REVISITING WORLD ENERGY INTENSITY CONVERGENCE: REGIONAL DIFFERENCES AND INSTITUTIONAL INFLUENCES

Brant Liddle
Centre for Strategic Economic Studies, Victoria University
Melbourne, Australia
June 2009

Outline

• Intro to convergence
• World energy intensity convergence
• Convergence among China’s provinces
Why Study Convergence

• Income & quality of life measures
  – One world or many?

• CO₂ emissions & energy
  – Convergence among developed countries may encourage developing countries to join global accords
  – Will a similar set of policies/global policy work?

Goals & Findings

• Updates/expands Ezcurra (2007)
• Considers convergence across geography/development groups
• Examines determinants of convergence via conditioned distributions

• OECD & Eurasia converge; SSA converge amongst each other; LAC & MENA diverge
• Institutions that lead to stable economic growth linked to energy intensity convergence
Types & Tools of Convergence

• Beta-convergence
  – Do countries catch up?
    • Regress rates of change on initial levels

• Sigma-convergence
  – Do cross-country differences decline?
    • Calculate coefficient of variation over time
    • Estimate kernel density or histogram over time

Types & Tools of Convergence

• Gamma-convergence
  – Do countries move within the distribution?
    • Transition probability matrix or stochastic kernels (3D)
    • Rank concordance index

• Stochastic convergence
  – Are shocks permanent or temporary?
    • Panel unit root test
Convergence Analyses

• **GDP per capita** (numerous studies)
  – Developed countries converge; primarily divergence at world-level

• **Living standards** (Neumayer 2003; Maza & Villaverde 2008)
  – Educational enrolment, literacy, & electricity consumption: high to some convergence

• **Demographics** (Wilson 2001)
  – Life expectancy & fertility converge

Convergence Analyses

• **CO₂ per capita** (number of studies since 2003)
  – Developed countries converge; less developed countries diverge

• **Energy productivity** (Miketa & Mulder 2005)
  – Convergence in less energy intensive sectors; divergence to no convergence in more energy intensive sectors (non-ferrous metals)
Other Convergence Analyses

- **GDP per capita** (numerous studies)
  - Developed countries converge; primarily divergence at world-level
- **CO₂ per capita** (number of studies since 2003)
  - Developed countries converge; less developed countries diverge

Energy Intensity Convergence

- Markandaya et. al. (2006): Eastern European countries converged toward EU average since 1992
- Liddle (2009): Among OECD countries commercial electricity intensity converging toward bell-shaped, but industry electricity intensity converging toward bi-modal distribution
Data

- Natural log TPES/real GDP (IEA)
- 111 countries over 1971-2006
- 134 countries over 1990-2006

Beta-Convergence

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>t-Statistic</th>
<th>1971-2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.034</td>
<td>-10.35</td>
<td></td>
</tr>
<tr>
<td>Beta</td>
<td>-0.022</td>
<td>-11.05</td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>111</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>t-Statistic</th>
<th>1990-2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.031</td>
<td>-7.67</td>
<td></td>
</tr>
<tr>
<td>Beta</td>
<td>-0.016</td>
<td>-5.55</td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>134</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Gamma-Convergence

$$\gamma = \frac{\text{Variance \ (AR(I)_{it} + AR(I)_{i0})}}{\text{Variance \ (2 \cdot AR(I)_{i0})}}$$

Boyle and McCarthy (1997)
Regional Sigma-Convergence

Economic Growth Stability
Regional Contributions to Sigma-Convergence

Two Convergence Clubs
### Conditional Convergence

- **Parametric**
  - Beta-convergence
    - Multivariate regression
- **Non-parametric**
  - Sigma-convergence
    - Conditioned kernel density estimates (Quah)

### Determinants of World Energy Intensity Convergence

- **Important**
  - Share of services & manufacturing in GDP
  - Stability (CV) of economic growth
  - Quality of governance
- **Not important/Marginal importance**
  - GDP per capita
  - GDP per capita growth
  - Share exports in GDP
  - Share electricity in energy consumption
Conditioned Kernel Density Functions, 2006

Share of services & manufacturing

CV annual GDP per capita growth, 1971-2006

Conditioned Kernel Density Functions, 2006

Index of quality of governance
Conclusions

- Continued world convergence in energy intensity, however,…
- Two clubs forming:
  - Limited to no convergence among LAC, MENA, SSA
  - Substantial convergence among OECD & Eurasia
    - Contribution of Central Asia & North Korea reflects extremely
      high initial energy intensity
- Energy intensity convergence analogous to economic growth convergence
  - Economic structure, growth stability, & quality governance all matter
- Excluding Iraq but including former Soviet Baltic countries & new Balkan countries (former Yugoslavia) increases convergence

Sigma-Convergence in China’s Provinces
Sigma-Convergence: Eastern vs. Interior Provinces