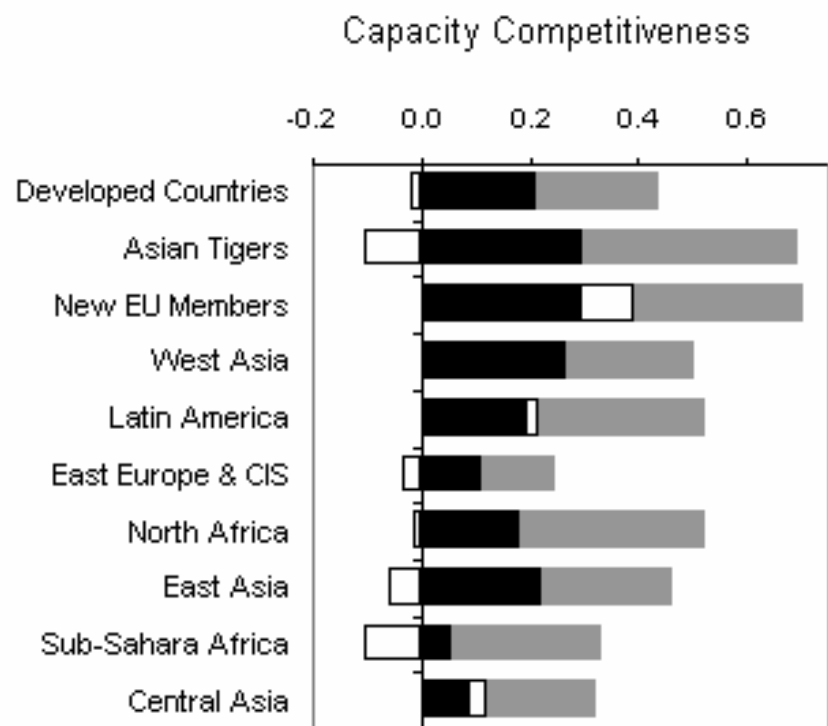
Actual and estimated differences in growth vis-à-vis the world average, 1993-2001

	N	Initial GDP per capita	Actual difference in growth	Estimated difference in growth	Contribution of the explanatory factors					
					Initial GDP per cap.	Tech-nology	Capacity	Price	Demand	Fixed factors
Developed Countries	24	19,902	0.2	0.5	-1.0	0.7	0.0	0.0	0.2	0.5
Asian Tigers	4	14,305	2.9	2.3	-0.7	1.5	0.3	0.1	0.8	0.3
New EU Members	10	9,436	-0.7	-1.7	-0.4	-0.1	0.5	-0.1	0.2	-1.8
West Asia	6	6,536	1.6	0.4	0.1	-0.3	0.1	0.1	0.1	0.4
Latin America	18	5,625	0.4	0.8	0.1	-0.3	0.2	0.1	-0.2	0.9
East Europe & CIS	12	5,113	-4.6	-3.6	0.2	-0.4	-0.3	-0.2	-0.2	-2.6
North Africa	4	3,771	0.7	0.9	0.4	-0.5	0.1	0.0	0.2	0.6
East Asia	5	3,466	2.8	1.6	0.6	-0.3	0.0	0.1	0.5	0.7
Sub-Sahara Africa	11	2,235	0.5	0.7	1.3	-0.4	-0.3	-0.1	-0.5	0.7
Central Asia	5	1,606	1.4	0.7	1.2	-0.5	-0.2	0.2	-0.4	0.4

# What explains the change in technology and capacity competitiveness?



■ R&D ■ Patents □ S&E articles ■ Computers



■ Education □ Governance ■ Financial system

# Convergence or divergence in the global economy?

- Forging ahead (technology): Asian tigers
- Catching up, for different reasons, EU-accessing and Asian Developing
- EU, "Middle of the road", with small EU countries doing better than large ones
- Falling behind, along all dimensions, former CIS/South-East Europe