International spillovers in a world of technology clubs

Roman Stöllinger
Vienna Institute for International Economic Studies (wiiw)

October 29th, 2011
Schumpeter Conference, Vienna

wiiw

Objective

- Test the catch-up hypothesis of the Convergence Club literature: Do Countries with higher absorptive capacity benefit more strongly from international technology spillovers?
- Detect non-linearities in the catch-up effect of countries within a Benhabib-Spiegel type growth framework using threshold regressions

Related Literature

Theoretical Background

- Howitt & Mayer-Foulkes (2005)

  R&D, Implementation and Stagnation: A Schumpeterian Theory of Convergence Clubs

Empirical work

- Benhabib & Spiegel (1994), (2005)

  The role of human capital in economic development
  Human capital and technology diffusion

- Castellacci (2008)

  Technology clubs, technology gaps and growth trajectories development

- Crespo, Martín & Velázquez (2004)

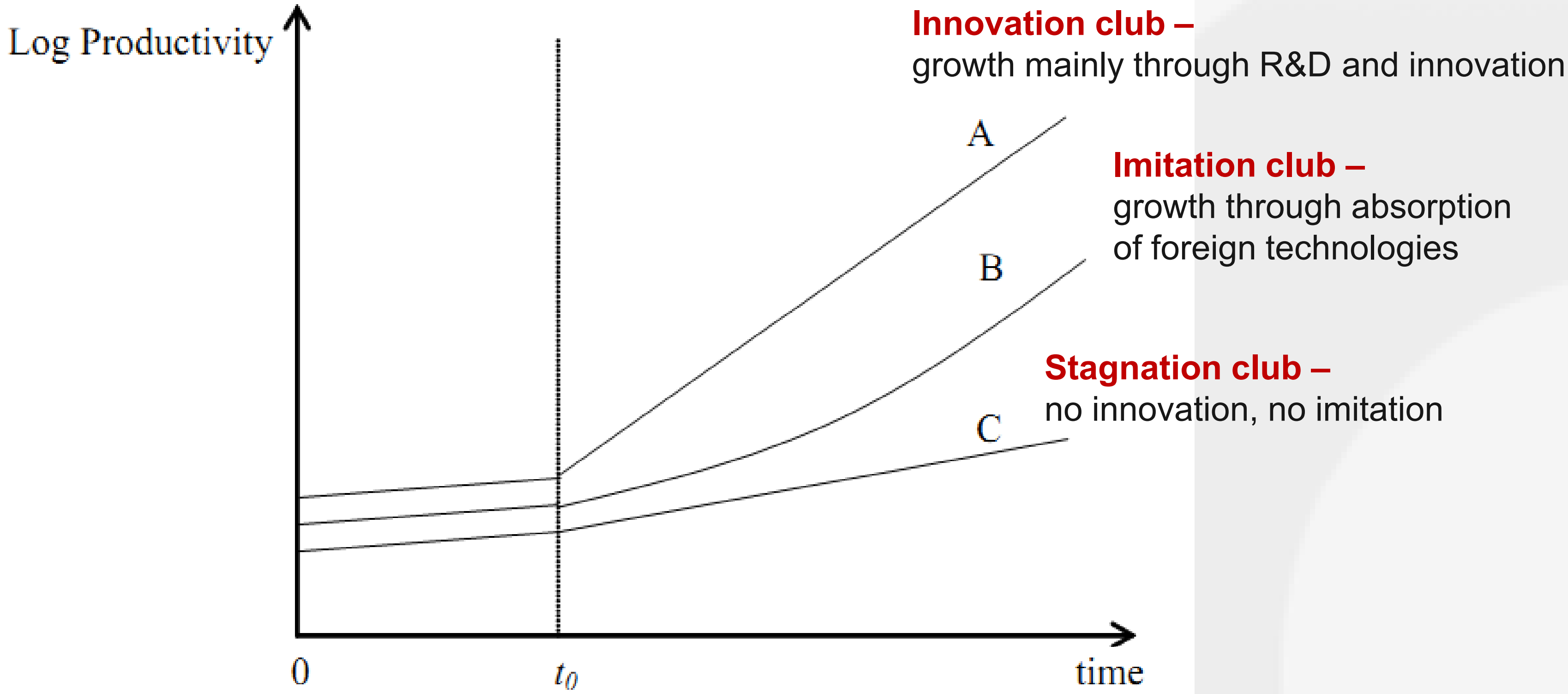
  The role of International Technology Spillovers in Economic Growth of the OECD countries

Data

- World Development Indicators
  GDP, labour force, GFCF for the years 1980-2009
- Barro-Lee Educational Attainment Databaset
  average years of schooling for 1980-2010
- Data for 76 countries
- The time span 1980-2009 is divided into 6 five-year periods

Theory of Convergence Clubs

- A country's long term growth is determined by its innovative and absorptive capacities (multiple equilibria)



Source: Howitt & Mayer-Foulkes (2005)

wiiw

Empirical Model

- Cobb-Douglas production function

$$\Delta ln\, Y_{it} = \alpha \cdot \Delta ln\, K_{it} + \beta \cdot \Delta ln\, L_{it} + \Delta ln A_{it} + \varepsilon_{it}$$

- Law of motion for productivity à la Benhabib-Spiegel

$$\Delta ln\, A_{it} = \gamma + \delta \cdot H_{it} + \underbrace{\phi \cdot (H_{it}) \cdot \left(\frac{A_t^{max} - A_{it}}{A_t^{max}} \right)}_{\text{catch-up term}}$$

- Combining the two and including fixed effects yields:

$$\Delta ln\, Y_{it} = \gamma + \alpha \cdot \Delta ln\, K_{i,t} + \beta \cdot \Delta ln\, L_{i,t} + \delta \cdot H_{i,t-1} +$$

$$+ \phi \cdot \left(H_{i,t-1} \cdot GAP_{i,t-1} \right) + \eta_t + \mu_i + \varepsilon_{i,t}$$

OLS regression results – dependent variable: ΔlnGDP

	Pooled		Fixed effects		
	base (1)	full (2)	base (3)	full (4)	productivity gap (5)
$\Delta \ln K_{i,t}$	0.4854 ***	0.4802 ***	0.4157 ***	0.4320 ***	0.4323 ***
	0.035	0.035	0.065	0.063	0.063
$\Delta \ln L_{i,t}$	0.2312 **	0.2076 *	0.3846 **	0.3848 **	0.3824 **
	0.097	0.105	0.173	0.171	0.167
$H_{i,t-1}$	-0.0039 *	0.0046	-0.0601	-0.0124	-0.0103
	0.002	0.005	0.014	0.016	0.011
$(HxGAP)_{i,t-1}$	0.0092 ***	0.0001	**0.0610 *** **	**0.0026**	
	0.003	0.006	**0.011**	**0.020**	
$(GAP)_{i,t-1}$		0.0935		**0.8161 *** **	**0.8446 *** **
		0.063		**0.255**	**0.142**
constant	0.0607	-0.0221	0.2339	-0.4407 **	-0.4643 ***
	0.021	0.051	0.097	0.198	0.141
F-test	70.207	58.978	12.167	12.311	13.792
R^2	0.421	0.423	0.595	0.606	0.606
R^2-adj.	0.415	0.415	0.482	0.494	0.496
Obs.	380	380	380	380	380

Note: *Standard errors indicated below coefficients*

Threshold Model (I) – Technology gap variant

Threshold regression approach (Hanson, 2000) :

- Threshold variable: human capital
- Non-linear variable: technology gap
- Basic idea: Let the data select the most appropriate threshold λ on the human capital dimension such that the explanatory power of the model is maximized.

$$
\begin{aligned}
\Delta ln\, Y_{it} = \gamma + \alpha \cdot \Delta ln\, K_{it} + \beta \cdot \Delta ln\, L_{it} + \delta \cdot \mathrm{H}_{i,t-1} \\
+\theta_1 \cdot \left(GAP_{i,t-1}\right)\left(if\ \mathrm{H}_{i,t-1} \leq \lambda\right) + \\
+\theta_2 \cdot \left(GAP_{i,t-1}\right)\left(if\ \mathrm{H}_{i,t-1} > \lambda\right) + \\
+\eta_t + \mu_i + \varepsilon_{it}
\end{aligned}
$$

Threshold Model (I) – Expected results

The link between the threshold regression framework and the theory of technology clubs is non-linearity in the effect of the technology gap on economic growth

- Members of both the imitation and the stagnation club have large technology gaps. In the stagnation club levels of human capital are low. In the imitation club absorptive capacity and benefits from international technology spillovers are high:
  Prediction 1: $\theta_{imitation} > \theta_{stagnation}$
- Members of both the innovation and the imitation club have high levels of human capital (absorptive capacity). The technology gaps in the imitation club are larger:
  Prediction 2: $\theta_{imitation} > \theta_{innovation}$

wiiw

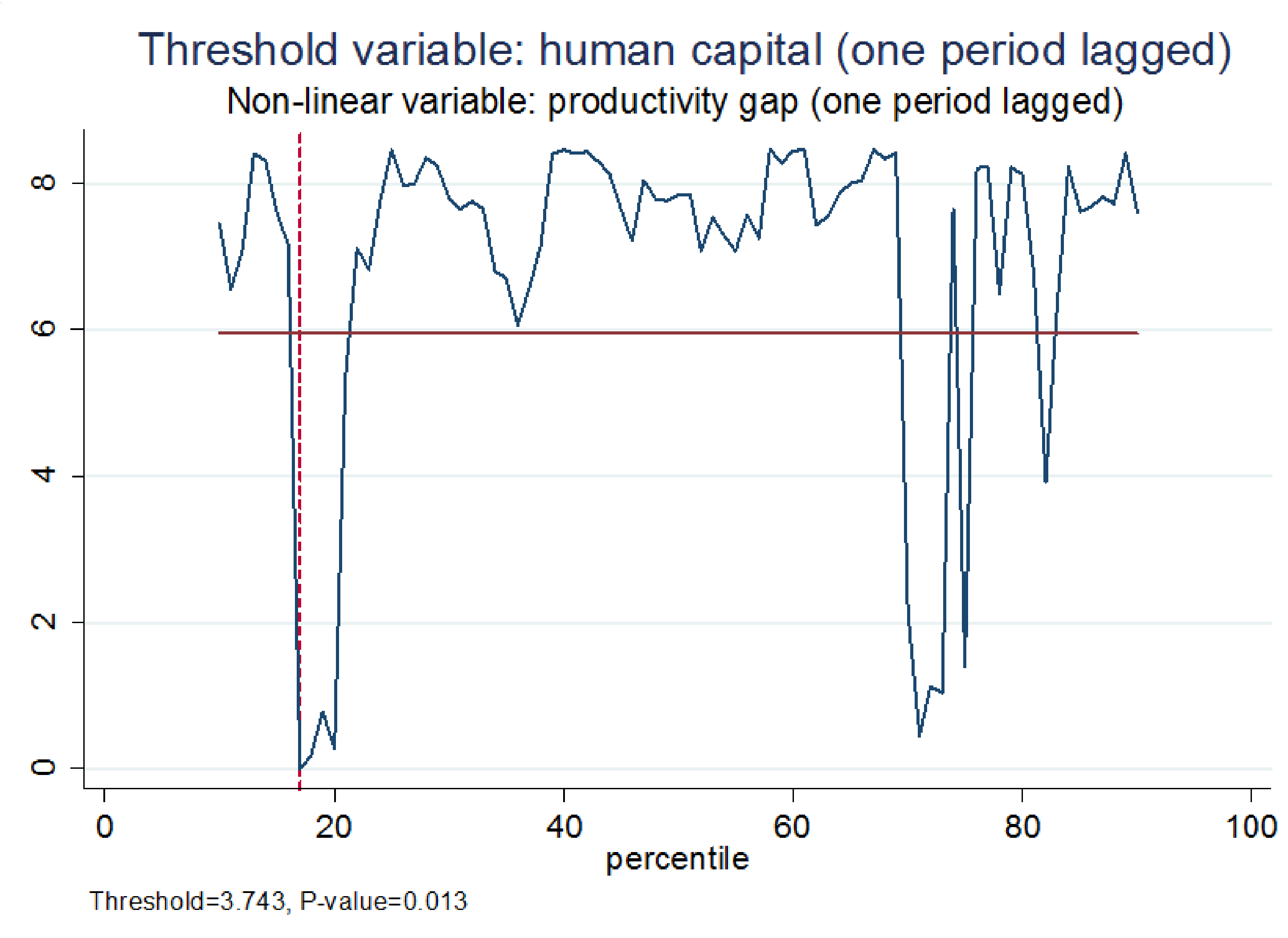
Threshold regression results (I) – dependent variable: ΔlnGDP

Variables	Threshold 1 (I.1)	Threshold 2 (I.2)
$\Delta \ln K_{i,t}$	0.443***	0.422***
	0.0628	0.064
$\Delta \ln L_{i,t}$	0.345**	0.386**
	0.169	0.168
$H_{i,t-1}$	-0.0163	-0.0114
	0.0113	0.0112
$GAP_{i,t-1}$ low regime	0.752***	0.794***
	0.146	0.136
$GAP_{i,t-1}$ medium regime		0.835***
		0.131
$GAP_{i,t-1}$ high regime	0.808***	0.769***
	0.141	0.136
constant	-0.386***	-0.431***
	0.139	0.132
F-stat	12.89	13.12
R^2	0.615	0.62
Threshold	3.743	8.401
Percentile	17	70
P-value	0.013	0
Obs.	380	380

Note: *Standard errors indicated below coefficients. Time and country fixed effects included*

wiiw

Likelihood ratio of 1st threshold (17th percentile)



wiiw

Threshold regression results (I) – dependent variable: ΔlnGDP

Variables	Threshold 1 (I.1)	Threshold 2 (I.2)
$\Delta \ln K_{i,t}$	0.443***	0.422***
	0.0628	0.064
$\Delta \ln L_{i,t}$	0.345**	0.386**
	0.169	0.168
$H_{i,t-1}$	-0.0163	-0.0114
	0.0113	0.0112
$GAP_{i,t-1}$ low regime	0.752***	0.794***
	0.146	0.136
$GAP_{i,t-1}$ medium regime		0.835***
		0.131
$GAP_{i,t-1}$ high regime	0.808***	0.769***
	0.141	0.136
constant	-0.386***	-0.431***
	0.139	0.132
F-stat	12.89	13.12
R^2	0.615	0.62
Threshold	3.743	8.401
Percentile	17	70
P-value	0.013	0
Obs.	380	380

Note: *Standard errors indicated below coefficients. Time and country fixed effects included*

Threshold Model (II) – Technology gap variant

Threshold regression approach (Hanson, 2000):

- Threshold variable: human capital
- Non-linear variable: catch-up term
- Basic idea: Let the data select the most appropriate threshold λ on the human capital dimension such that the explanatory power of the model is maximized.

$$
\begin{aligned}
\Delta \ln Y_{it} = {} & \gamma + \alpha \cdot \Delta ln\, K_{it} + \beta \cdot \Delta \ln L_{it} + \delta \cdot \mathrm{H}_{i,t-1} \\
& + \quad \theta_1 \cdot \left(H_{i,t-1} \cdot GAP_{i,t-1}\right)\left(if\ \mathrm{H}_{i,t-1} \leq \lambda_1\right) + \\
& + \quad \theta_2 \cdot \left(H_{i,t-1} \cdot GAP_{i,t-1}\right)\left(if\ \mathrm{H}_{i,t-1} > \lambda_2\right) + \\
& + \quad \eta_t + \mu_i + \varepsilon_{it}
\end{aligned}
$$

Threshold Model (II) – Expected results

The link between the threshold regression framework and the theory of technology clubs is the non-linearity in the catch-up variable

- Members of both the imitation and the stagnation club have large technology gaps. In the stagnation club levels of human capital are low. In the imitation club absorptive capacity and benefits from international technology spillovers are high:
  Prediction 1: $\theta_{imit} \cdot \overline{(H \; x \; GAP)}_{imit} > \theta_{stag} \cdot \overline{(H \; x \; GAP)}_{stag}$
- Members of both the innovation and the imitation club have high levels of human capital (absorptive capacity). The technology gaps in the imitation club are larger:
  Prediction 2: $\theta_{imit} \cdot \overline{(H \; x \; GAP)}_{inno} > \theta_{stag} \cdot \overline{(H \; x \; GAP)}_{inno}$

Threshold regression results (II) – dependent variable: ΔlnGDP

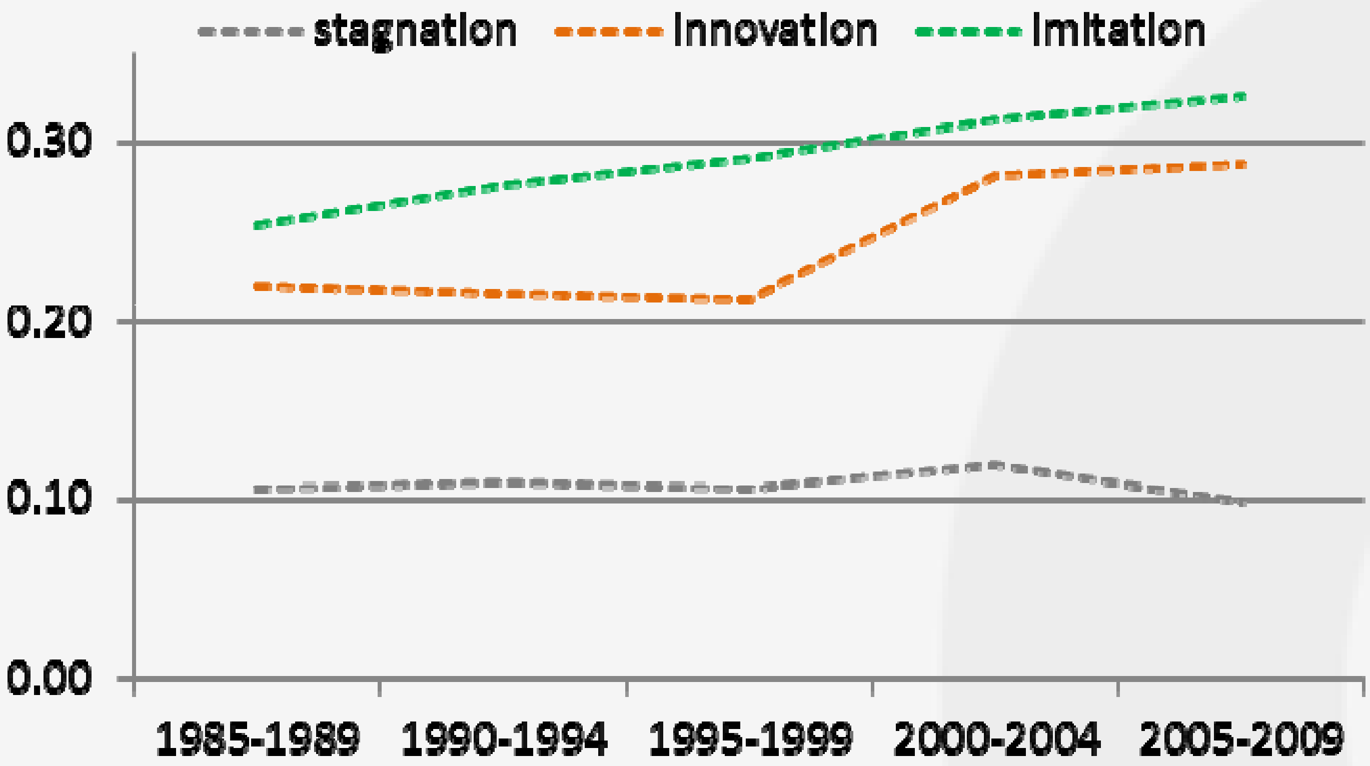
Variables	Threshold 1 (II.1)	Threshold 2 (II.2)
$\Delta \ln K_{i,t}$	0.426***	0.441***
	0.065	0.064
$\Delta \ln L_{i,t}$	0.342*	0.349**
	0.175	0.175
$H_{i,t-1}$	-0.0616***	-0.0644***
	0.014	0.015
$CATCH_{i,t-1}$ low regime	0.0404***	0.0417***
	0.015	0.015
$CATCH_{i,t-1}$ medium regime		0.0561***
		0.011
$CATCH_{i,t-1}$ high regime	0.0559***	0.0648***
	0.011	0.013
constant	0.277***	0.285***
	0.098	0.098
F-stat	11.27	10.02
R-squared	0.603	0.606
Threshold	3.743	9.398
Percentile	17	82
P-value	0.036	0.000
Obs.	380	380

Note: *Standard errors indicated below coefficients. Time and country fixed effects included*

wiiw

Elasticities of the catch-up term with respect to GDP growth by technology club (1)

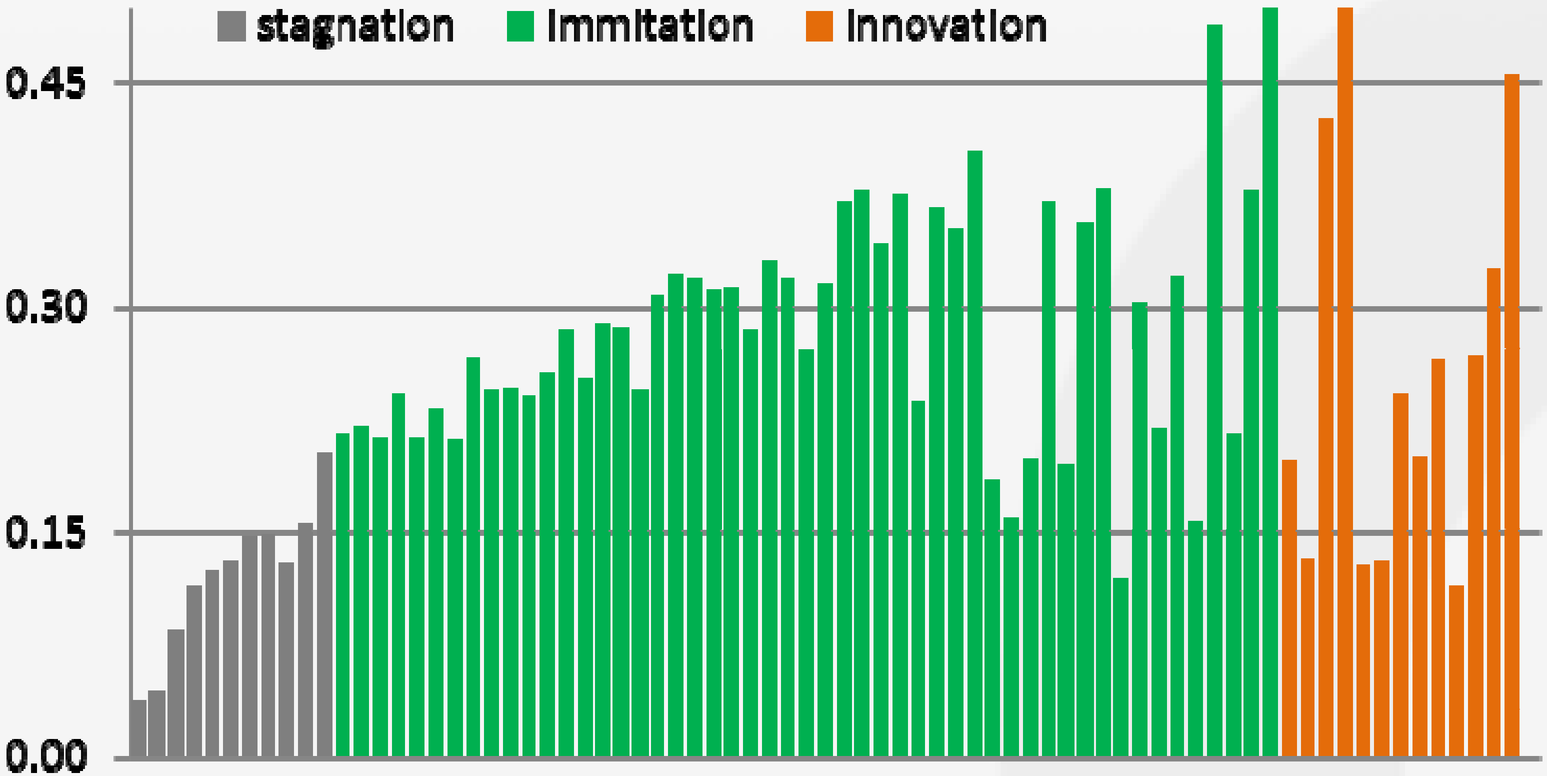
Catch-up effects are increasing over time except for the stagnation club



wiiw

Elasticities of the catch-up term with respect to GDP growth by technology club (2)

The threshold between the stagnation and the imitation club seem to clearer than between the imitation club and the innovation club



wiiw

Conclusions

- Significant growth effects from international technology spillovers (catch-up effects)
- Threshold regression model identifies two thresholds leading to three catch-up regimes or convergence clubs
- Estimated coefficients/elasticities for the technology gap/catch-up term fit the pattern predicted by Schumpeterian convergence club models

  → largest effects for countries with intermediate levels of human capital ("imitation club")

  → smaller effects for countries with lowest ("stagnation club") and highest ("innovation club") levels of human capital

Thank you

for your attention!

wiiw

Related Literature

Theoretical Background

- Howitt & Mayer-Foulkes (2005)

  R&D, Implementation and Stagnation: A Schumpeterian Theory of Convergence Clubs, Innovation Club; Imitation Club and Stagnation Club *(Journal of Money, Credit, and Banking)*

Empirical work

- Benhabib & Spiegel (1994), (2005)

  The role of human capital in economic development *(JME)*
  Human capital and technology diffusion *(Handbook of Economic Growth)*

- Castellacci (2008)

  Technology clubs, technology gaps and growth trajectories development *(Journal of Structural Change and Economic Development)*

- Crespo, Martín & Velázquez (2004)

  The role of International Technology Spillovers in Economic Growth of the OECD countries *(Global Economy Journal)*

wiiw

Likelihood ratio of 1st threshold (17th percentile)