Population Aging, the Demographic Dividend, and Economic Growth in Asia

Joon Kyung Ha

Sang-Hyop Lee

11th Global Meeting of the NTA Network

June 20-25, 2016, Saly, Senegal

Question

- East Asia has converged toward high-income economy
- Significant part of growth has been due to demographic transition (1st and 2nd DD)
- Can the other regions of Asia fully converge? Or not?

This paper: Demography-driven middle-income trap

- Develop models that incorporate the support ratio (SR), human capital, speed of convergence, and cost of children
- Support ratio explains a lot of economic convergence in Asia toward high-income economy
- However, if fertility responds too sensitively to economic convergence or if the cost of human capital investment is too high, then a middle-income trap is possible

(1) Growth model accounting for support ratio (SR)

Aggregate production: $Y = AK^{\alpha}(hL)^{1-\alpha}$

Per capita: $y = Ak^{\alpha}h^{1-\alpha}ml$

$y = Y/N, k = K/L, m = L/N_w, l(\mathrm{DSR}) = N_w/N$

$$y = Ak^{\alpha}h^{1-\alpha}qESR \qquad q \equiv \frac{\overline{c}}{\overline{y}},\ ESR \equiv \frac{\overline{y}L}{\overline{c}N}$$

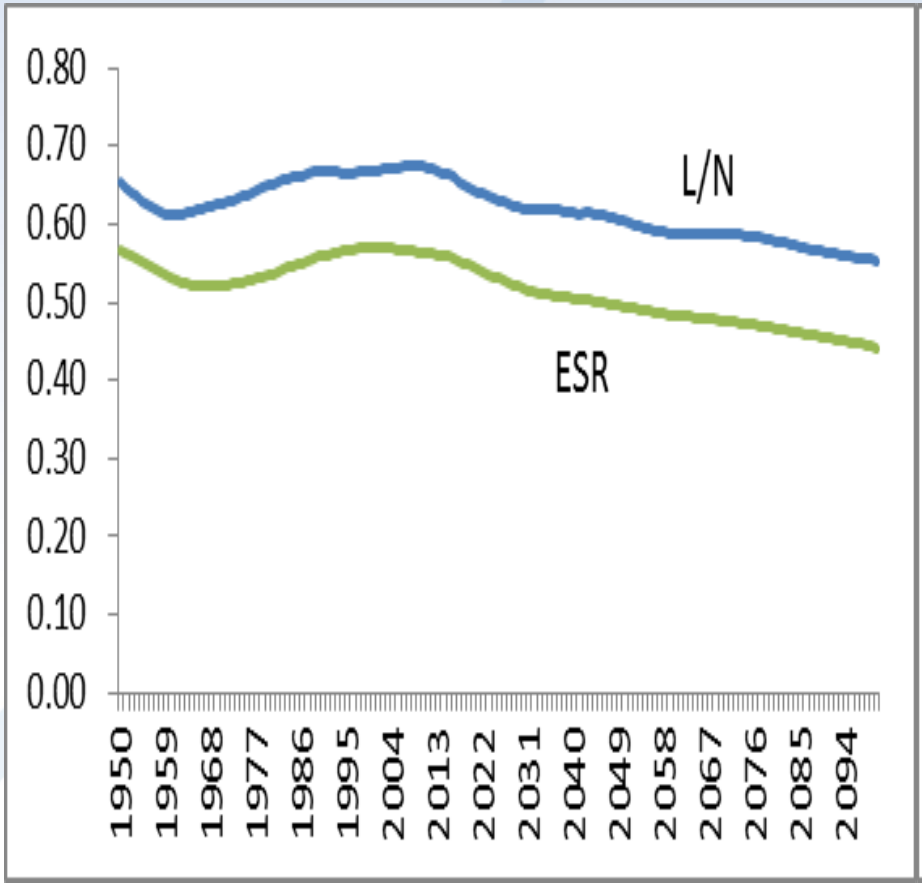
Decomposing the speed of convergence

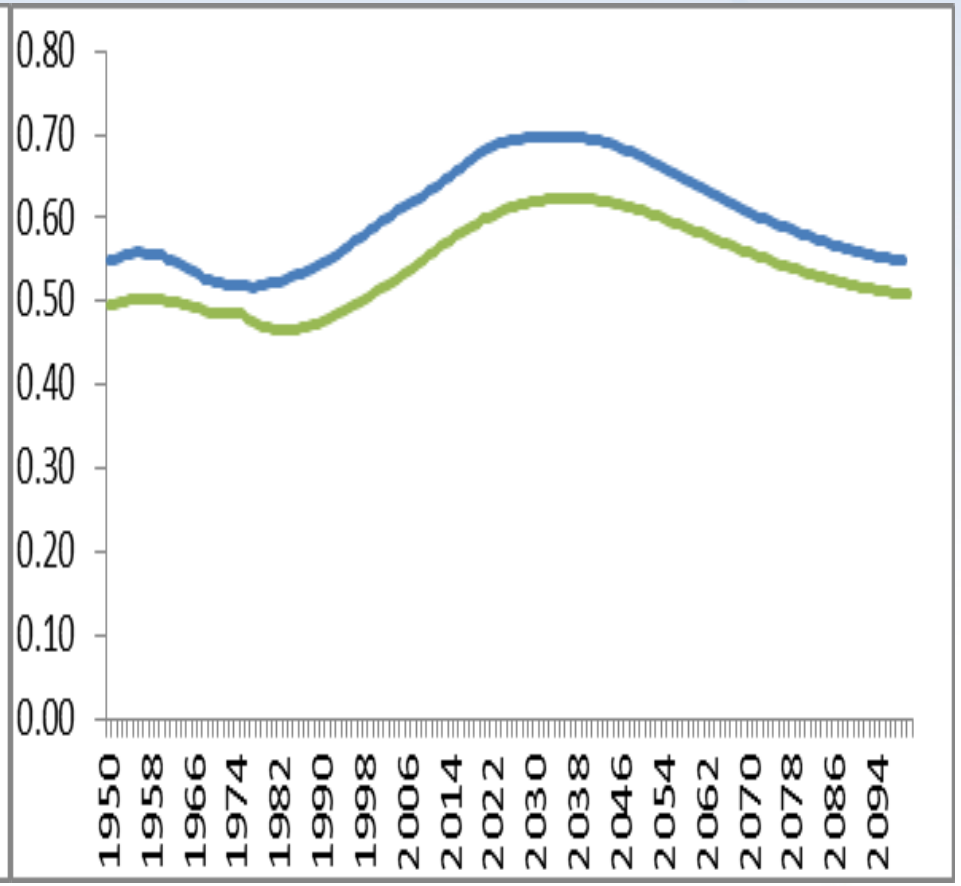
- $$\frac{y_i}{y_{max}} = \frac{A_i}{A_{max}} \frac{k_i^{\alpha}}{k_{max}^{\alpha}} \frac{h_i^{1-\alpha}}{h_{max}^{1-\alpha}} \frac{m_i}{m_{max}} \frac{l_i}{l_{max}}$$

- $$g\left(\frac{y_i}{y_{max}}\right) = g\left(\frac{A_i}{A_{max}}\right) + \alpha g\left(\frac{k_i}{k_{max}}\right) + (1-\alpha) g\left(\frac{h_i}{h_{max}}\right) + g\left(\frac{m_i}{m_{max}}\right) + \quad g\left(\frac{l}{l_{max}}\right)$$

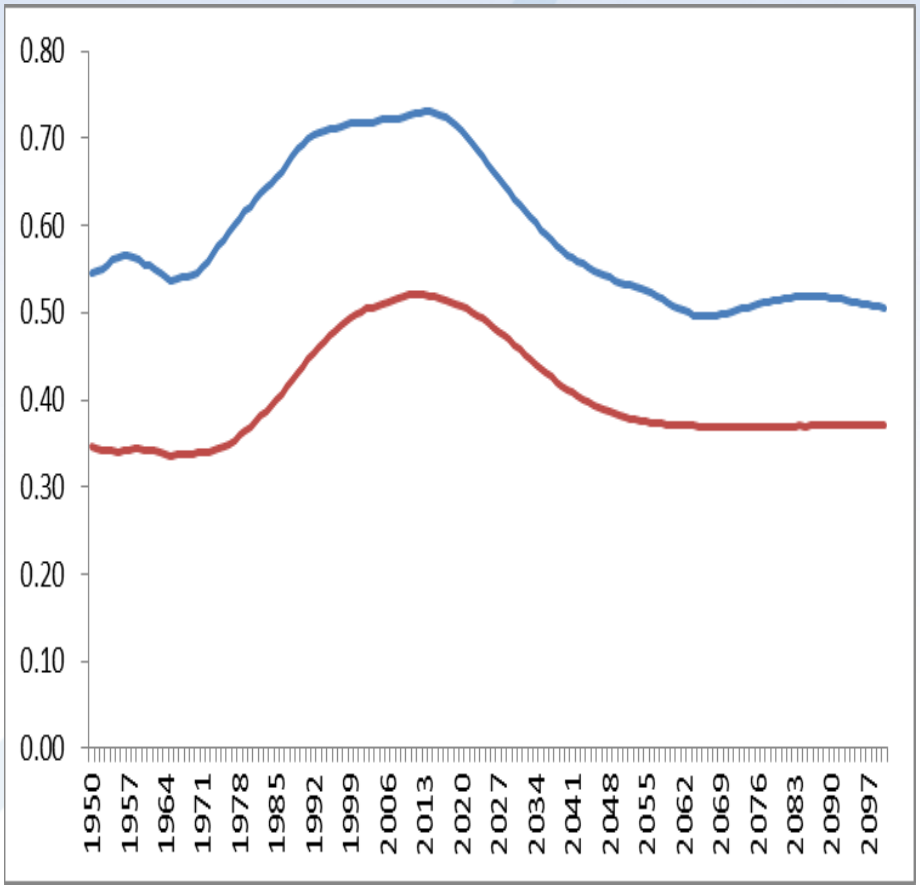
- Let's estimate: Data issues (simulation , # of countries)

Digression: DSR vs. ESR (1950–2100): Australia and Bangladesh

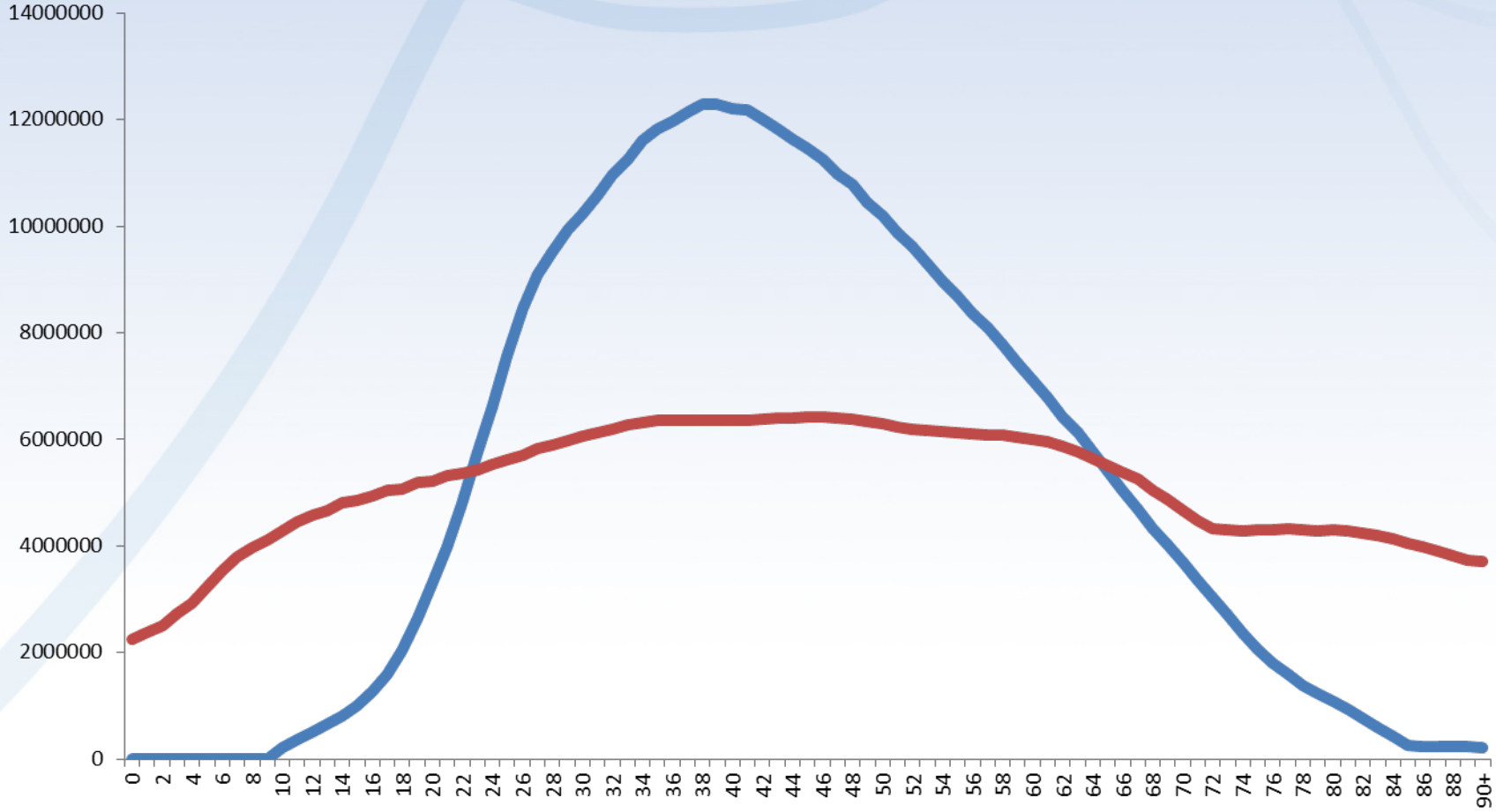




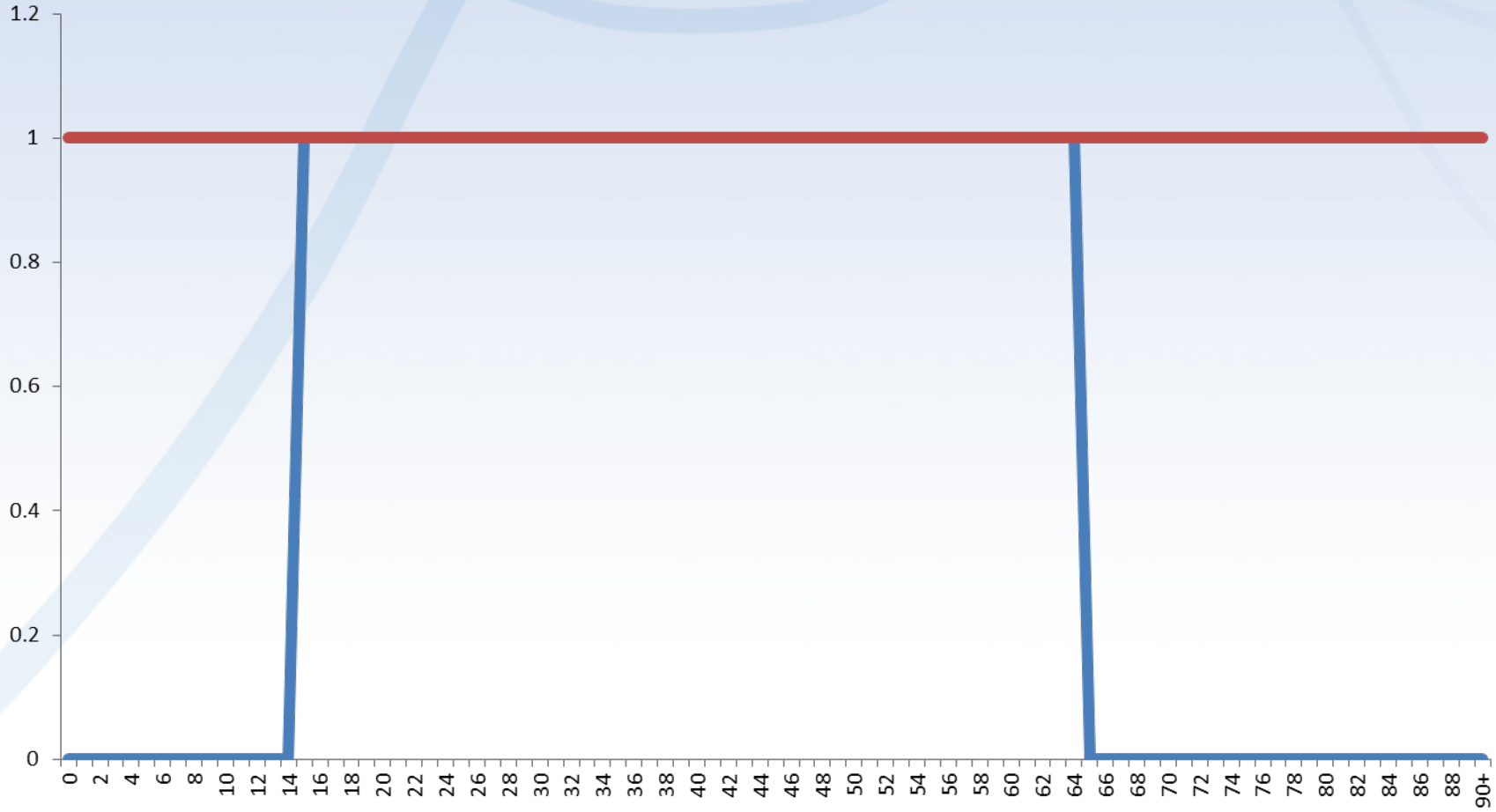
DSR vs. ESR (1950–2100): Korea and Indonesia



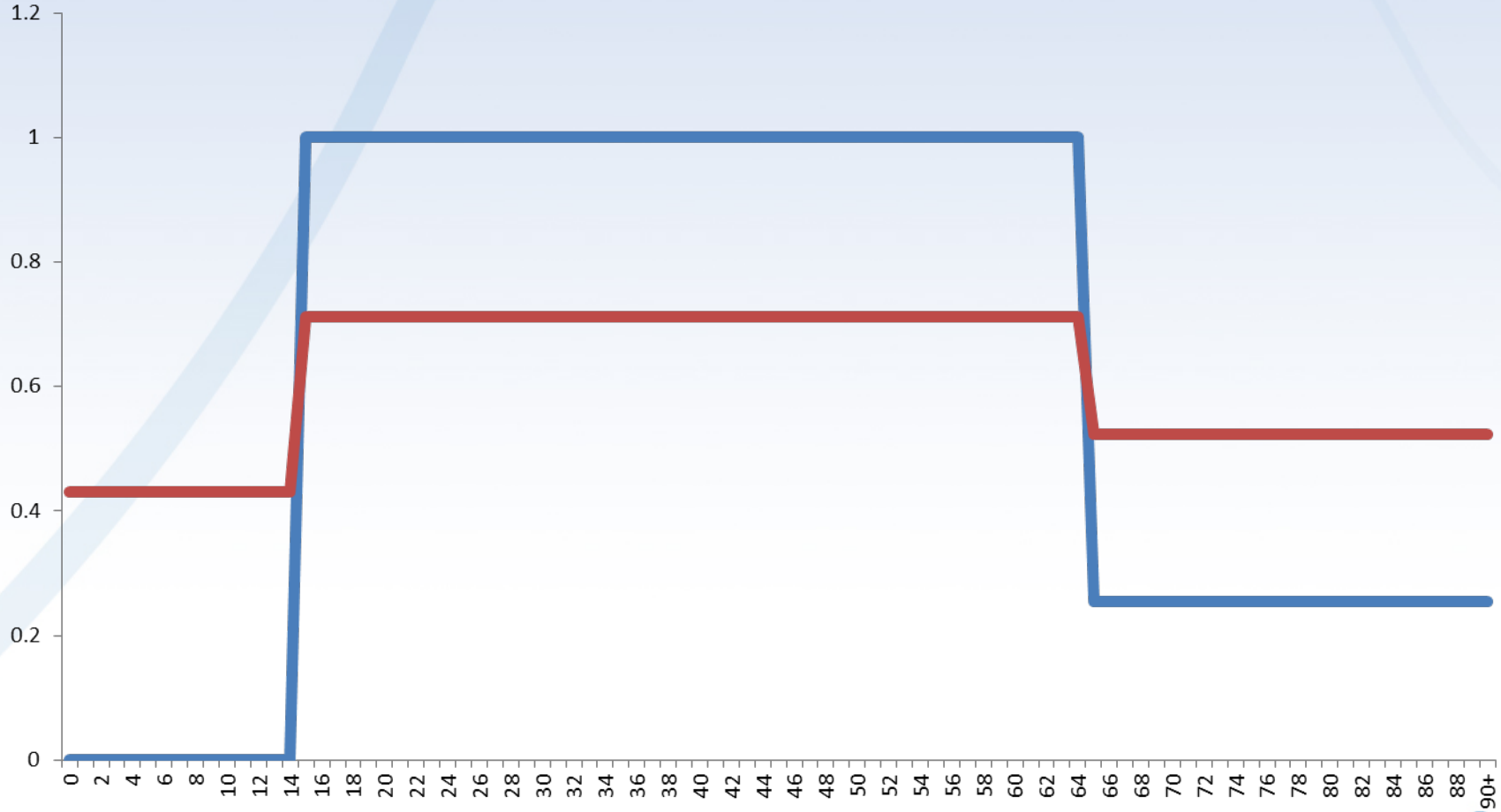
Alternative ideas? Realistic per capita flows (Lao PDR, 2012)—ESR



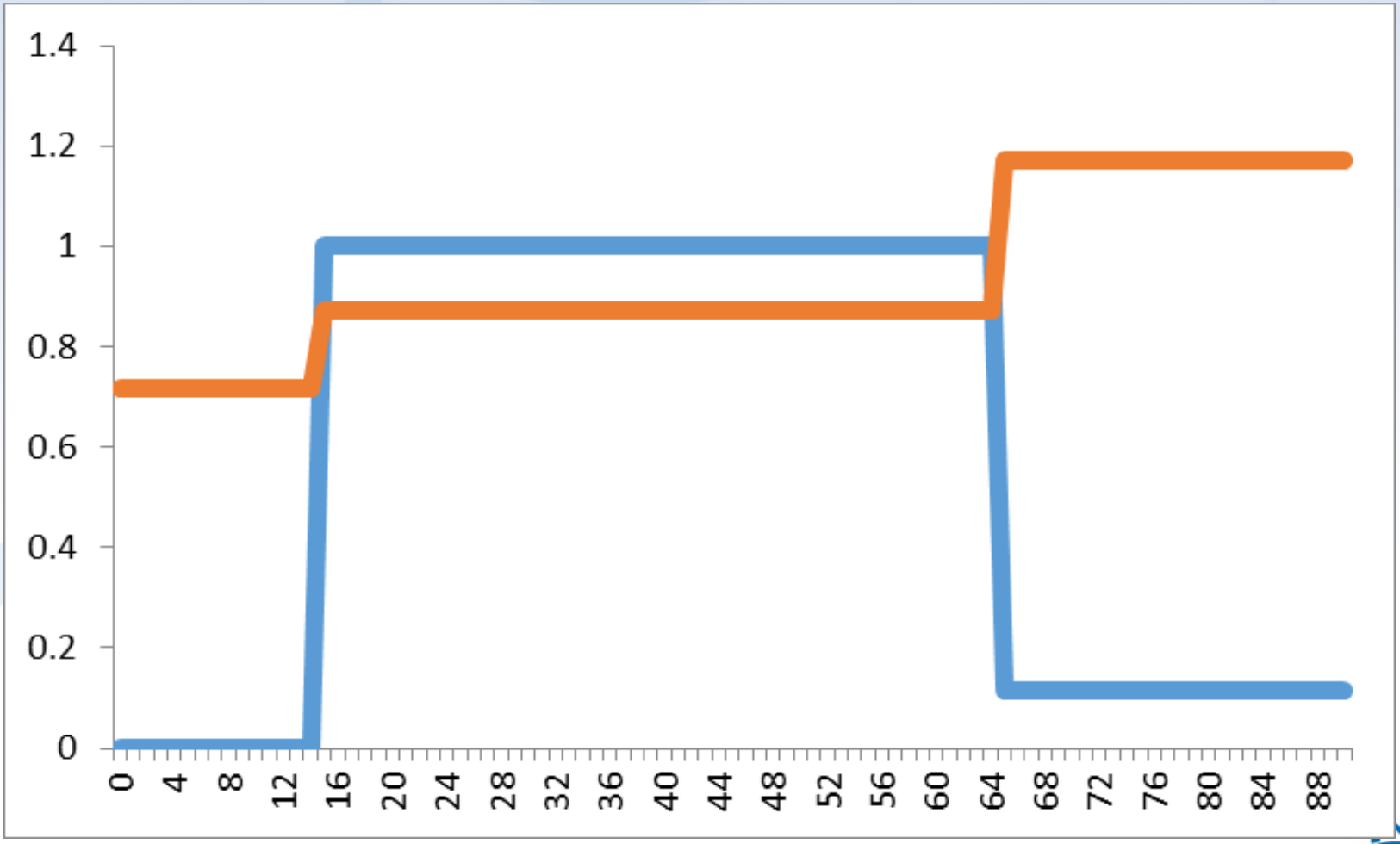
Not meaningful per capital flows: Any country—DSR



Abstract per capita flows: Lao PDR, 2012



Abstract per capita flows: Japan, 2009



Some observations on convergence (1970–2011)

- Per capita GDP
  - Convergence has been generally happening since the mid-1980s (Korea and Singapore the highest)
- Other variables
  - Capital per worker (8% in India, 50% in China) : Convergence happened only after the 1990s; however, Japan's physical capital per worker started to stagnate in the early 1990s
  - Human capital per worker converges in most Asian countries
  - TFP (18% in China, 39% in Korea) and employment/working age population: No trend and varies a lot
- Support ratios (direct impact)
  - Converging toward the US since the 1980s in most countries; however, countries such as Japan show a divergence

Figure 1. Income per capita of Asia (left) and the world (right) as a ratio of the US

Note: lb/ub refers to the 95% confidence interval.

Figure 2. Income per capita as a ratio of the US

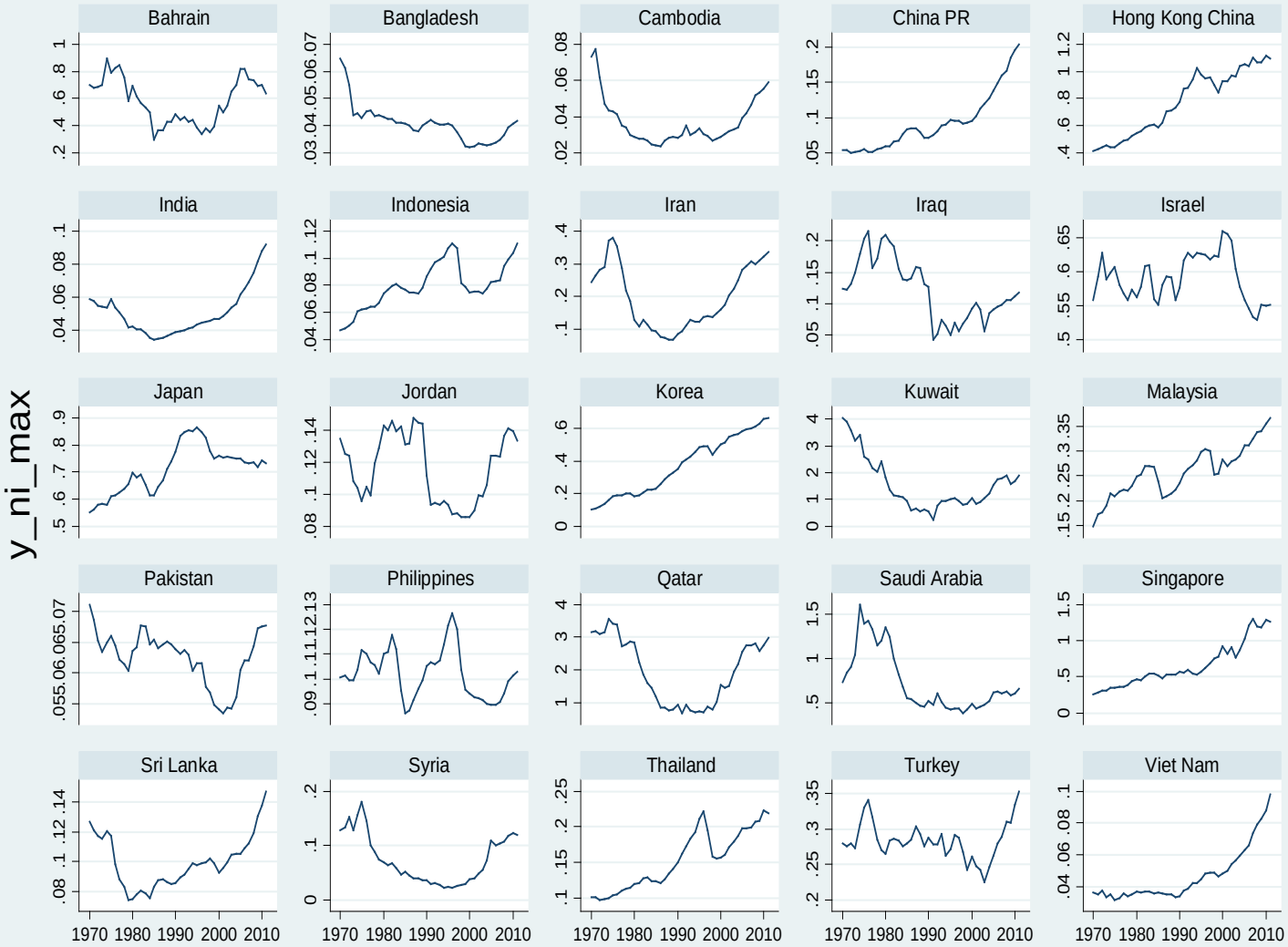
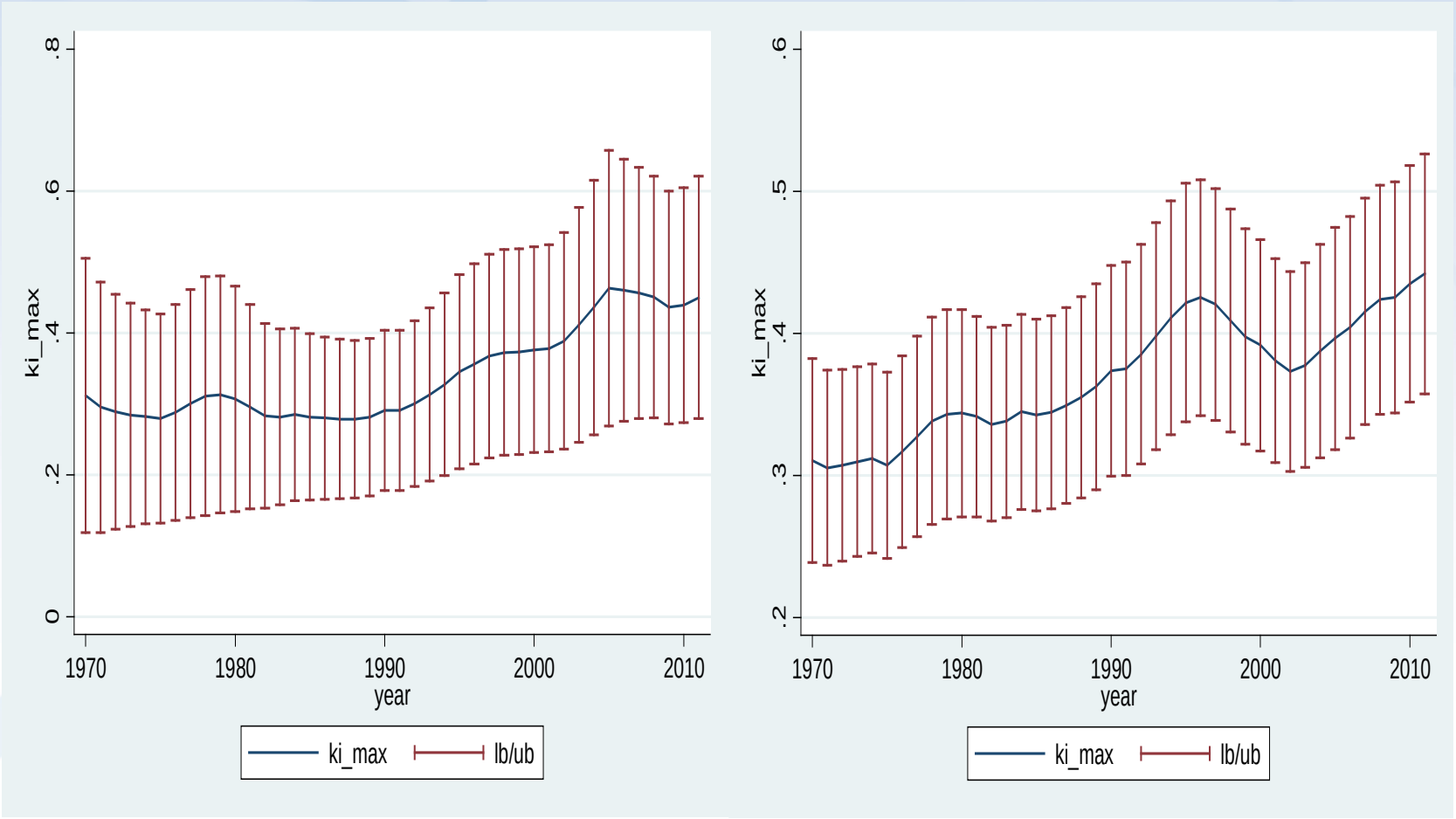


Figure 3. Capital per worker of Asia (left) and the world (right) as a ratio of the US



Note: lb/ub refers to the 95% confidence interval.

Figure 4. Capital per worker as a ratio of the US

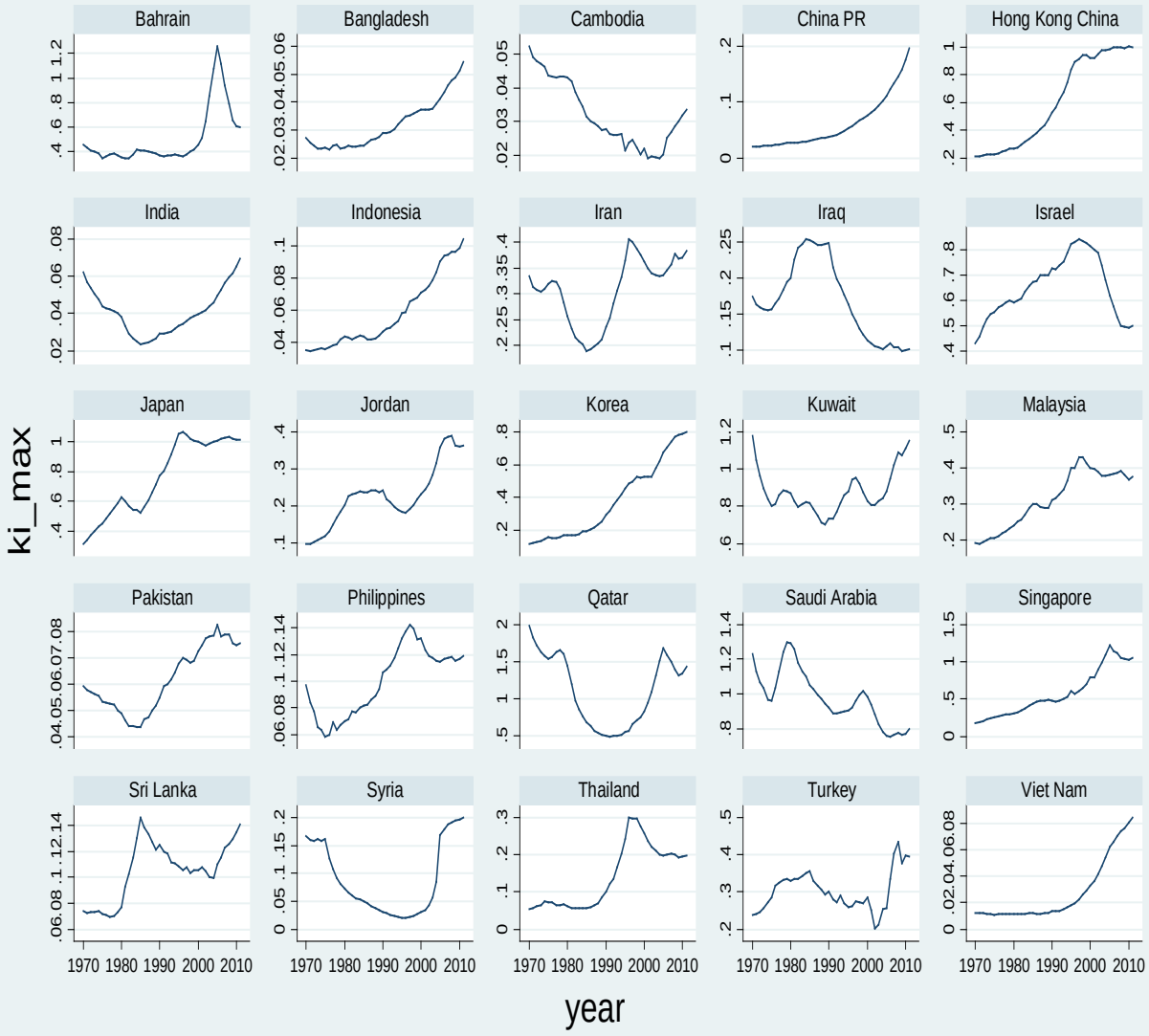
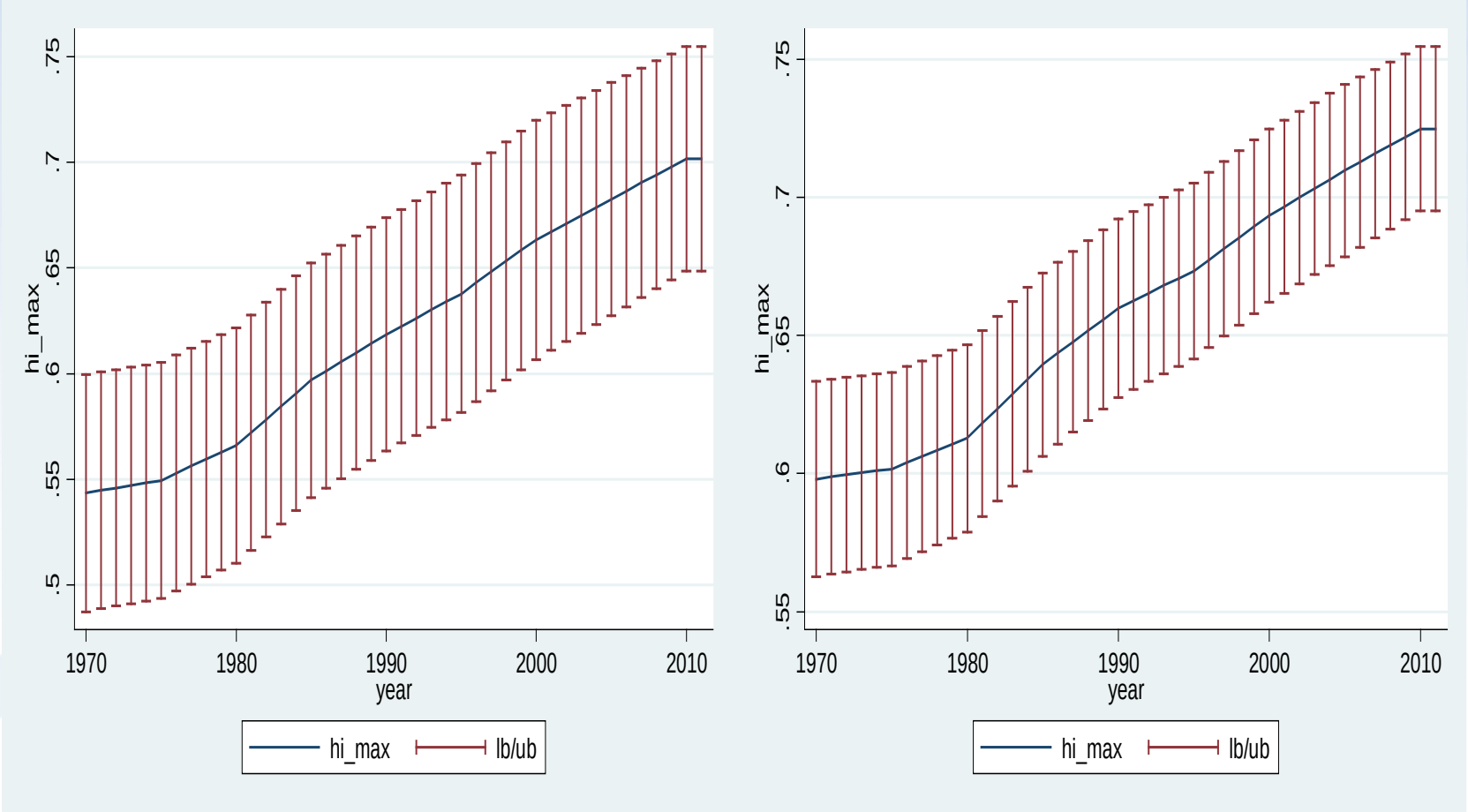


Figure 5. Human capital per worker of Asia (left) and the world (right) as a ratio of the US



Note: lb/ub refers to the 95% confidence interval.

Figure 6. Human capital per worker as a ratio of the US

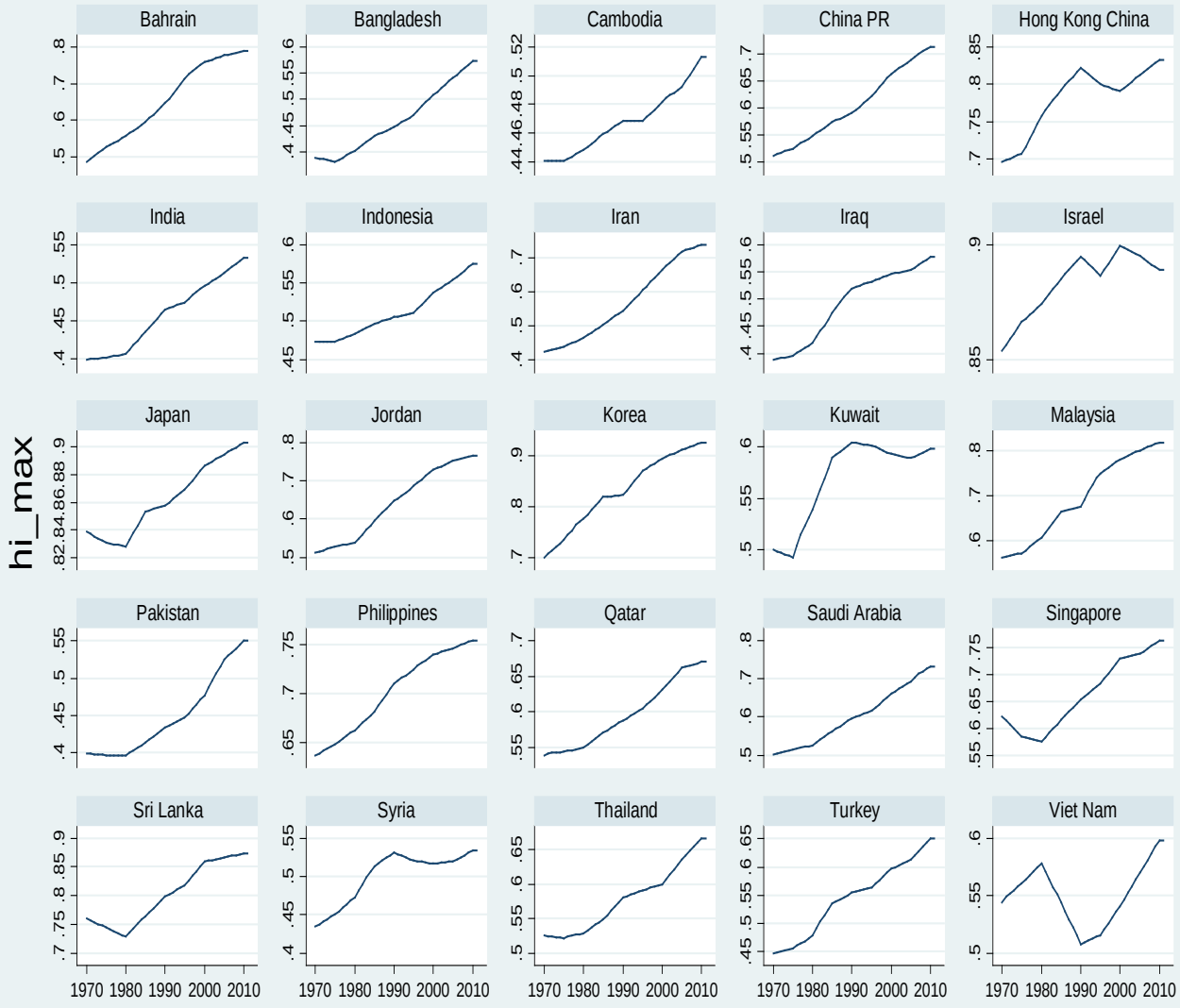
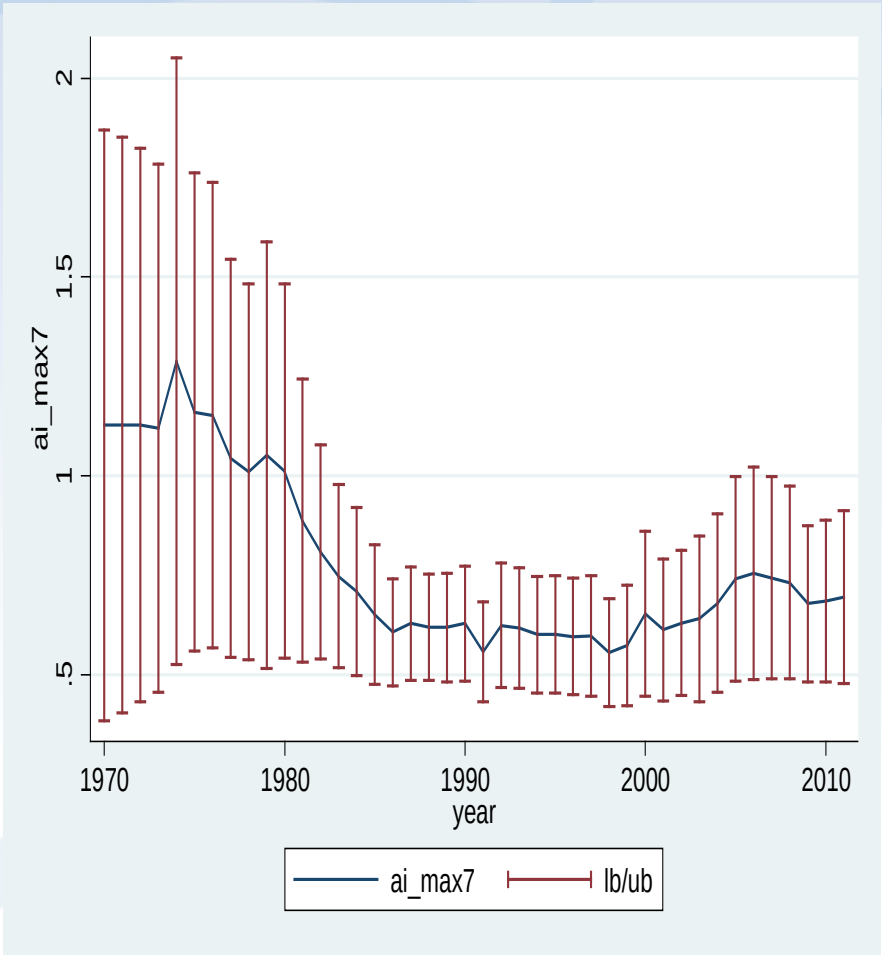
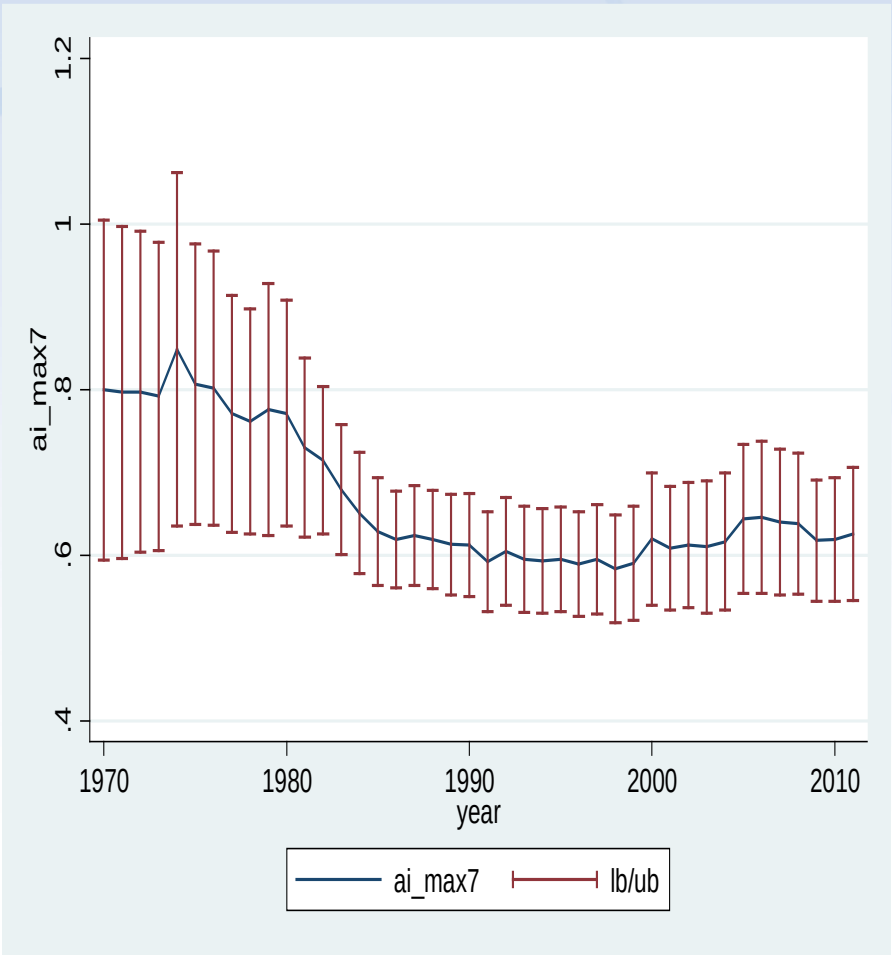


Figure 7. TFP of Asia (left) and the world (right) as a ratio of the US





Note: lb/ub refers to the 95% confidence interval.

Figure 8. TFP as a ratio of the US

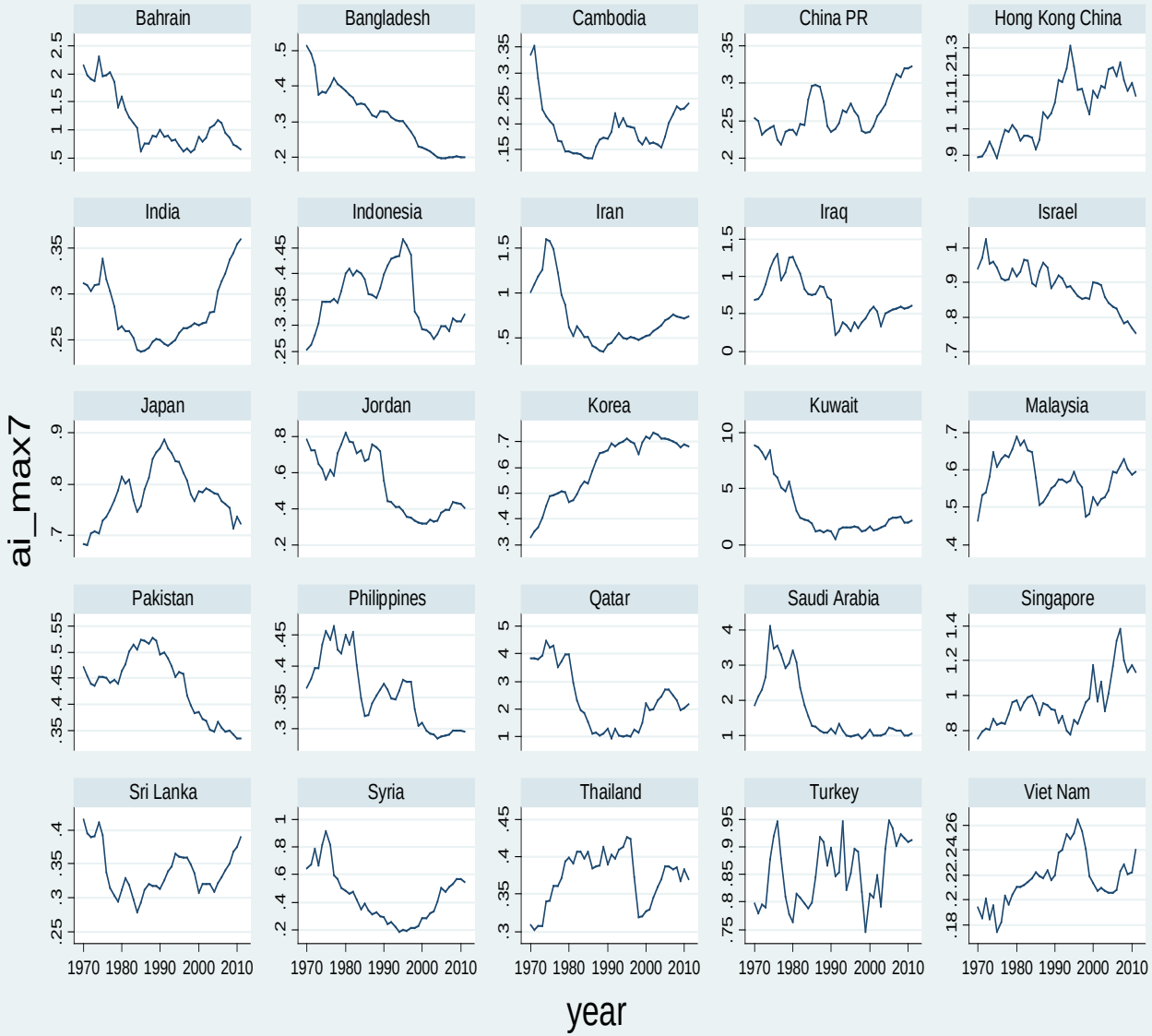
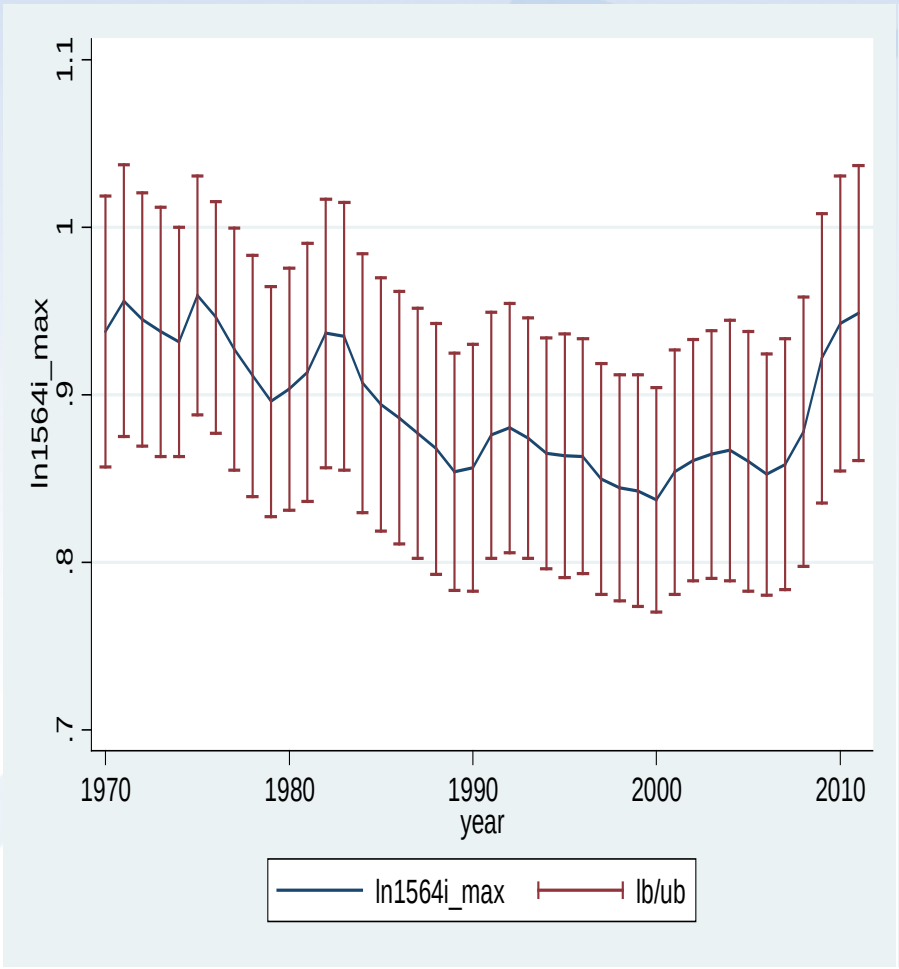
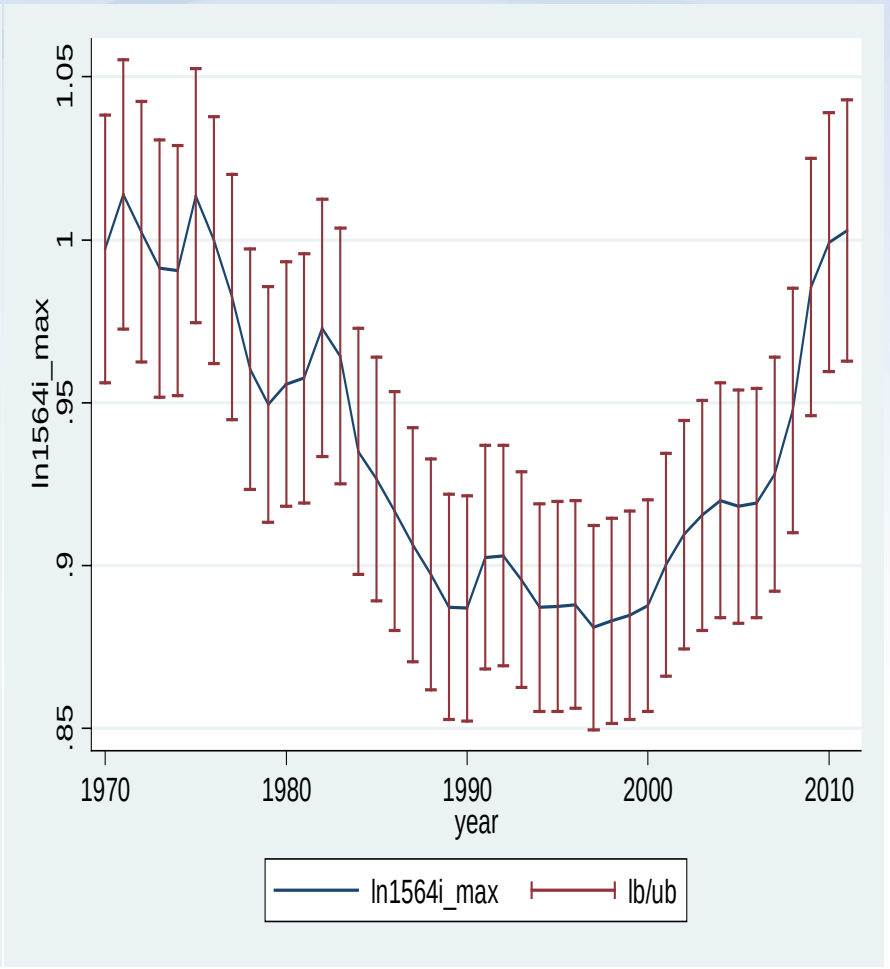


Figure 9. Employment-working age population ratio of Asia (left) and the world (right) as a ratio of the US





Note: lb/ub refers to the 95% confidence interval.

Figure 10. Employment-working age population ratio of Asia as a ratio of the US

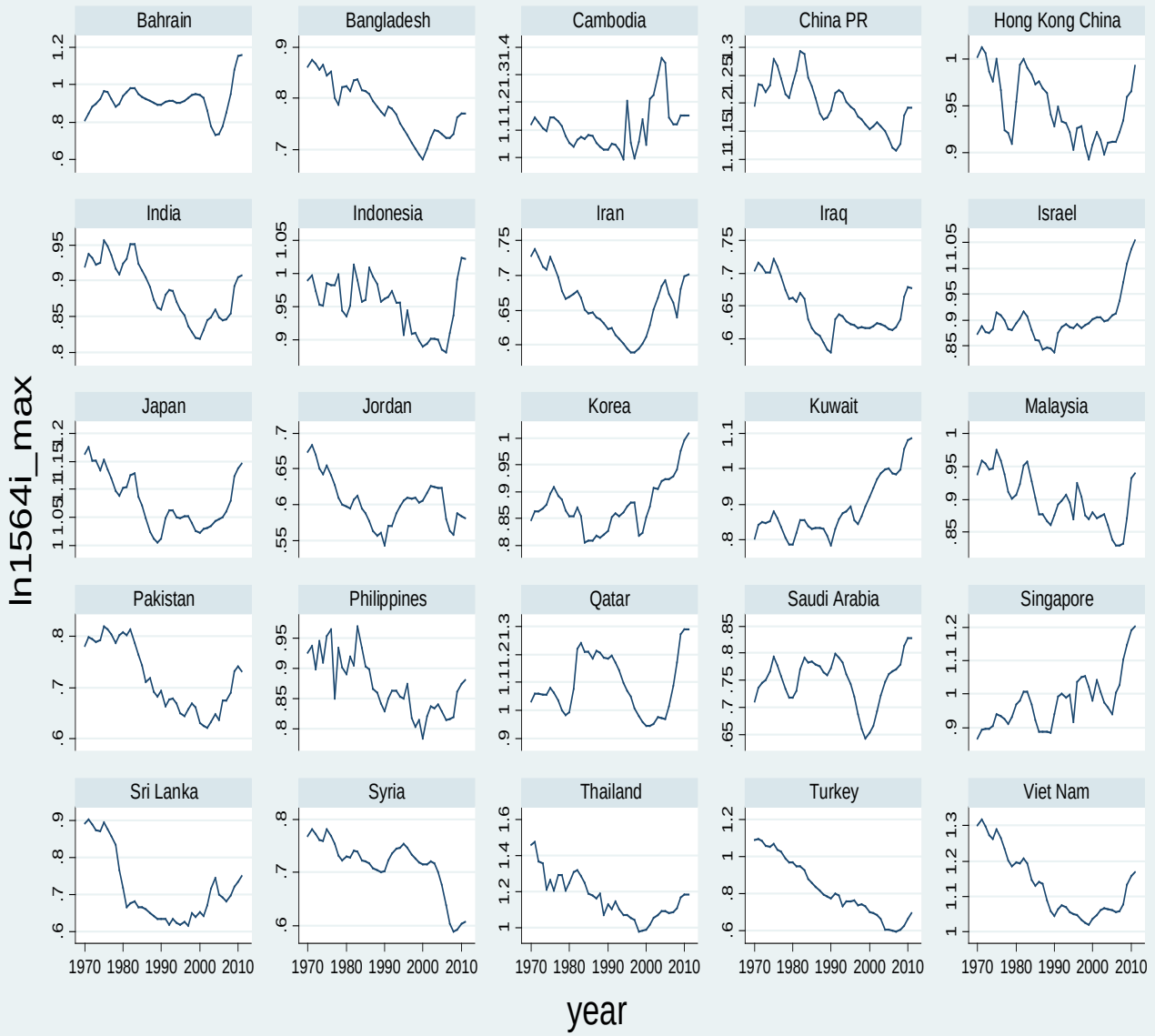
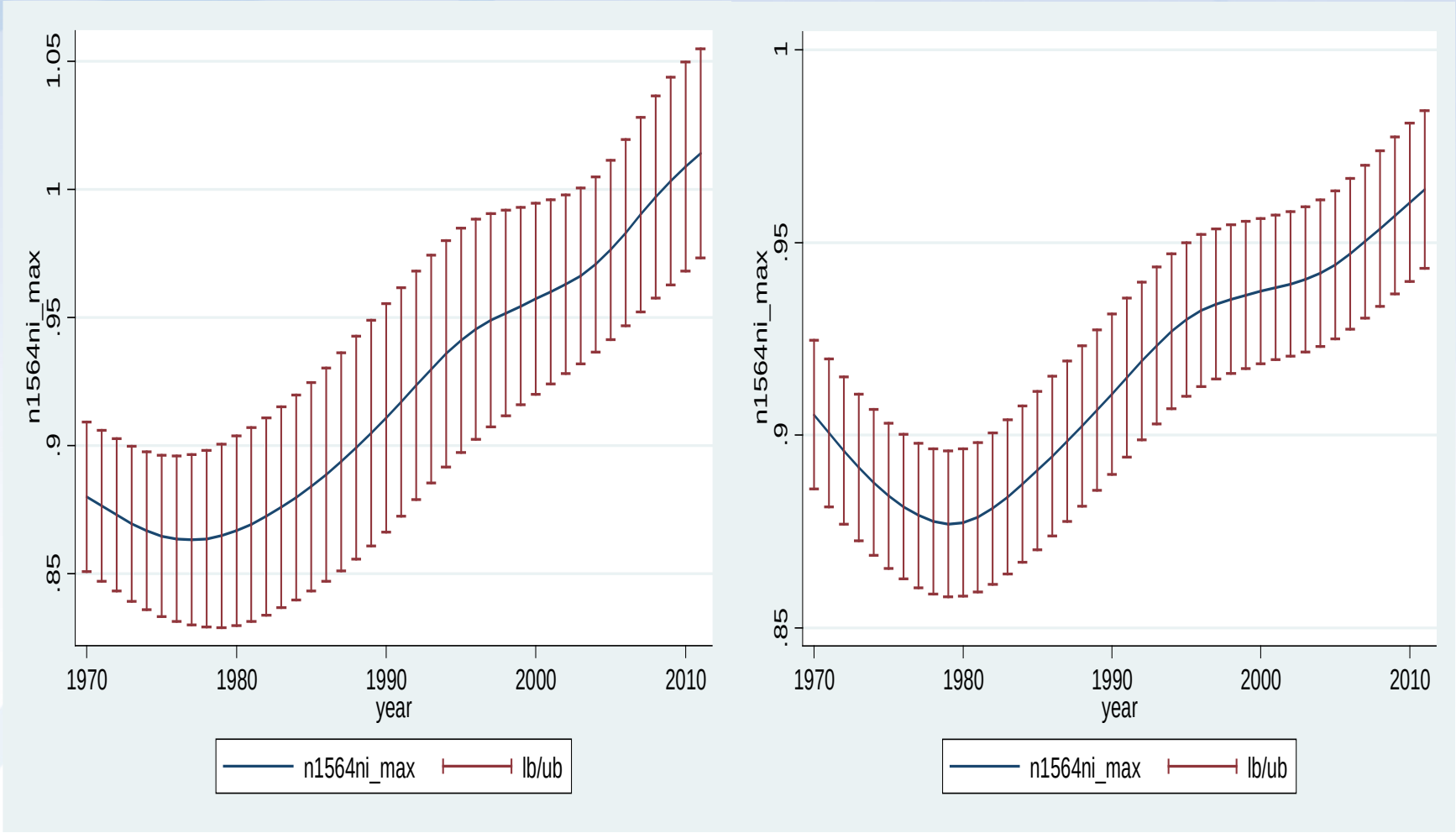
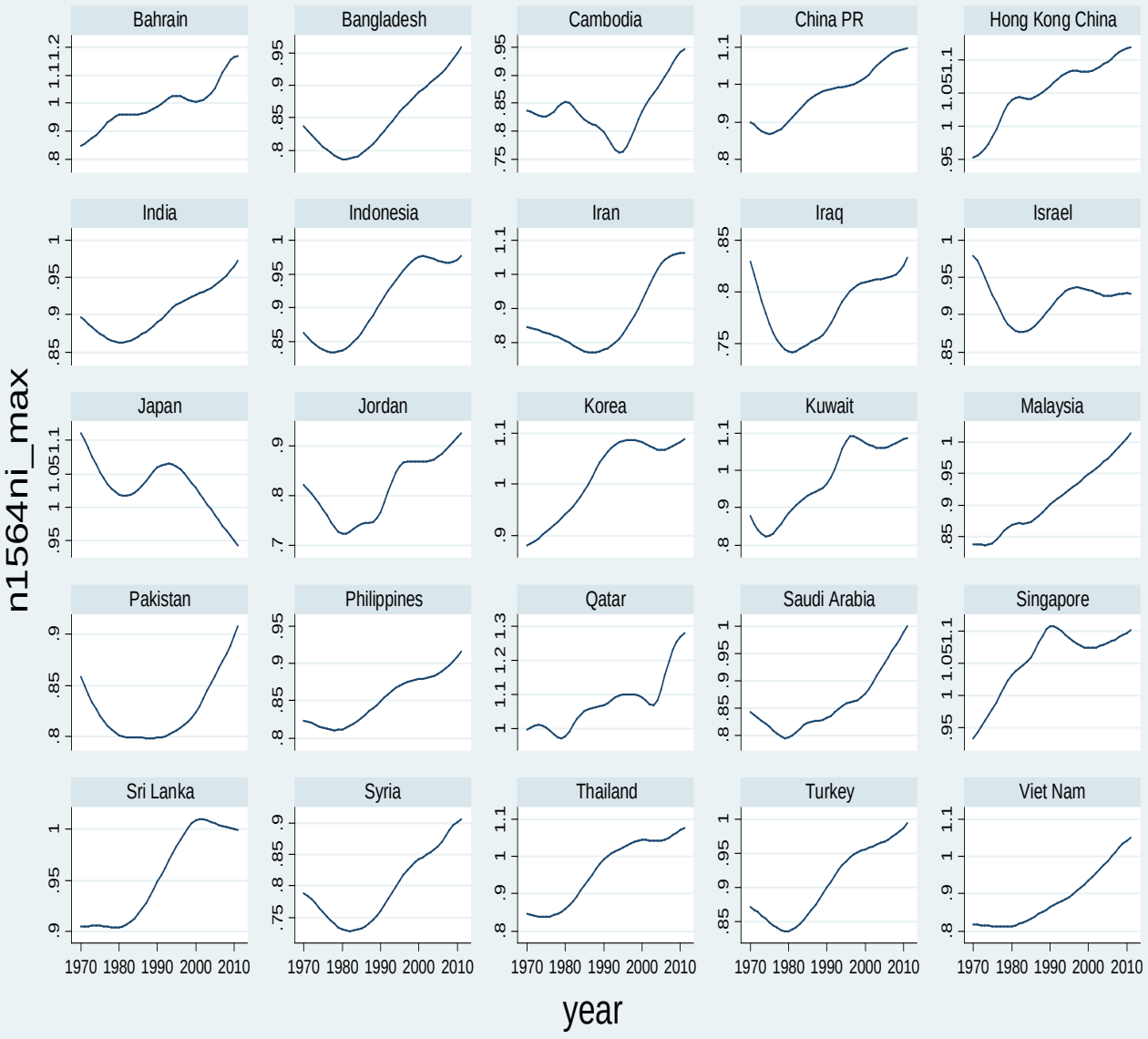


Figure 11. Support ratio of Asia (left) and the world (right) as a ratio of the US



Note: lb/ub refers to the 95% confidence interval.

Figure 12. Support ratio of Asia as a ratio of the US



(2) Model for the speed of convergence accounting for SR

- Absolute/conditional convergence hypotheses

$$g\left(\frac{y_i}{y_{max}}\right) = \beta \ln \frac{y_i}{y_{max}} + \sum \gamma_j \ln x_j$$

where x_j are investment rates and other relevant variables

- Nelson and Phelps (1966): *x* can be the level of human capital
- HC is needed to learn new technologies from the frontier

- **Our hypothesis: support ratio matters for the speed of convergence**
- Support ratio ↑ ➔ Saving/Investment ↑ ➔ Convergence ↑
- Sort of "2nd DD"

Figure 13. Support ratio (x-axis) and national saving rate (y-axis) for selected countries

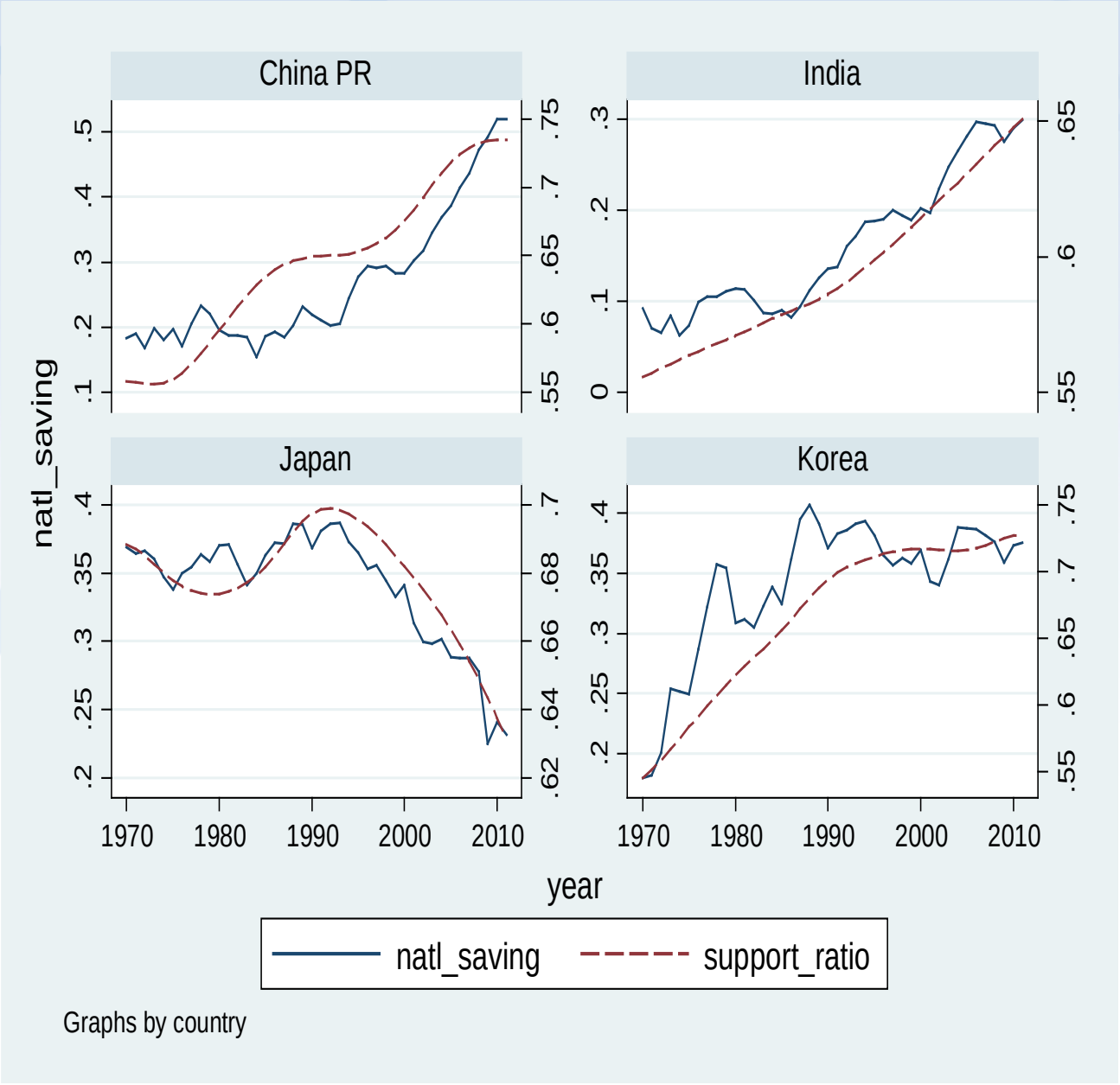


Table 2. Support ratios and national saving (GDP minus consumption and gov't spending) as a ratio of GDP – panel regression results for world and Asia

Dependent variable	National saving – world		National saving - Asia	
	Random effect	Fixed effect	Random effect	Fixed effect
Level of support ratio	1.7618*** (0.1595)	1.5337*** (0.1646)	1.9178*** (0.2348)	1.8443*** (0.2372)
Constant	-9.1003*** (0.6556)	-8.0694*** (0.6753)	-9.4484*** (0.9719)	-9.0777*** (0.9742)
# observations	3558	3558	988	988
# countries	93	93	25	25
R square	0.2166	0.2166	0.1660	0.1660

Note: All variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, 1%, respectively.

By sub-region in Asia (preliminary)

Region	coefficient	t value
East Asia	2.11	(10.49)
South Asia	2.34	(5.05)
South-East Asia	1.41	(5.01)

Panel regression with fixed effects, 1970–2011
Dependent variable: National saving rate (log)
Independent variable: Support ratio (log)

Table 3. Support ratios and investment rates – panel regression results for world and Asia

Dependent variable	Investment rate - world		Investment rate - Asia		Gov't edu spending (% of GDP) - world		Gov't edu spending (% of GDP) - Asia	
	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect
Level of support ratio	1.0698*** (0.0879)	0.9325*** (0.0910)	1.6192*** (0.1352)	1.5875*** (0.1384)	1.1462*** (0.0987)	1.1876*** (0.1026)	1.2465*** (0.1275)	1.2836*** (0.1289)
Constant	-6.0513*** (0.3611)	-5.4897*** (0.3724)	-8.2013*** (0.5570)	-8.0713*** (0.5674)	-3.3489*** (0.4067)	-3.4799*** (0.4221)	-3.9436*** (0.5300)	-4.0481*** (0.5294)
# observations	3906	3906	1050	1050	2077	2077	540	540
# countries	93	93	25	25	93	93	25	25
R square	0.2555	0.2555	0.2253	0.2253	0.0422	0.0422	0.0103	0.0103

Note: All variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, 1%, respectively.

Estimating $g\left(\frac{y_i}{y_{max}}\right) = \beta \ln \frac{y_i}{y_{max}} + \sum \gamma_j \ln x_j$

Table 4. Panel regression results for the speed of convergence (1)

Dependent variable: speed of convergence	(1) World		(1) Asia		(2) World		(2) Asia	
	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effec
GDP per capita relative to the US	-0.0020 (0.0019)	0.0446*** (0.0052)	-0.0065* (0.0037)	0.0360*** (0.0105)	-0.0022 (0.0018)	0.0449*** (0.0052)	-0.0060* (0.0036)	0.0341*** (0.0102)
Investment rate relative to the US	0.0075 (0.0031)	0.0088** (0.0041)	-0.0003 (0.0083)	-0.0168* (0.0098)	0.0064** (0.0031)	0.0083** (0.0041)	0.0009 (0.0081)	-0.0169* (0.0098)
Average human capital relative to the US	-0.0068 (0.0085)	0.0513** (0.0206)	0.0139 (0.0201)	0.0442 (0.0533)				
Support ratio relative to the US	0.1021*** (0.0215)	0.1000*** (0.0379)	0.1666*** (0.0427)	0.2032** (0.0873)	0.0937*** (0.0195)	0.1577*** (0.0290)	0.1783*** (0.0391)	0.2574*** (0.0577)
Constant	0.0081*** (0.0030)	0.1092*** (0.0117)	0.0195** (0.0097)	0.1079*** (0.0300)	0.0100*** (0.0024)	0.0922*** (0.0087)	0.0144** (0.0063)	0.0874*** (0.0168)
# observations	3772	3772	1025	1025	3813	3813	1025	1025
# countries	92	92	25	25	93	93	25	25
R square	0.0163	0.0089	0.0243	0.0081	0.0153	0.0092	0.0239	0.0086

Note: All variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, 1%, respectively.

$$g\left(\frac{y_i}{y_{max}}\right) = \beta \ln \frac{y_i}{y_{max}} + \sum \gamma_j \ln x_j$$

Table 5. Panel regression results for the speed of convergence (2)

Dependent variable: speed of convergence	(3) World		(3) Asia		(4) World		(4) Asia	
	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effec
GDP per capita relative to the US	-0.0015	0.0457***	-0.0059*	0.0328***				
	(0.0018)	(0.0052)	(0.0035)	(0.0102)				
Support ratio relative to the US	0.1040***	0.1698***	0.1796***	0.2244***	0.0919***	0.1956***	0.1433***	0.2722***
	(0.0189)	(0.0284)	(0.0373)	(0.0545)	(0.0125)	(0.0285)	(0.0305)	(0.0526)
Constant	0.0113***	0.0934***	0.0146**	0.0830***	0.0125***	0.0224***	0.0212**	0.0326***
	(0.0024)	(0.0087)	(0.0058)	(0.0167)	(0.0018)	(0.0030)	(0.0043)	(0.0057)
# observations	3813	3813	1025	1025	3813	3813	1025	1025
# countries	93	93	25	25	93	93	25	25
R square	0.0142	0.0089	0.0238	0.0084	0.0140	0.0140	0.0211	0.0211

Note: All variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, 1%, respectively.

(3) Model for the MIT accounting for SR

- Household's utility maximization: quality-quantity tradeoff
- $\mathrm{u} = \chi \log(\mathrm{b}) + (1-\chi)\log(c)$ s. t. b.c. $\tau \mathrm{I} \mathrm{b} + \mathrm{c} \leq \mathrm{I}$,

$$b = \frac{\chi}{\tau}$$

(b: fertility, χ: benefit, τ: child-rearing cost)

Our hypothesis: $\boldsymbol{\tau = \mathrm{z}\left(\frac{y_{i,-1}}{y_{max,-1}}\right)^{\eta} h_{-1}^{\nu}}$

$$\log(b) = \log(\chi) - \log(\mathrm{z}) - \eta \log\left(\frac{y_{i,-1}}{y_{max,-1}}\right) - \nu \log(h_{-1})$$

Figure 16. The stages of economic convergence and possibility of a middle income trap

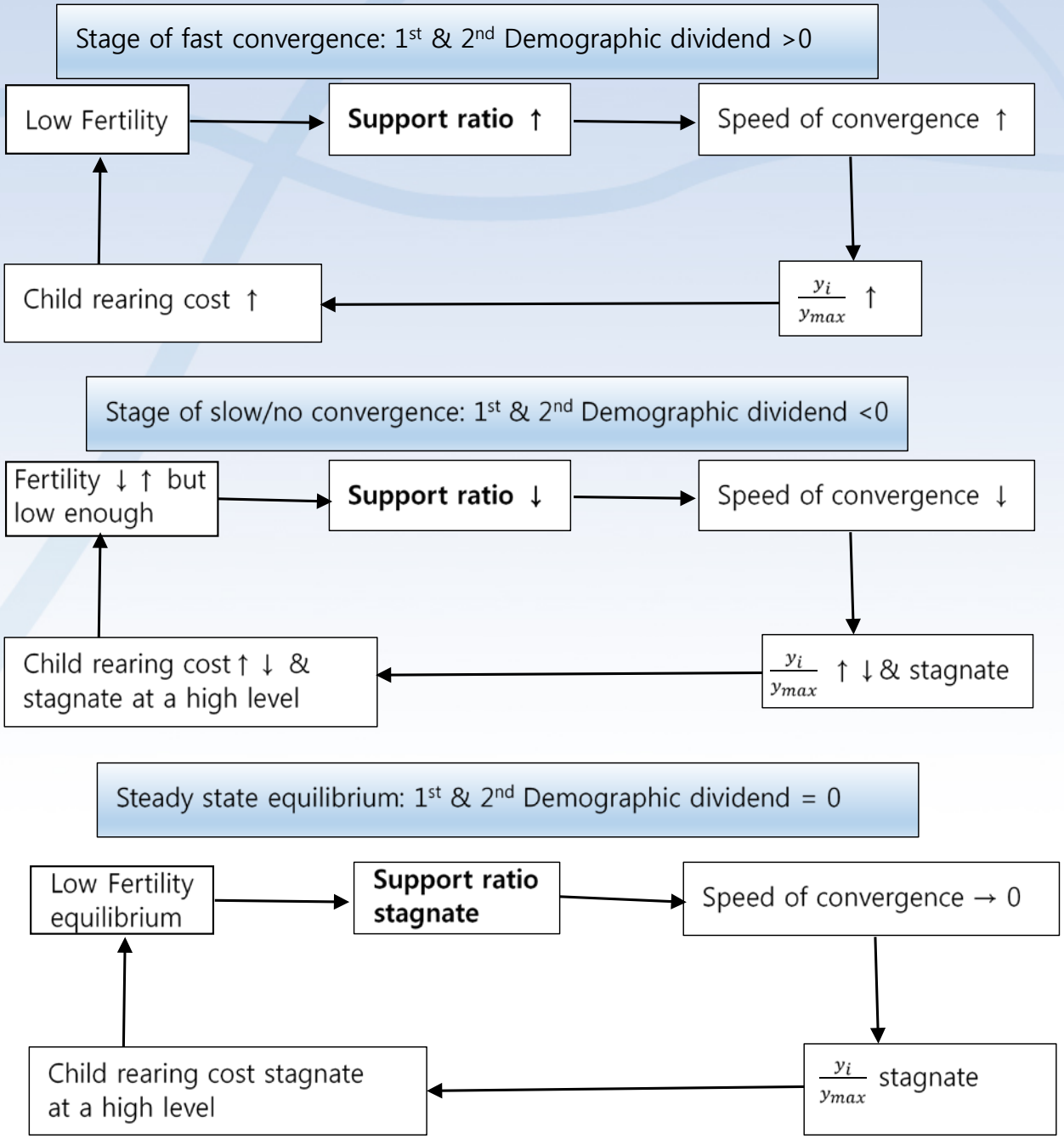


Table 6. Panel regression results for fertility – world and Asia

Dependent variable: fertility	(1) World		(1) Asia		(2) World		(2) Asia	
	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effect	Random effect	Fixed effec
GDP per capita relative to the US(lagged)	-0.0422*** (0.0078)	-0.0411*** (0.0082)	-0.0907*** (0.0130)	-0.0999*** (0.0133)	-0.0878*** (0.0133)	-0.0120*** (0.0152)	-0.1373*** (0.0263)	-0.1377*** (0.0288)
Level of human capital per worker(lagged)	-1.6510*** (0.0177)	-1.6568*** (0.0180)	-2.0574*** (0.0341)	-2.0695*** (0.0340)				
Constant	2.3166*** (0.0330)	2.3229*** (0.0189)	2.5219*** (0.0724)	2.5156*** (0.0342)	0.9646*** (0.0381)	1.0870*** (0.0246)	0.9621*** (0.0866)	0.9619** (0.0492)
# observations	3771	3771	1024	1024	3812	3812	1024	1024
# countries	92	92	25	25	93	93	25	25
R square	0.6873	0.6869	0.5036	0.5006	0.4786	0.4786	0.1017	0.1017

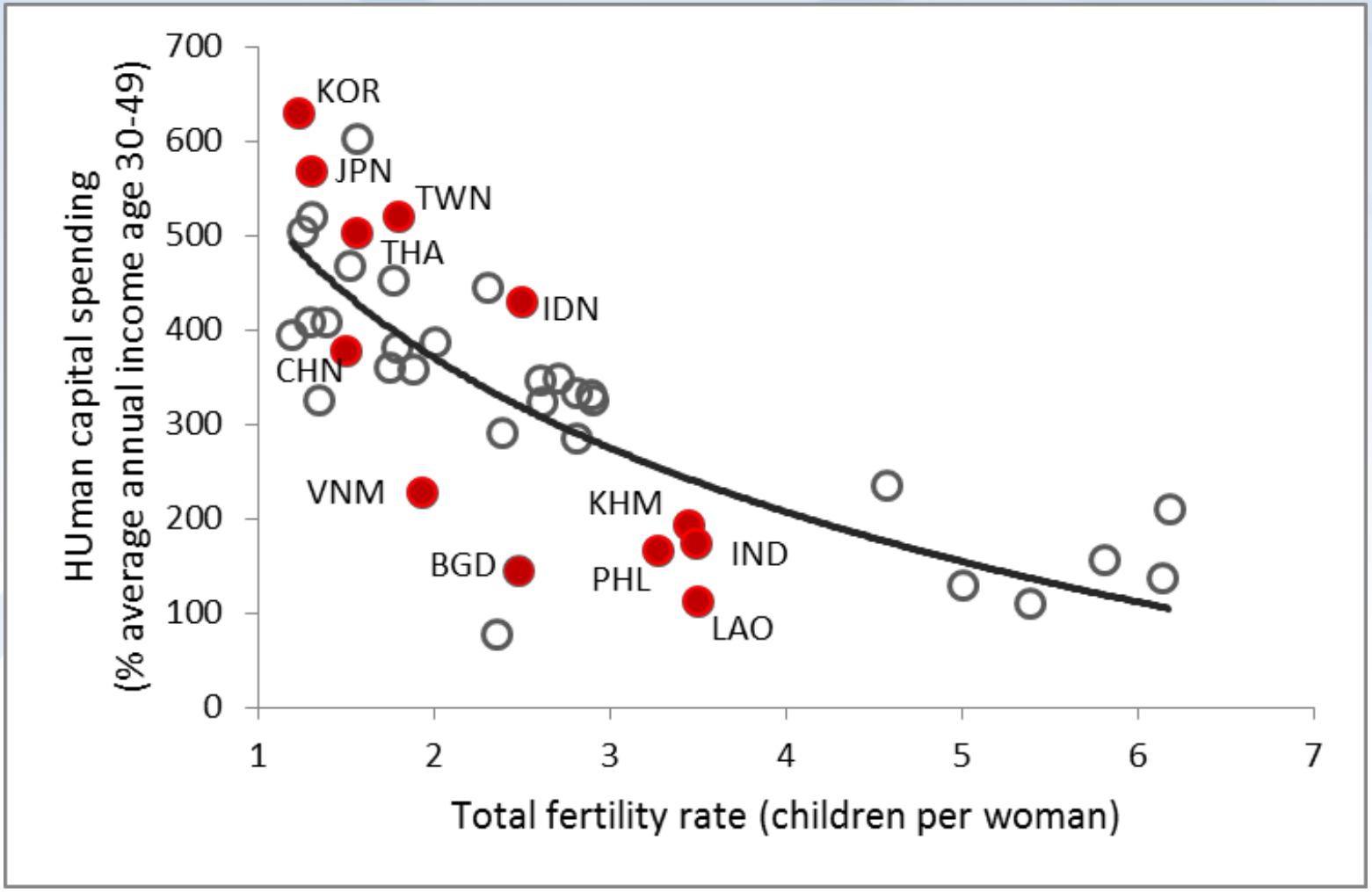
Note: All variables are logged. Numbers in parenthesis are standard errors. *, **, *** refers to the significance level of 10%, 5%, 1%, respectively.

By sub-region in Asia (preliminary)

Region	coefficient	t value
East Asia	-0.833	(-24.12)
South Asia	-0.170	(-2.01)
South-East Asia	-0.798	(-16.10)

Panel regression with fixed effects, 1970–2011
Dependent variable: Level of development: GDP per capita as a ratio of the US (log)
Independent variable: Total fertility (log)

Fertility/human capital tradeoff



Updated from NTA database www.ntaccounts.org

Conclusion

- Support ratio explains a lot of economic convergence in Asia toward high-income economy
- Asia's speed of convergence is highly sensitive to support ratios
  - Efficiently reaping the benefits of the demographic dividend
- Asia's fertility is perhaps too sensitive to economic development

  (Getting "very" old before getting rich in Asia)
  - Demographic dividend grows faster but it also declines faster: Possibility of demography-driven middle income trap
- East Asia vs. South East Asia
  - There may be within-Asia convergence for some time, but it is not clear if Asia will eventually converge to the frontier countries

What is necessary for convergence? (avoiding DD MIT)

- Reducing fertility below the long-run SR-optimal level falls into a trap

- Raising fertility in the short-run could be very costly → making fertility less sensitive to the level of development?
  - Socializing costs of childbearing?
  - Reducing transfers to elderly?