



POTSDAM-INSTITUT FÜR
KLIMAFOLGENFORSCHUNG

Roadmaps towards Sustainable Energy Futures (RoSE): A potential platform to collaborate?

Elmar Kriegler

Research Domain III „Sustainable Solutions“
Potsdam Institute for Climate Impact Research

3rd RoSE Project Meeting
PIK, Potsdam, 6 June 2011

RoSE Project

Goal: Provide **credible information on rapid decarbonization pathways for the global economy to assess feasibility, costs and risks of ambitious climate mitigation**

Unique features:

- Inclusion of research institutions from US, China, EU under a single funding roof
- Resources provided to pursue large-scale multi-model ensemble experiments with harmonized input assumptions
- Resources provided to invite domain experts to discuss and evaluate model scenarios

Funded by Stiftung Mercator with 1,17 Mio Euro for 3 years



Stiftung Mercator

RoSE – The Concept

Overarching RoSE policy question:

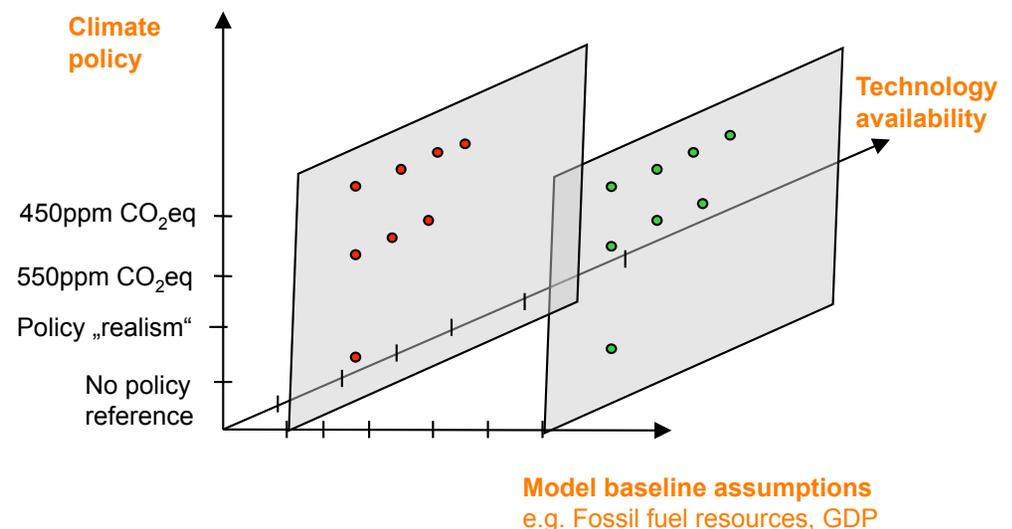
What are *robust* scenarios for achieving a sustainable global energy future in compliance with ambitious climate protection goals?

Tools of the analysis: “*Integrated assessment models*” (IAMs)
i.e. coupled global energy-economy-(land use)-climate models

Assessing „robustness“:

Explore IAM scenarios w.r.t.

- differences across models
- key assumptions in models
- effects neglected in models



RoSE Participants and Contributing Domain Experts

Coordination: Elmar Kriegler, Ottmar Edenhofer (PIK)

Integrated assessment modeling teams:

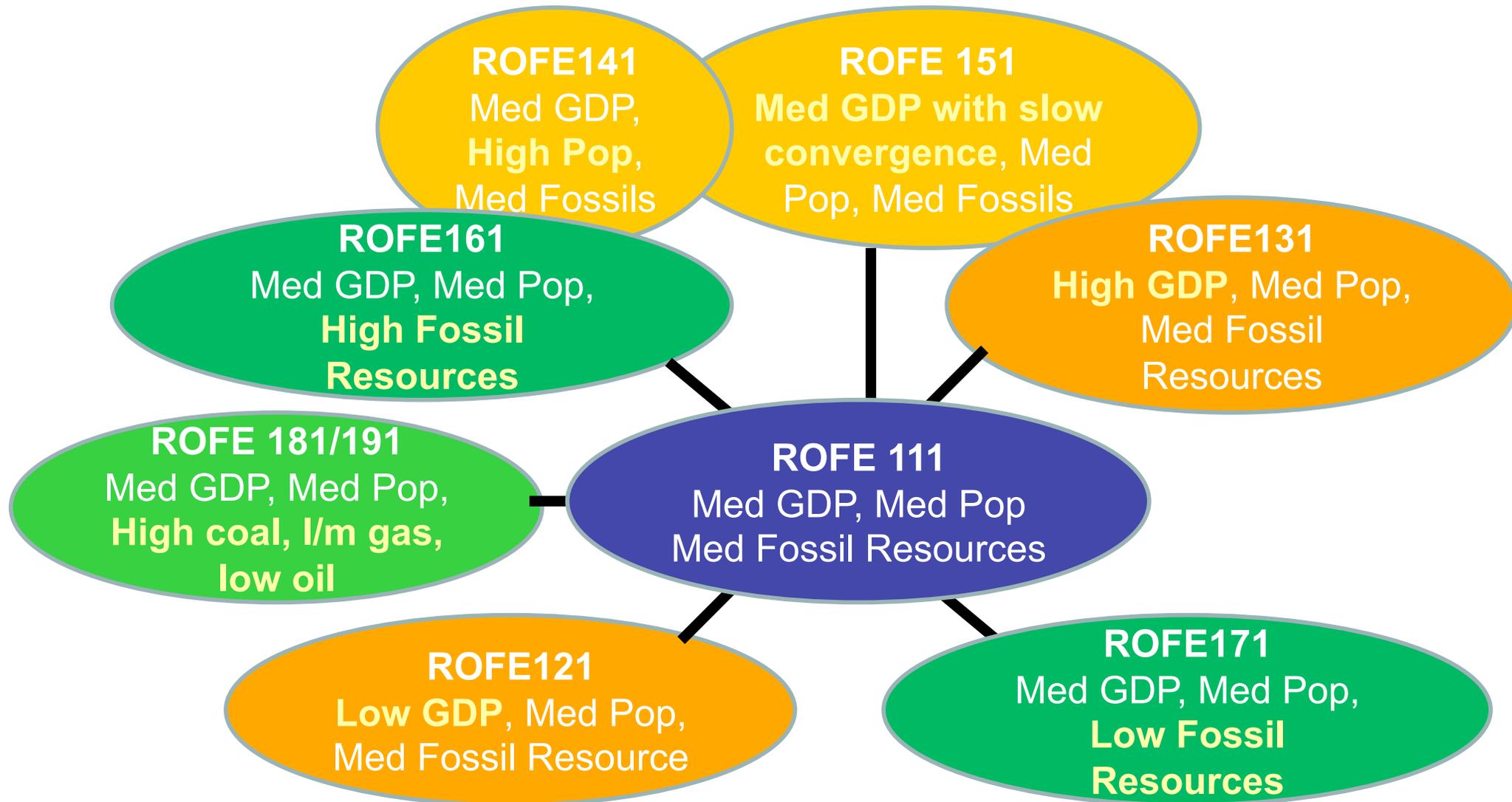
- **CMCC:** Carlo Carraro, Massimo Tavoni, Enrica DeCian, Fabio Sferra; (*WITCH*)
- **JGCRI/PNNL:** Jae Edmonds, Leon Clarke, Kate Calvin (*GCAM*)
- **ERI:** Jiang Kejun (*IPAC*)
- **PIK:** Gunnar Luderer, Ioanna Mouratiadou, Lavinia Baumstark, Jessica Strefler, Nico Bauer, Anastasis Giannousakis (*ReMIND*)
- **Tsinghua University:** Chen Wenying, Yin Xiang (*China-MARKAL*)

Domain experts:

- **Aleh Cherp** (Central European University; *Energy Security*)
- **Doyne Farmer** (Santa Fe Institute; *Technological Progress*)
- **Hans-Holger Rogner** (IAEA; *Energy Resources*)
- **Andreas Schäfer** (Stanford University; *Transport*)
- **Shonali Pachauri** (IIASA; *Energy Access and Household Consumption*)
- Further topics still open: Water resources, Policy scenarios, Institutional needs, (Rare) Material supply for the energy transformation

Key decisions made: Harmonization

- Population, GDP growth, fossil resource availability (coal, oil, gas)

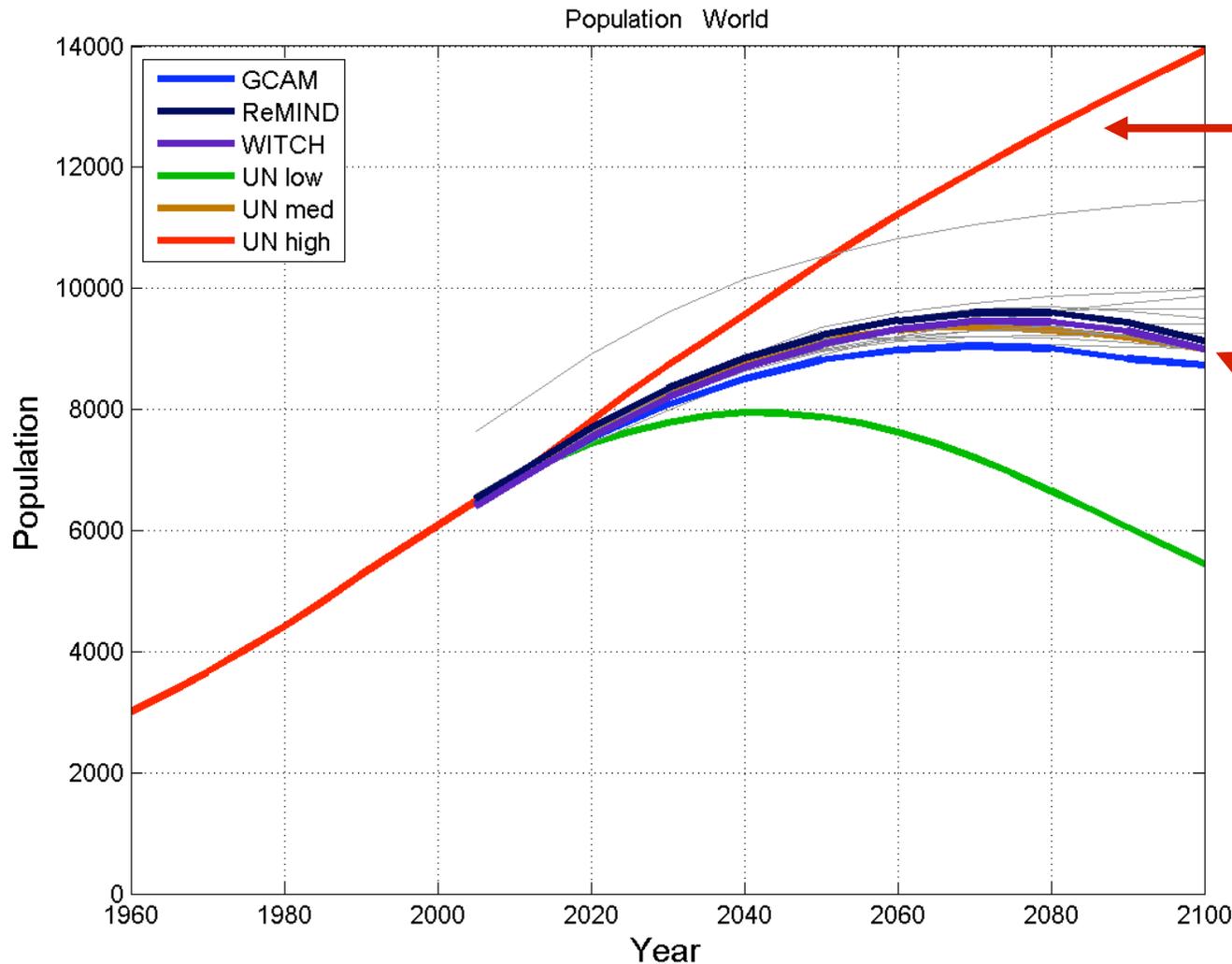


Harmonization: Population and GDP scenarios

- Latest (2011) UN Population scenarios adopted for RoSE
- GDP Scenarios developed by Elmar Kriegler, Teresa Lenz, Marian Leimbach for 26 world regions
- Three factors combine to 18 GDP scenarios
 - Low / Med / High population
 - Slow / Med / Fast growth of tech leader (USA)
 - Slow and fast convergence of developing countries

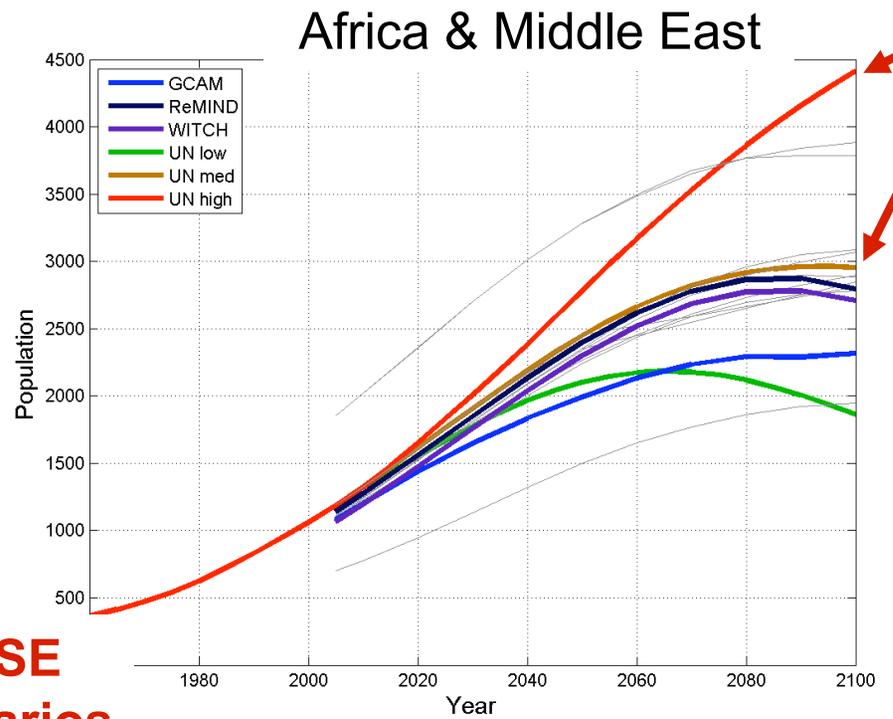
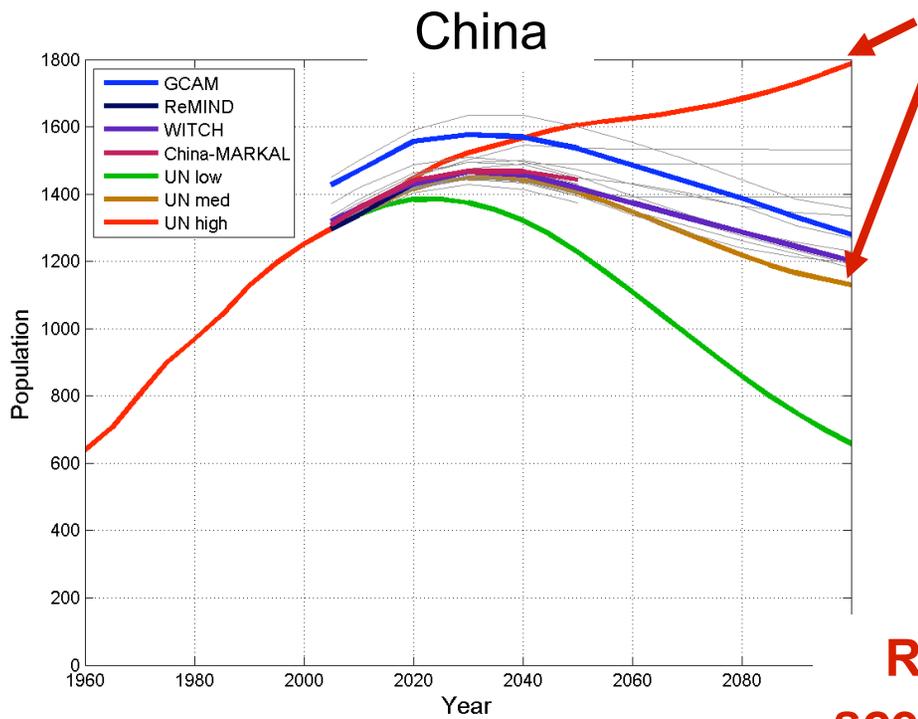
#	GDP-Pop Scenario
G1	Low Pop - Slow Growth - Slow Convergence (Div)
G2	Low Pop - Slow Growth - Fast Convergence (Conv)
G3	Low Pop - Medium Growth - Slow Convergence (Div)
G4	Low Pop - Medium Growth - Fast Convergence (Conv)
G5	Low Pop - Fast Growth - Slow Convergence (Div)
G6	Low Pop - Fast Growth - Fast Convergence (Conv)
G7	Med Pop - Slow Growth - Slow Convergence (Div)
G8	Med Pop - Slow Growth - Fast Convergence (Conv)
G9	Med Pop - Medium Growth - Slow Convergence (Div)
G10	Med Pop - Medium Growth - Fast Convergence (Conv)
G11	Med Pop - Fast Growth - Slow Convergence (Div)
G12	Med Pop - Fast Growth - Fast Convergence (Conv)
G13	High Pop - Slow Growth - Slow Convergence (Div)
G14	High Pop - Slow Growth - Fast Convergence (Conv)
G15	High Pop - Medium Growth - Slow Convergence (Div)
G16	High Pop - Medium Growth - Fast Convergence (Conv)
G17	High Pop - Fast Growth - Slow Convergence (Div)
G18	High Pop - Fast Growth - Fast Convergence (Conv)

Harmonization: UN Population scenarios

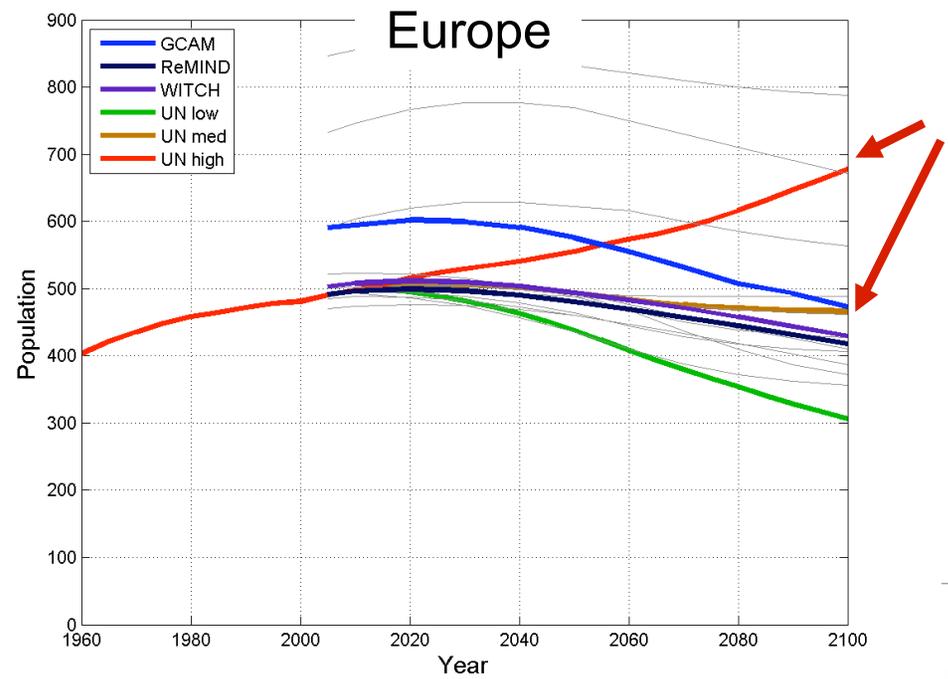
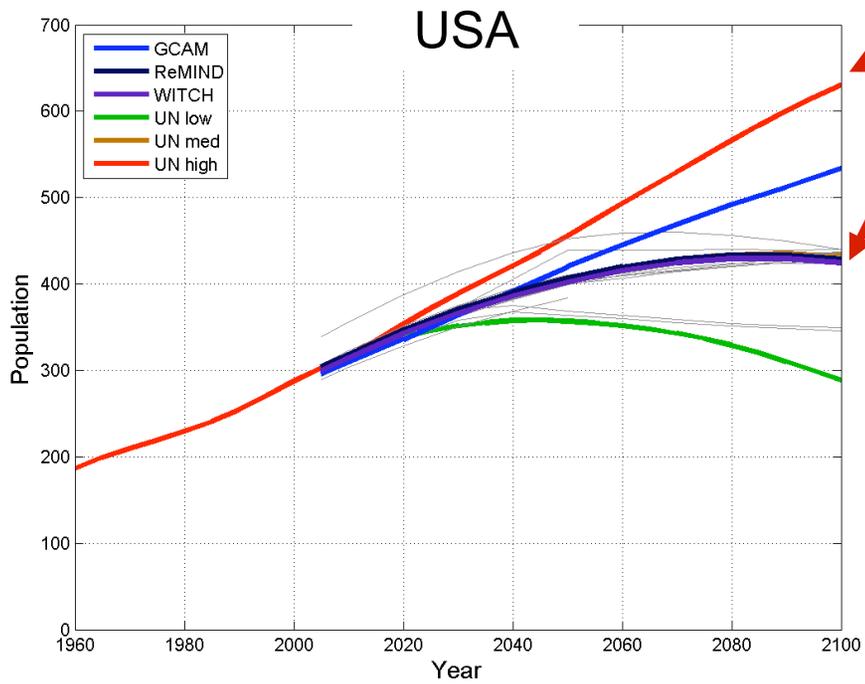


**RoSE harmonization:
UN high scenario**
(for scenario: R141)

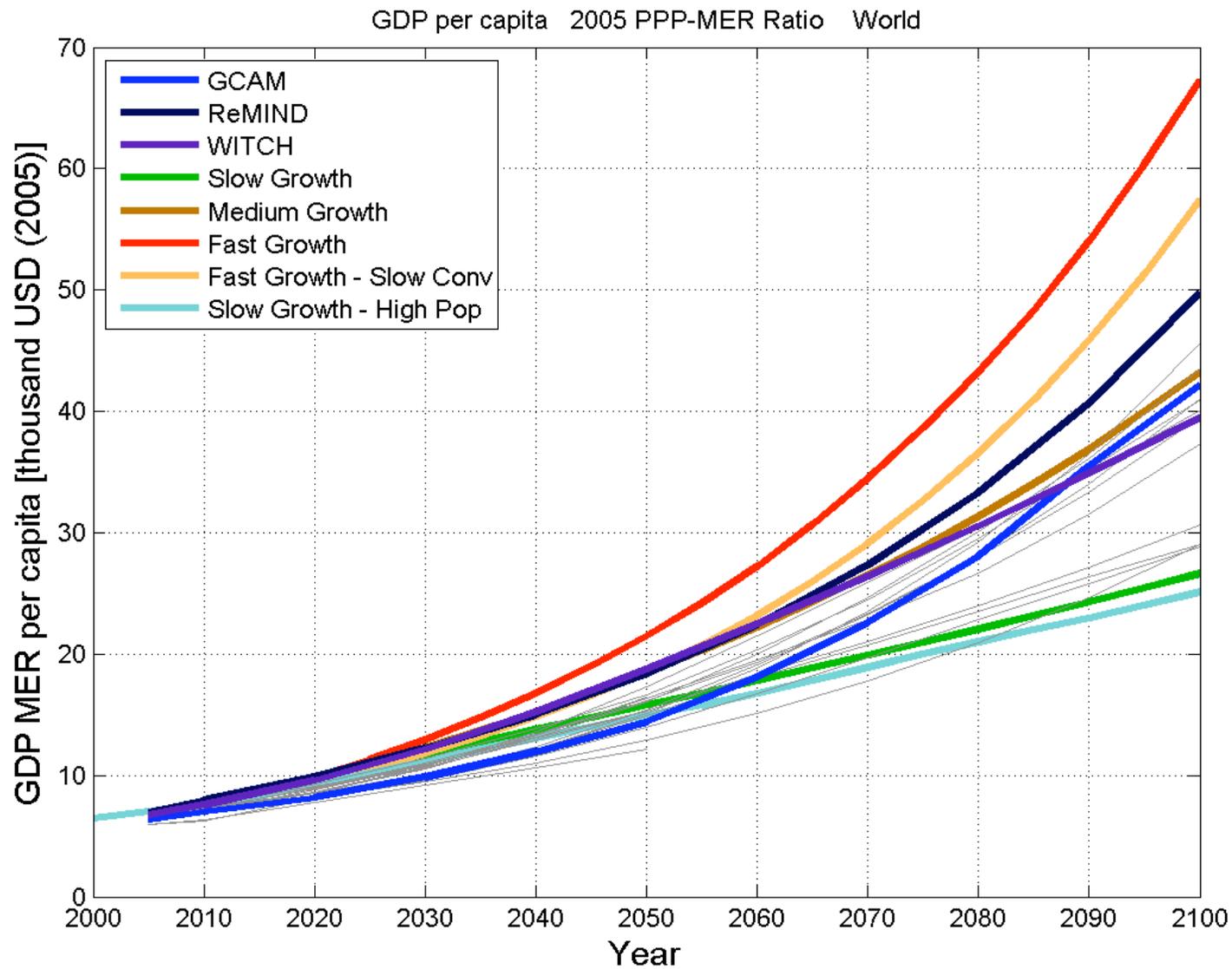
**RoSE harmonization:
UN medium scenario**
(for all but one RoSE
scenario)



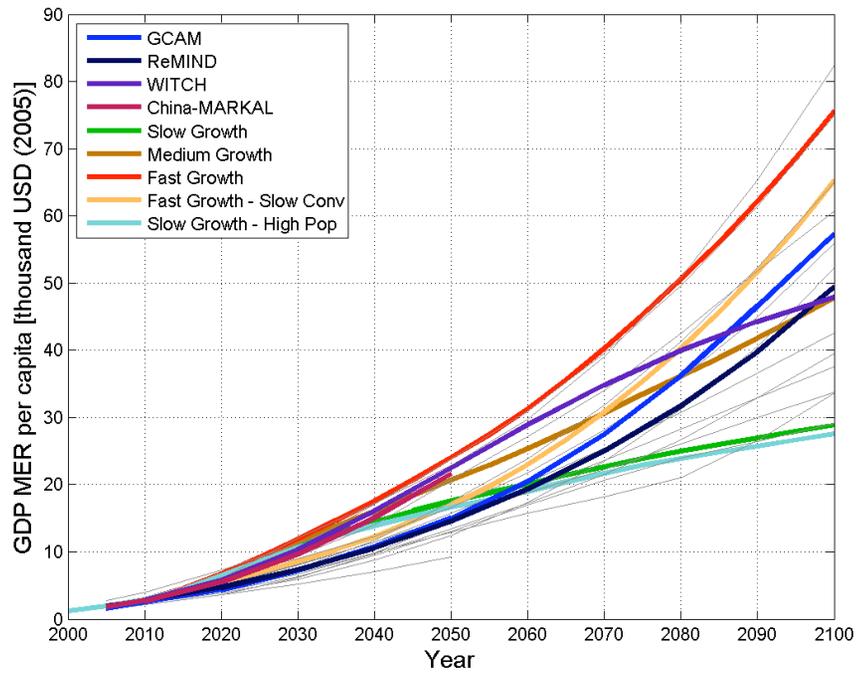
RoSE scenarios



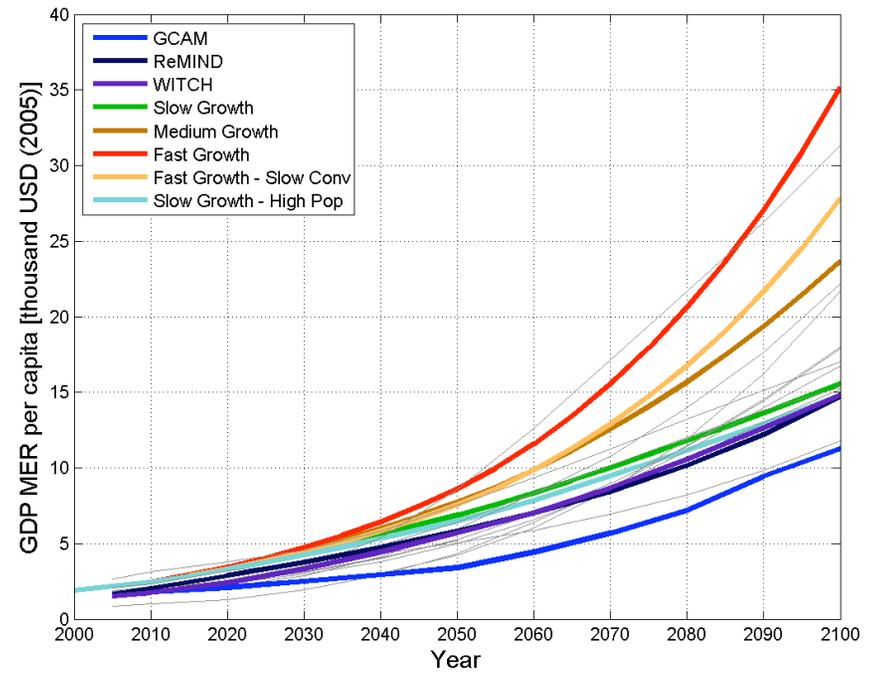
Harmonization: GDP per capita scenarios



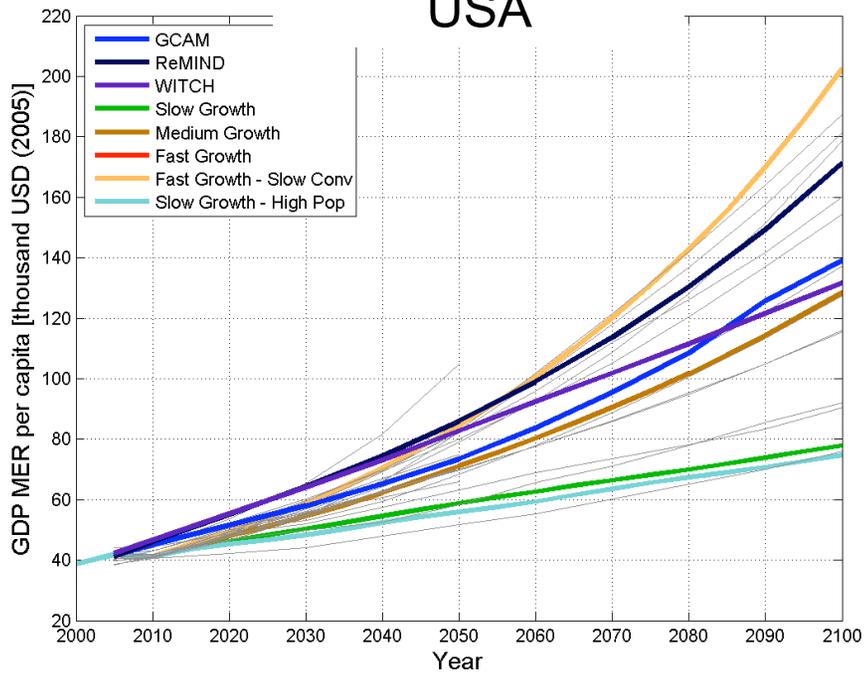
China



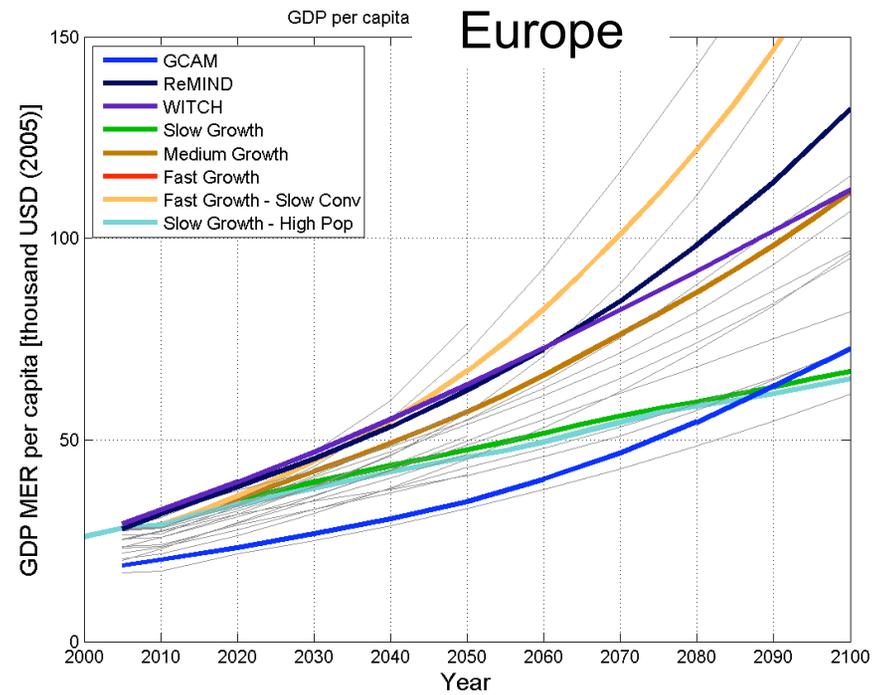
Africa & Middle East



USA



Europe



nal

Basic approach

Based on Methodology by PricewaterhouseCoopers

Hawksworth, J. (2006), *The World in 2050 How big will the major emerging market economies get and how can the OECD compete.*

Cobb-Douglas production function:

$$Y = AK^a L^{1-a}$$

Y = GDP

A = total factor productivity

K = physical capital stock

L = quality adjusted input of labor

a = share of capital in total nation income ($a=1/3$)

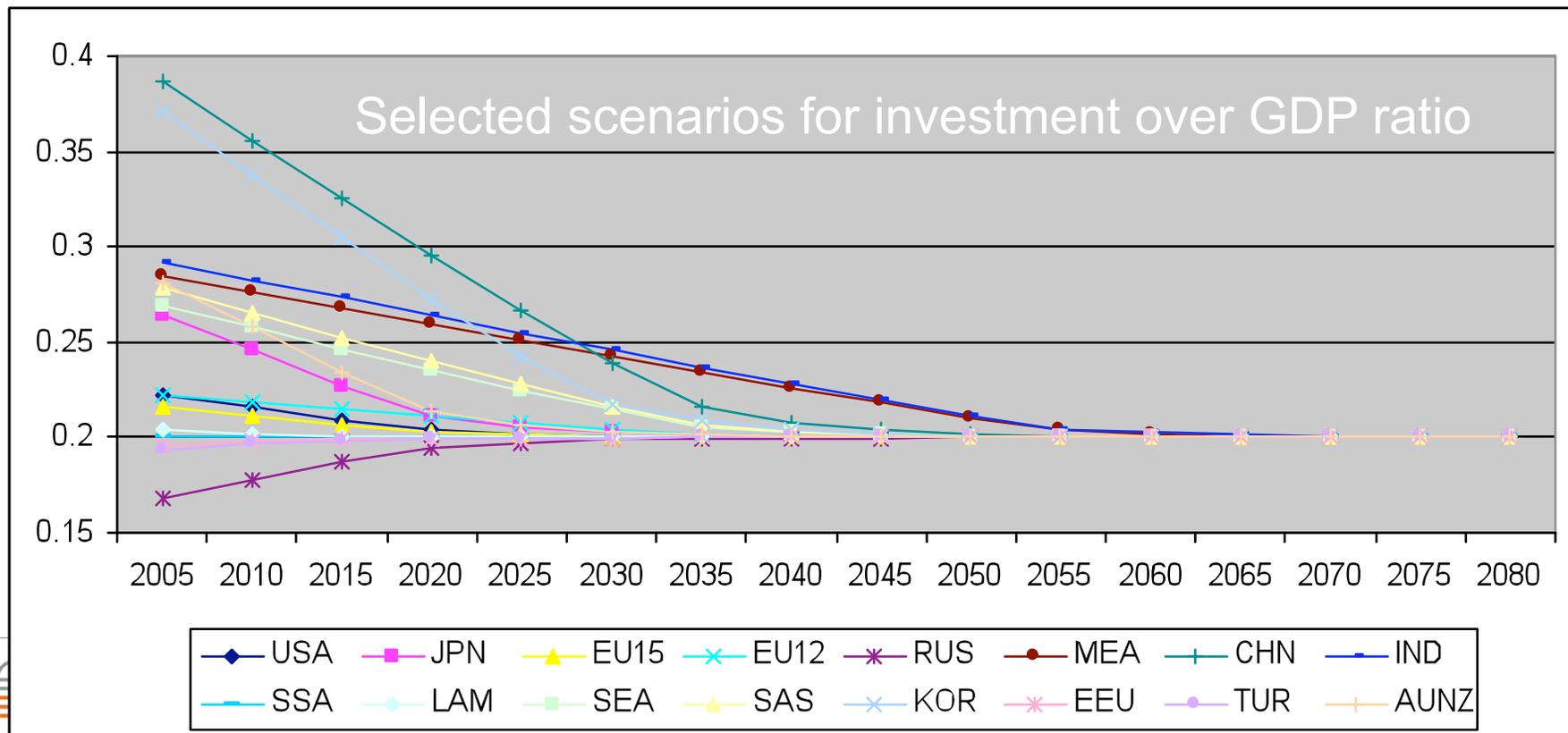
Growth of capital stock: A function of investment

● Calculation after standard formula:

$$K_t = K_{t-1}(1 - d) + I_t$$

d = depreciation rate ($d = 0.05$)

I_t = gross investment in year t



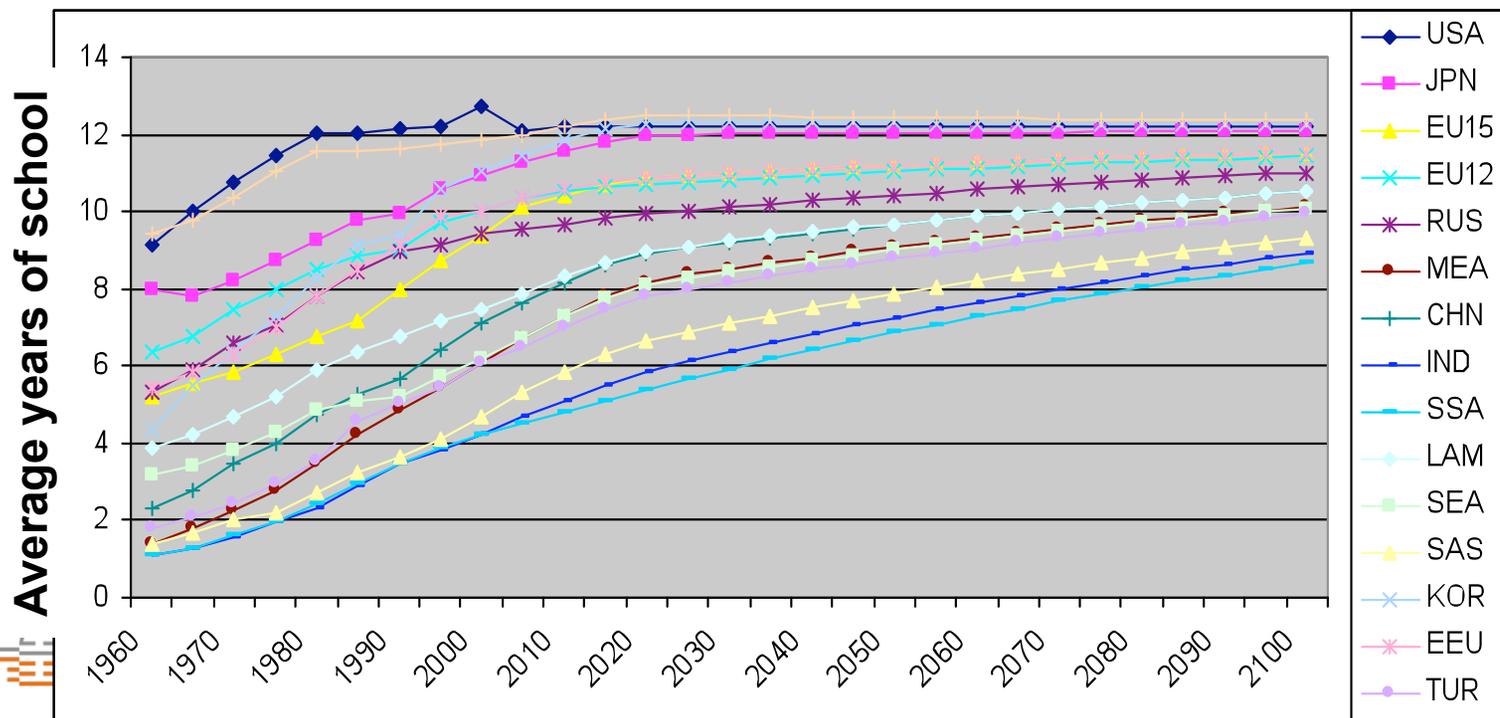
Quality adjusted input of labor

$$L = h(s) (e_1 N(15-64 \text{ yr}) + e_2 N(65+ \text{ yr}))$$

s = average years of school (data from Barro and Lee, 2001; Scenario after 2010)

e_1 = employment rate working age population (Varies from 55% – 75% across regions. Cultural factors dominating? Assumed constant after 2010)

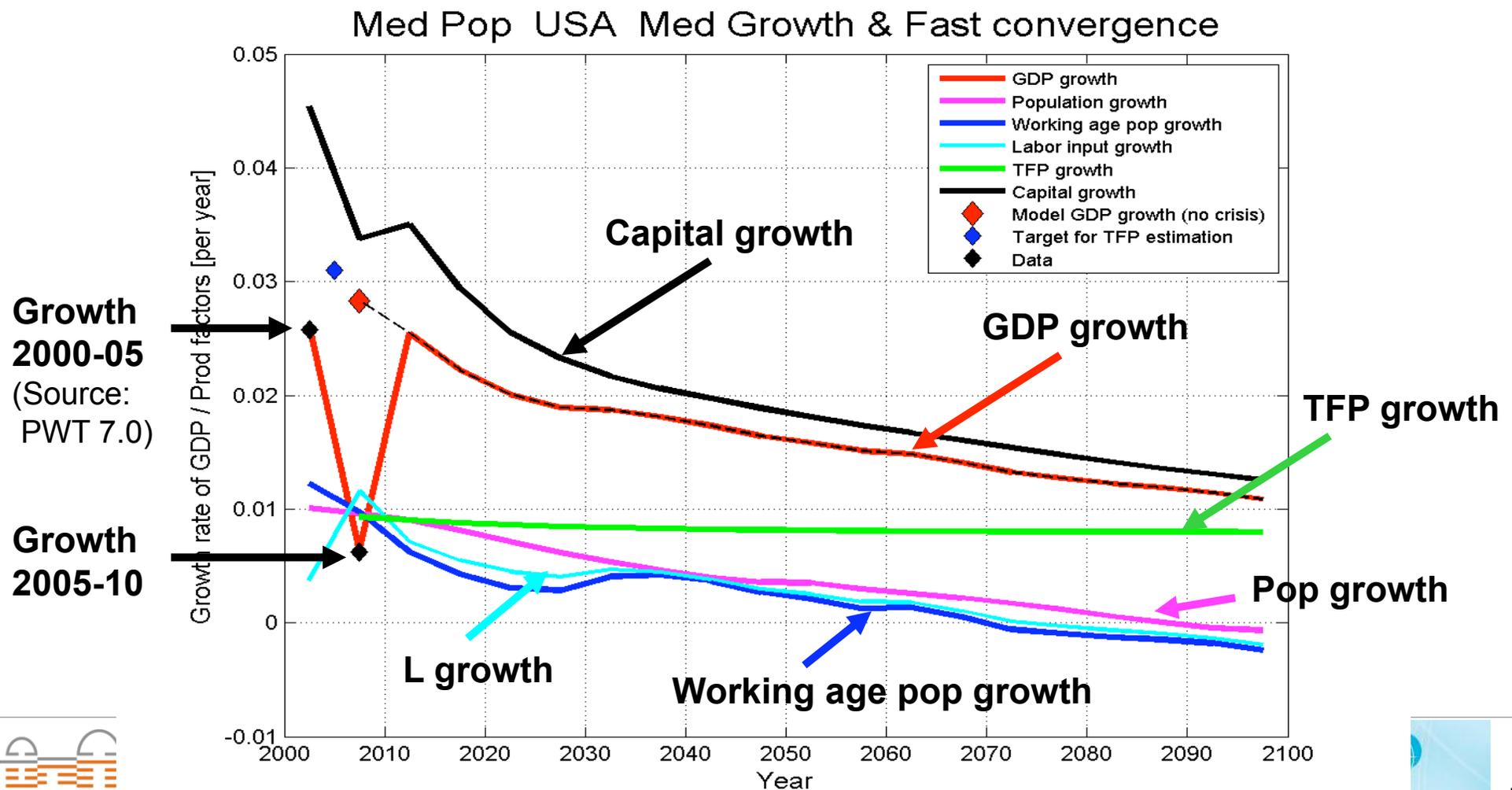
e_2 = employment rate of population 65+ years old
(Varies from 3% – 50% across regions. Dominated by per capita income. 3%-20% in developed countries. Scenario assumed after 2010)



Technological improvement ...

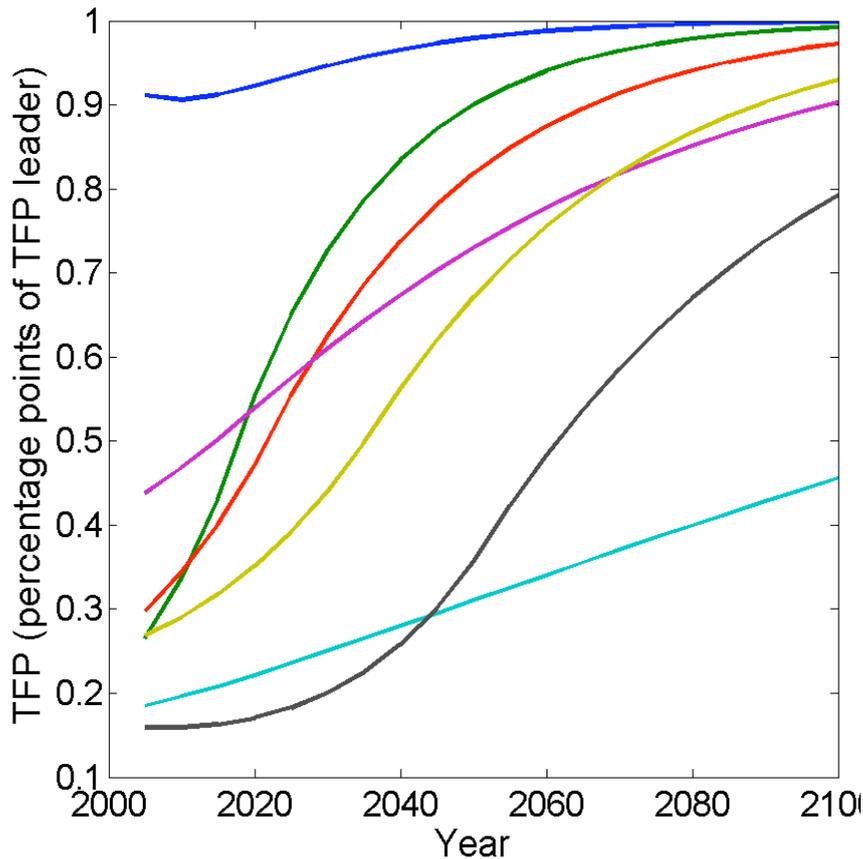
... reflected in increasing total factor productivity (TFP)

Technology leader USA: TFP growth 0.35% (slow), 0.8% (medium), 1.2% (fast)



Convergence of technology followers

Fast convergence
(Medium growth of leader)



Slow convergence
(Medium growth of leader)

