ELECTRIC POWER RESEARCH INSTITUTE

Technological Convergence Between Developed and Developing Countries

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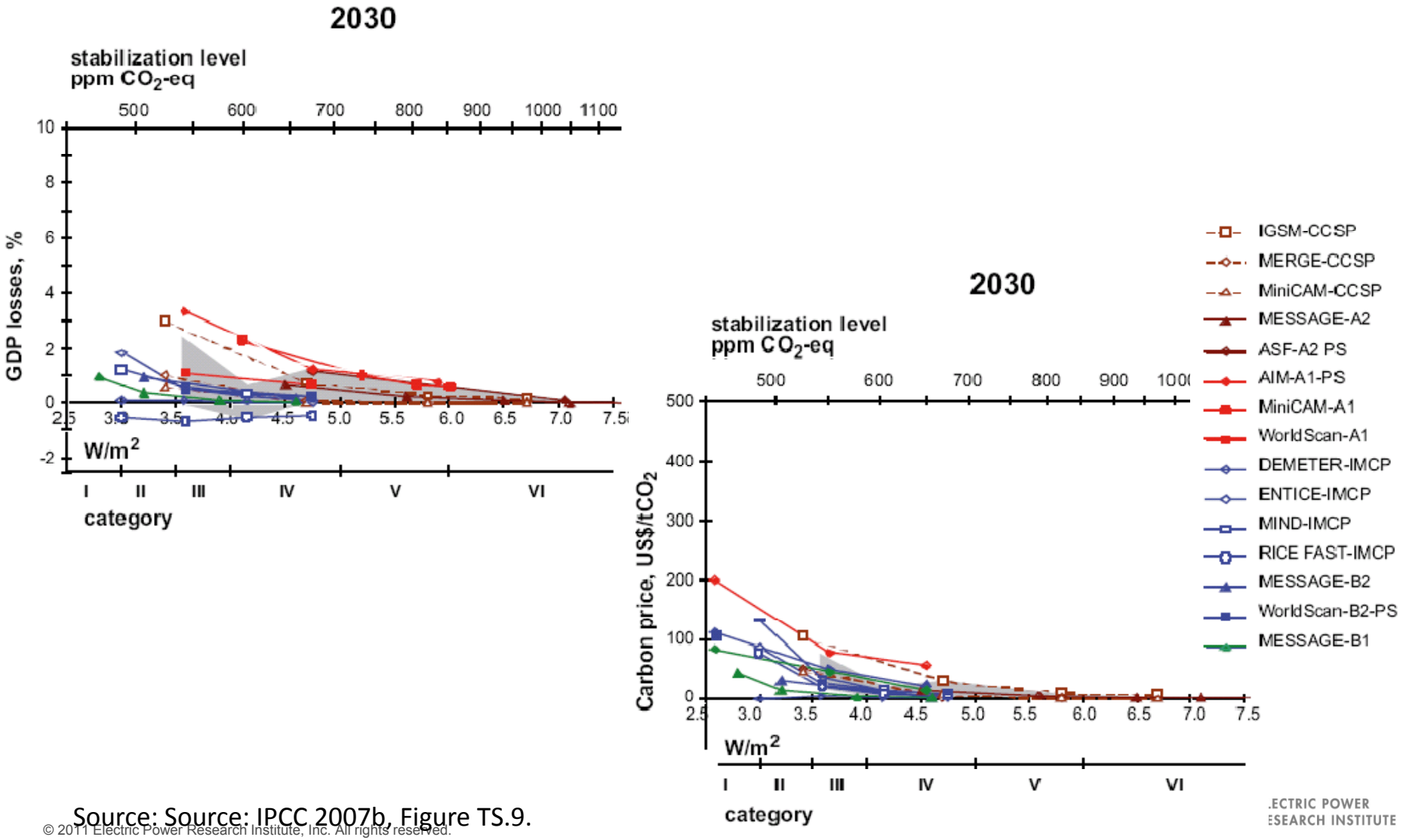
Research question:

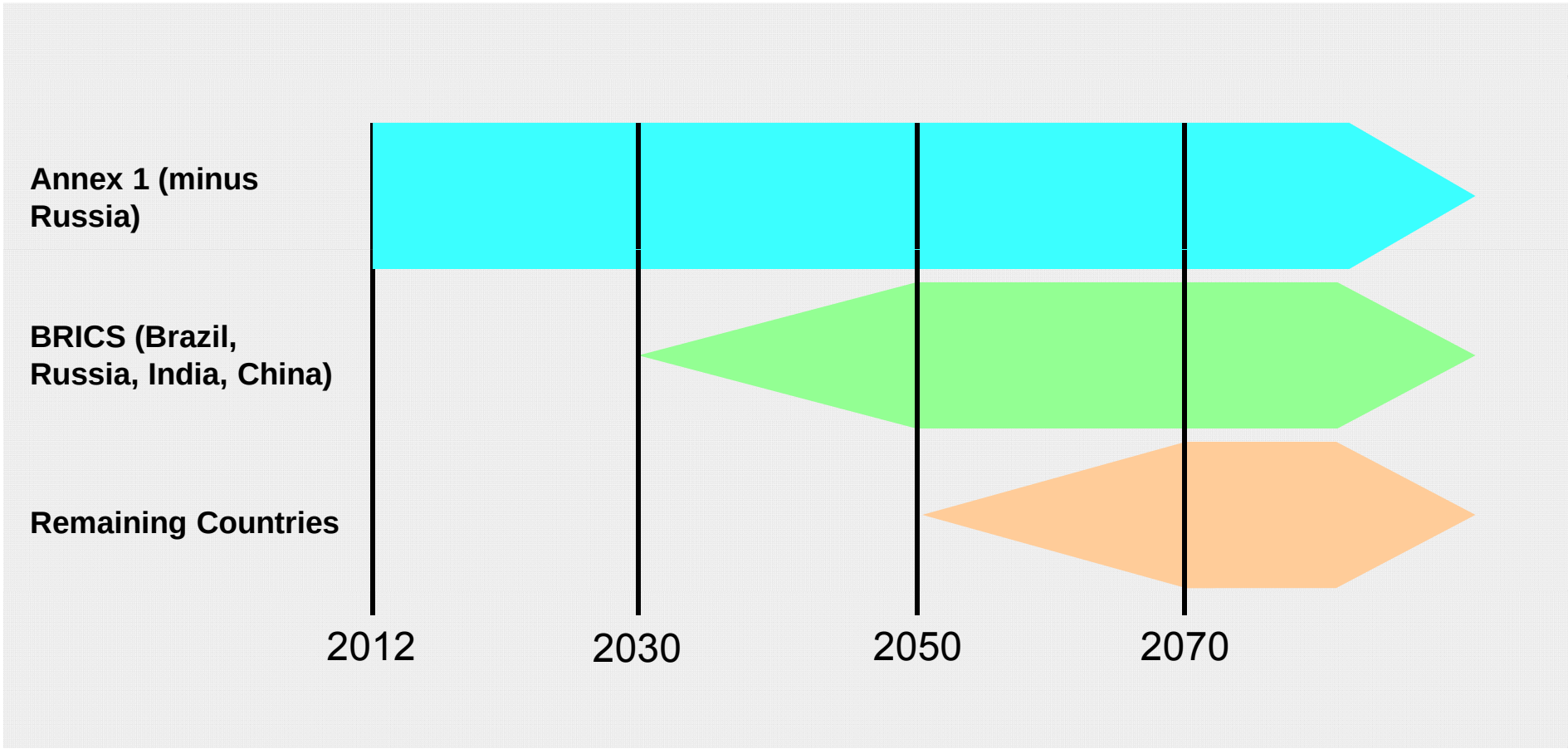
- Is there a pattern of technological diffusion and convergence between middle & low income countries and high income countries similar to the pattern observed within high income countries, particularly in energy-related technologies?

Relationship between cost and climate change stabilization



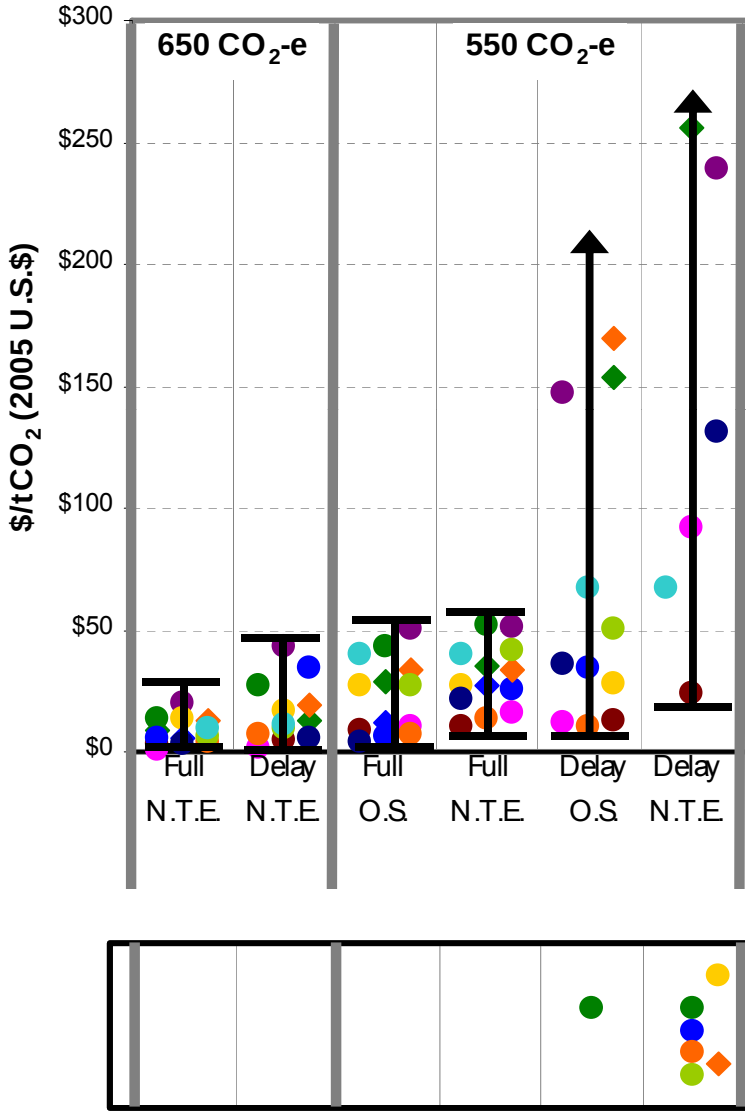
Source: Source: IPCC 2007b, Figure TS.9.

Delayed Participation: Regions Enter the Global Coalition over Time



Source: Weyant & de la Chesnaye presentation to the National Academies of Science, International Context for America's Climate Choices

Annex 1 2020 Carbon Prices



- ETSAP-TIAM
- FUND
- GTEM
- IMAGE
- IMAGE-BECS
- MERGE Optimistic
- MERGE Pessimistic
- MESSAGE
- MESSAGE-NOBECS
- MiniCAM - Base
- MiniCAM - Lo Tech
- POLES
- SGM
- WITCH

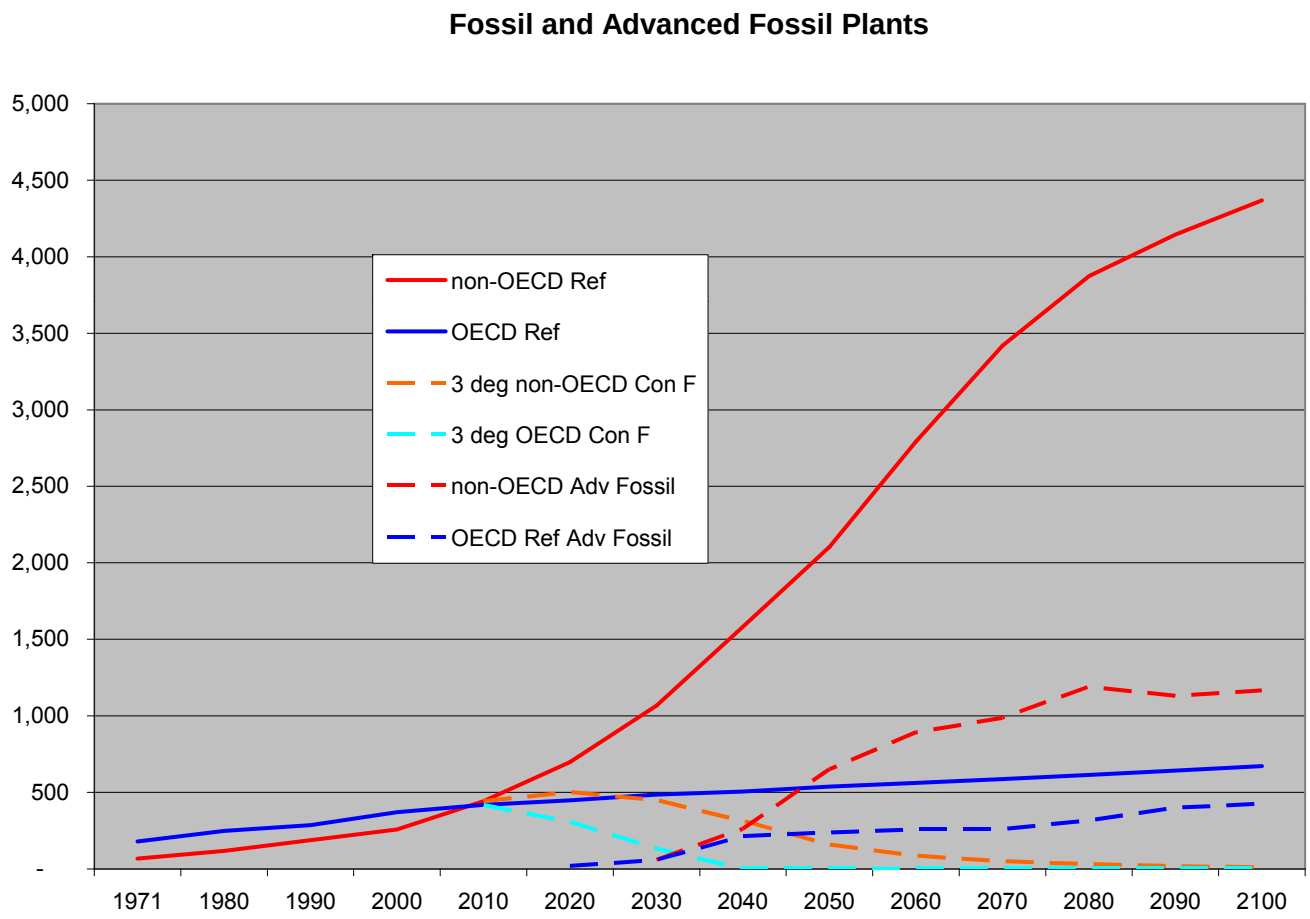
Scenarios that could not be modeled under criteria of study.

Source: Weyant & de la Chesnaye presentation to the National Academies of Science, International Context for America's Climate Choices

Key Characteristics of Selected Climate Economic Models

Model	Model Type	Solution Concept	Technology Diffusion
AIM: Asian-Pacific Integrated Model (Kainuma, et al, 2007)	Multi-Sector General Equilibrium	Recursive Dynamic	Expert elicitation on introduction of new technologies
GEMINI-E3: General Eq. Model of Int. Interaction for Economy-Energy-Env (Bernard et al, 2006)	Multi-Sector General Equilibrium	Recursive Dynamic	Instantaneous
EPPA: Emissions Projection and Policy Analysis Model (Paltsev, et al, 2005)	Multi-Sector General Equilibrium	Recursive Dynamic	Endogenously determined depending on technology costs, including fuels, for each region
MERGE: Model for Evaluating Regional and Global Effects of GHG Reductions Policies (Blanford et al, 2009)	Aggregate General Equilibrium	Intertemporal Optimization	Lagged by one or two decades depending on region income level
IMAGE: Integrated Model to Assess the Global Env (van Vliet et al, 2009)	Market Equilibrium	Recursive Dynamic	Instantaneous
MESSAGE: Model for Energy Supply Strategy Alternatives and Their General Env. Impact (Krey and Riahi, 2009)	Market Equilibrium	Recursive Dynamic	Instantaneous
MiniCAM: Mini-Climate Assessment Model (Calvin et al, 2009)	Market Equilibrium	Recursive Dynamic	Instantaneous

Different Rates of Technological Convergence and Technology Diffusion



Approximation of the number of fossil fuel power plants based on historical and projected electricity generation data. Sources: Historical data, IEA, 2009; Projections, Blanford et al, 2009.

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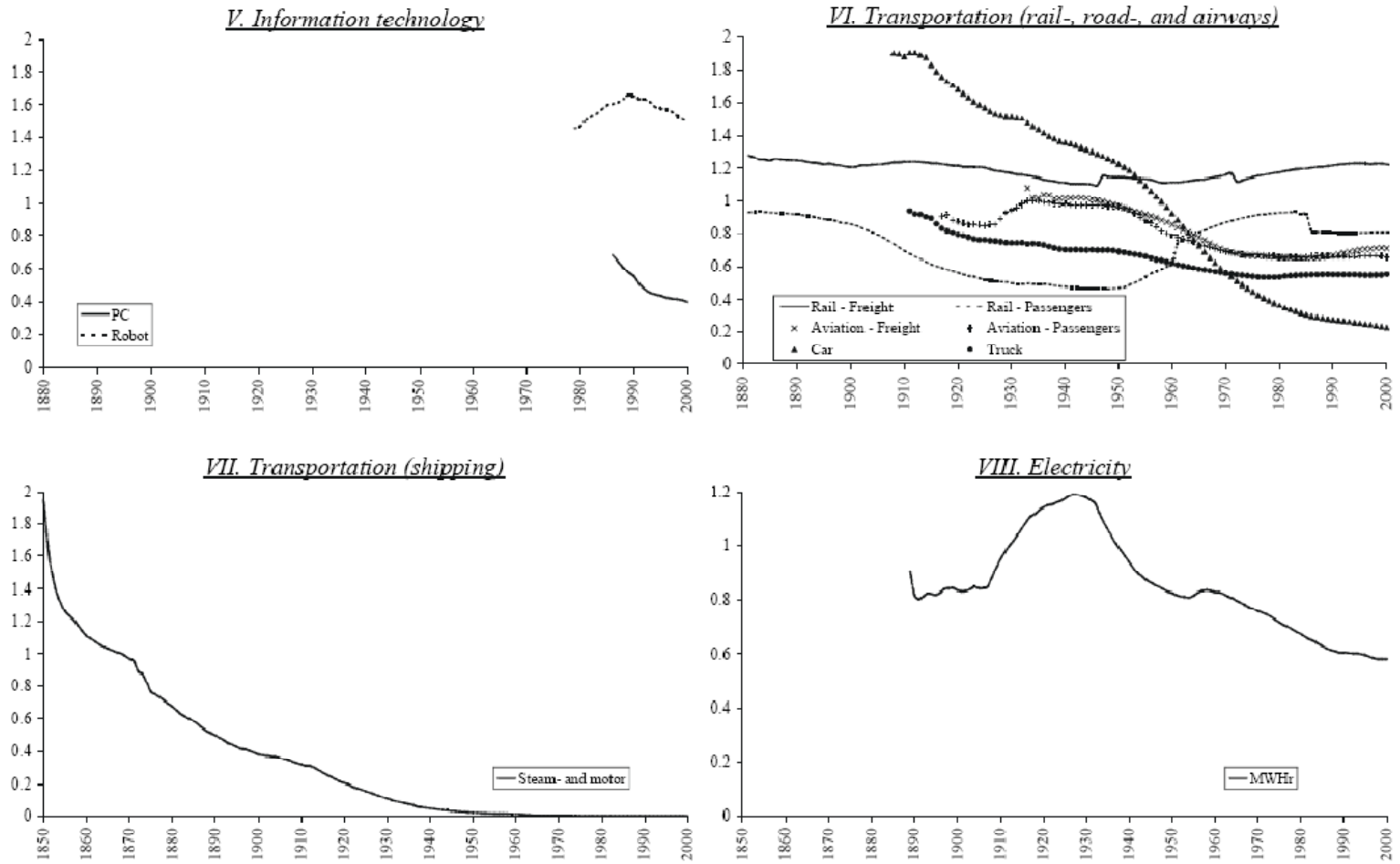
Historical Technological Convergence Between Developed and Developing Countries



Note:
All series are 25 year moving averages (5 year moving averages for V) of time varying coefficients of variation. The coefficients are only calculated if the sample size is bigger than or equal to 10 (5 for electricity).

Source: Comin and Hobijn (2004)

Research task: add technology measures for energy related sectors and developing countries

Electricity

KWhr of electricity produced per unit of real GDP per year

KWhr of electricity produced by coal units

KWhr of electricity produced by gas units

KWhr of electricity produced by biomass-waste renewable units

KWhr of electricity produced by wind & solar renewable units

Petroleum refining / fuels

Kiloton of Oil Equivalent (KTOE) per unit of real GDP per year

KTOE of petroleum for Transportation

KTOE of petroleum for Oil Refining (excluding transportation uses)

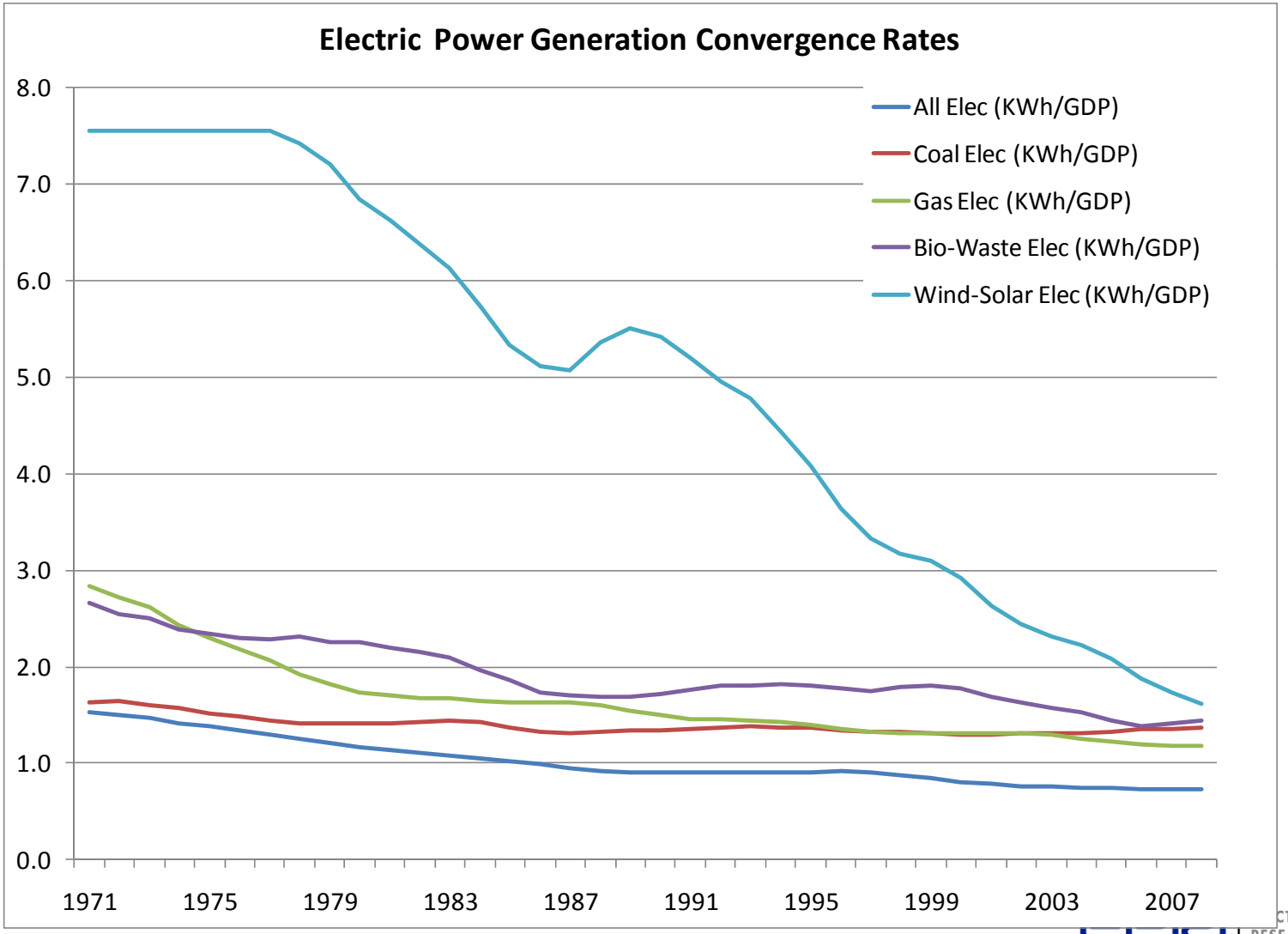
KTOE of petroleum for Chemical and Petrochemical production

Obtain data for additional Low- & Middle–Income Countries, focusing on the following large CO_2 emitting countries

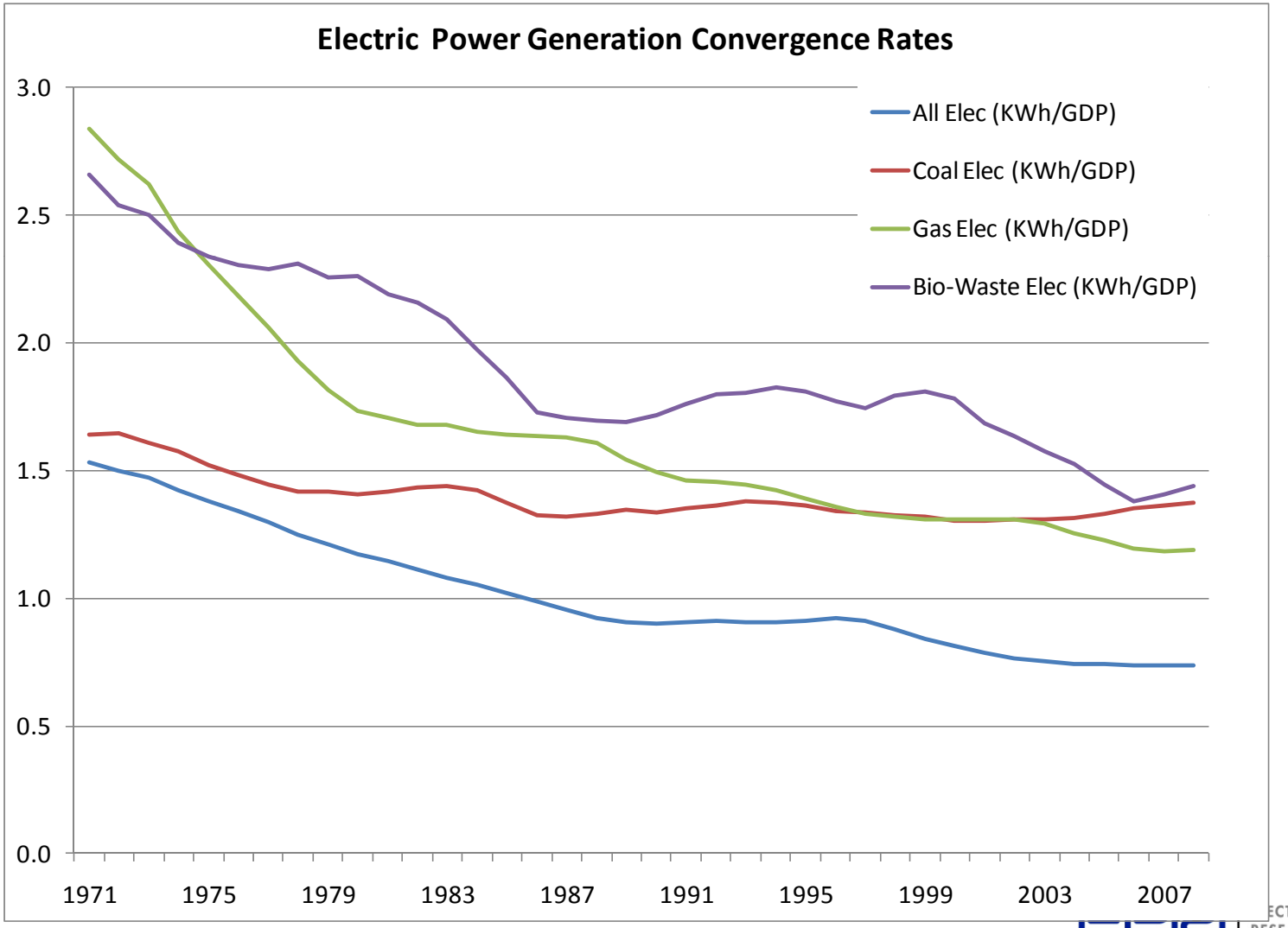
1. China
2. Brazil
3. Indonesia
4. Russian Federation
5. India
6. Mexico
7. South Korea
8. Iran
9. Ukraine

1. Nigeria
2. Venezuela
3. Turkey
4. South Africa
5. Saudi Arabia
6. Poland
7. Thailand
8. Argentina

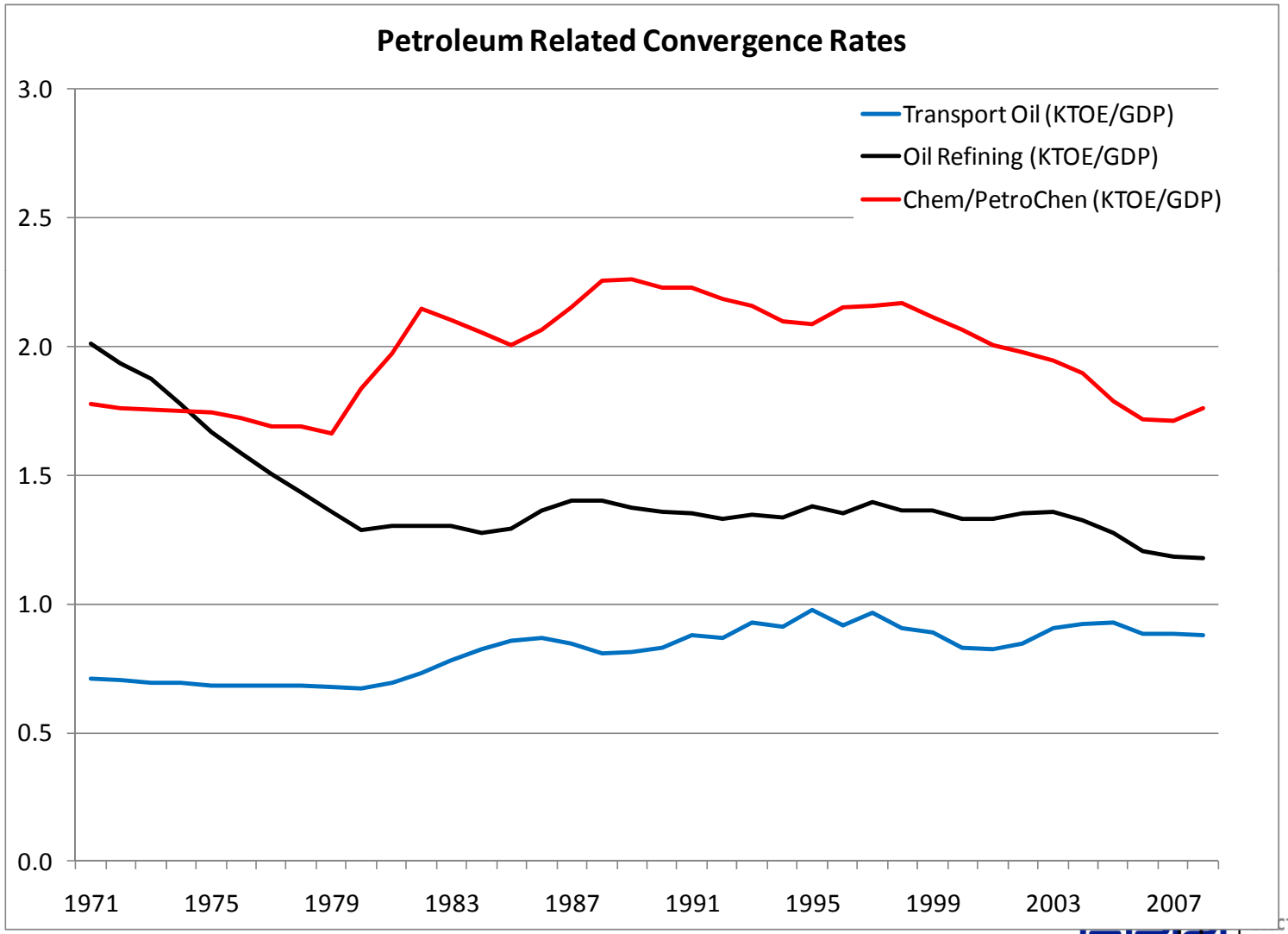
Electricity Generation Convergence Between Developed and Developing Countries



Electricity Generation Convergence Between Developed and Developing Countries



Petroleum-related Technological Convergence Between Developed and Developing Countries



Results on Speed of Convergence

Estimates of βs and the speed of convergence, in percent, for selected technologies

All Electricity	Coal Electricity	Gas Electricity	Bio-Waste Electricity	Wind-Solar Electric
0.71 (0.05) 34% R^{-2} = 0.66	0.43 (0.22) 86% R^{-2} = 0.67	0.85 (0.07) 16% R^{-2} = 0.67	0.83 (0.11) 19% R^{-2} = 0.50	0.56 (0.16) 57% R^{-2} = 0.18
Transportation Oil	**Refineries Oil**	**Chemical Petrochemical**		
0.58 (0.07) 54% R^{-2} = 0.37	0.92 (0.03) 8.4% R^{-2} = 0.90	0.77 (0.06) 27% R^{-2} = 0.70		
Standard errors are in parenthesis. Speed of convergence is calculated as -ln(β).				

Conclusions

- There is an observed pattern of technological convergence between developed and developing countries in the observed data, i.e., more detailed assessment of electric generation and petroleum-related technologies.
- For electric generation technologies, convergence is faster between developed and developing countries than that observed between OECD countries.
- This is the same for oil refining, however, transportation and chemical production show very distinct patterns.
- Key insight # 1: Patterns and speed of convergence with a technology group (all electricity) can be very different (gas vs coal).
- Key insight # 2: Newer technologies (wind and solar) exhibit much faster convergence rates than stable technologies.
- Take away: Details within technology groups matter; more detail the better for specifying convergence rates.