Productivity growth at the sectoral level: measurement and projections

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Michiel van Dijk (LEI – Wageningen UR

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Introduction

- Increasing use of scenario analysis and integrated assessment modelling to analyse complex issues such as climate change, food security, energy security and land use change.
- Frequent use of global computable general equilibrium (CGE) models (e.g. GTAP, MAGNET and MIRAGE).
- Requires assumptions and projections on technical change at the sectoral level; key determinants of structural change and economic development.
- Most current models use simplistic or ad hoc assumptions which are often not based on empirical analysis and are not in line with productivity studies.

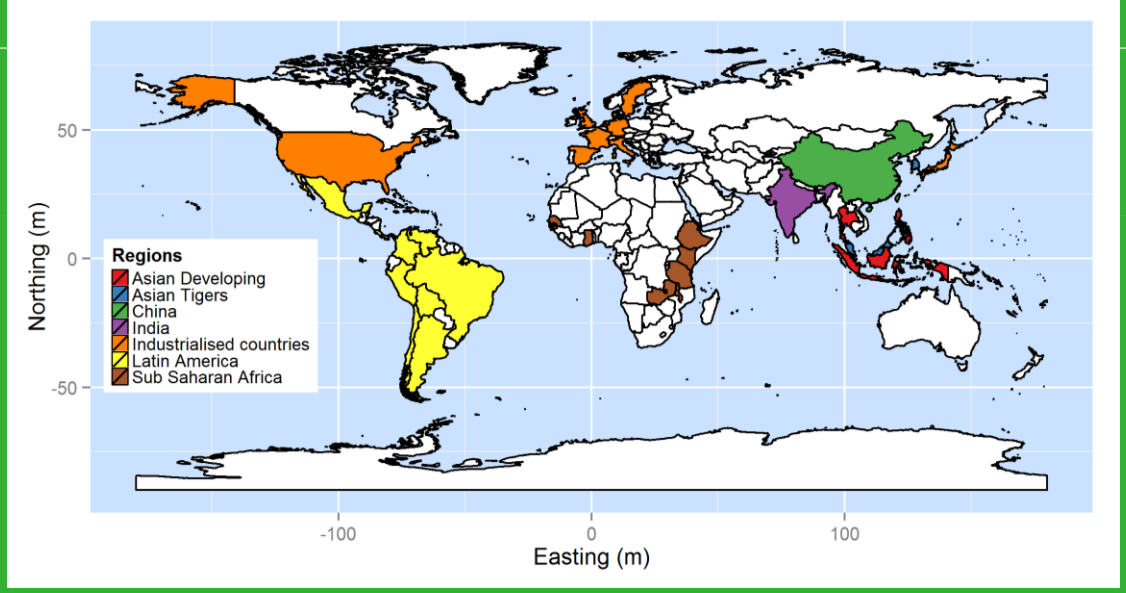
Aim

- Construct productivity projections for long-run economic modelling that:
  - Are based on empirical analysis.
  - Are in line with economic growth theory.
  - Have global coverage.
  - Are disaggregated at the sectoral level but cover the broad economy.

Methodology

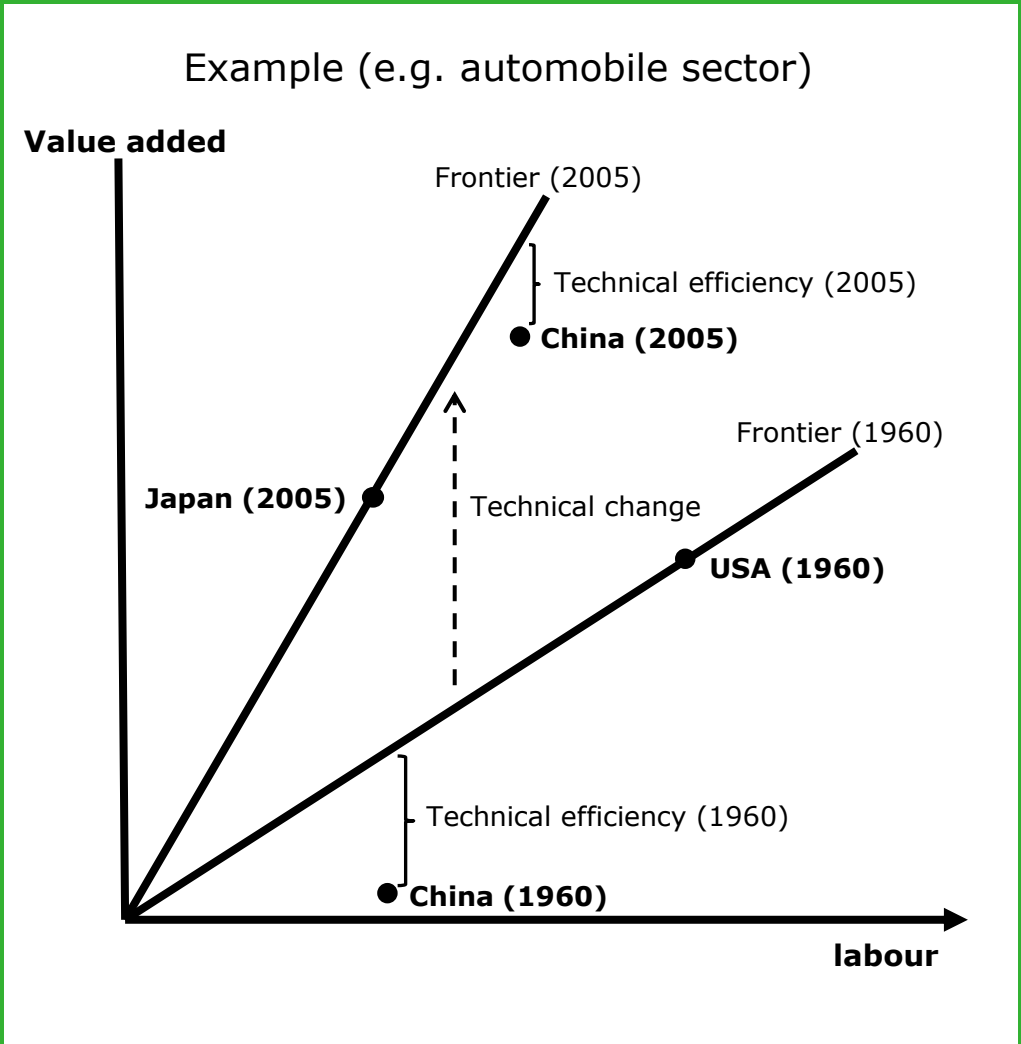
- Follow the approach of Nin *et al.* (2005) and Ludena *et Al.* (2007) who provide detailed productivity projections for agriculture.
- Step 1: Decomposition of historical productivity growth (1960-2005) using data envelopment analysis (DEA) into:
    1. Movement of the technical frontier, i.e. technical change.
    2. Movement towards the frontier, i.e. catching up.
- Step 2: Productivity projections up to 2050 that explicitly account for the limitations to catch up when countries reach the frontier.

Step 1: Data



- Trade off between coverage (many countries and sectors) and detailed analysis (sector and input-output disaggregation).
- Sectoral database from McMillan and Rodrik (2011) and Timmer and De Vries (2009) that covers:
  - 38 advanced and developing countries.
  - Nine main sectors that sum to total GDP for the period 1960-2005.
- Main limitation:
  - Only harmonised data on value added and labour => analysis limited to labour productivity development.

Step 1: Decomposition of productivity growth



Productivity Growth (LPG) = Technical efficiency change/catch up (EFF) x Technical change (TCH)

Additional steps:

- Cumulative production frontier that eliminates possibility of regress.
- Hodrick-Prescott filter to smooth business cycles.

Step 2: Productivity projections

- Separate projections for catch up and technical change
- Potential for catch up decreases when countries reach the technical frontier.
- Technical efficiency change is modelled as a diffusion process following an S-shaped curve (Griliches, 1957). Estimation and extrapolation of logistical functional form:

$$\text{technical efficiency} = \frac{maximum\ efficiency\ (=100\%)}{1+e^{=\alpha+\beta}}$$

- Accounting for structural breaks (Bai and Perron, 2003).
- Assume that the rate of future technical change is the same as in the past.

Results

Technical change/shift of the frontier (TCH)

- Highest in agriculture and manufacturing.
- Lowest in construction and pers. services.
- In line with detailed productivity studies (e.g. Jorgenson and Timmer, 2011).

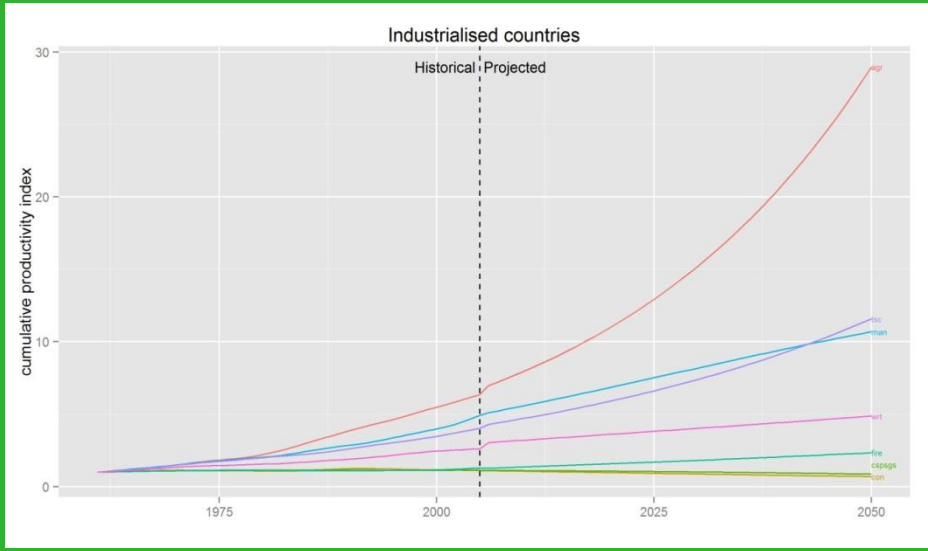
Productivity projections and catching up

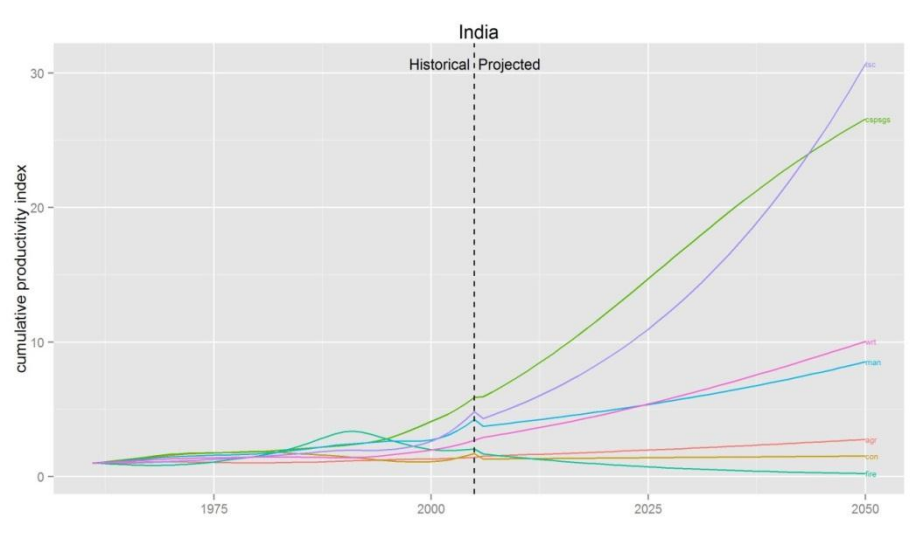
- *Indus. countries* remain producing on the frontier. Future LPG is close to TCH.
- *Asian Tigers and China* remain catching up but LPG is slowing down as countries reach the frontier in the future.
- *India's* performance is mixed. Some sectors are catching up while others are falling behind.
- Asian dev. Countries, Latin America and SSA are falling behind.

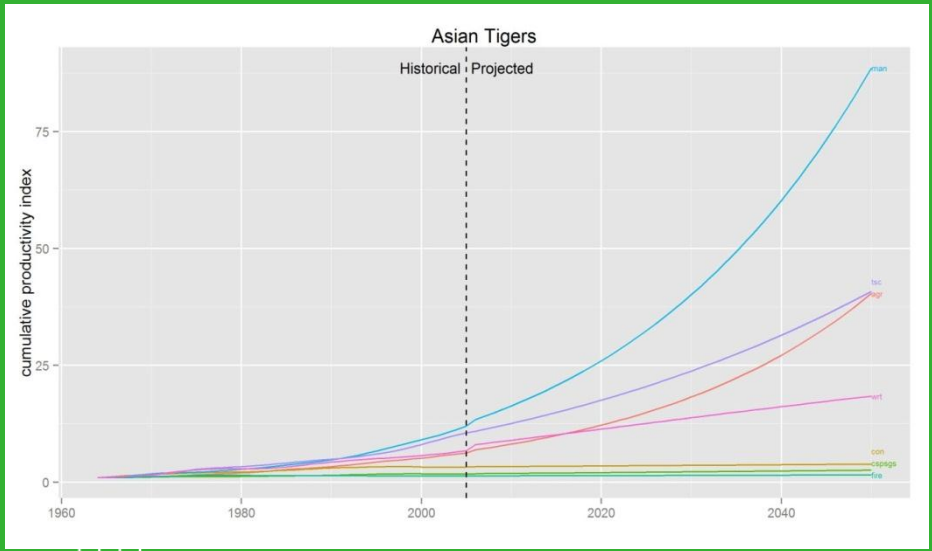
Productivity growth decomposition (annual change) Asian Tigers

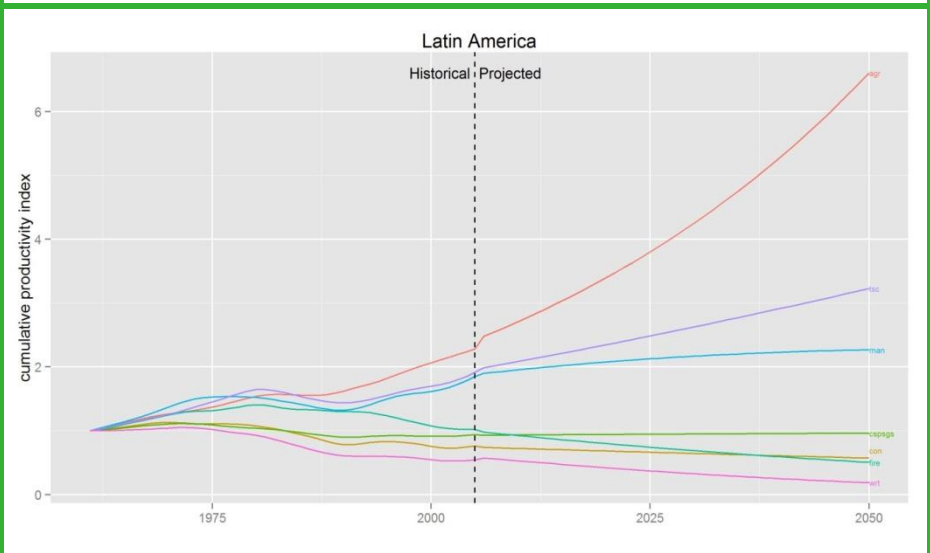
	1961-1990			1991-2005			2006-2050		
	LPG	EFF	TCH	LPG	EFF	TCH	LPG	EFF	TCH
Agriculture (agr)	4.83	1.31	3.45	4.29	0.82	3.47	4.23	0.75	3.46
Construction (con)	4.79	4.76	0.18	0.44	0.44	0.00	0.38	0.26	0.12
Personal services (cspsgs)	1.52	1.05	0.48	1.03	0.60	0.44	0.89	0.43	0.47
Financial services (fire)	1.26	0.54	0.95	-0.27	-0.27	0.00	0.28	-0.35	0.63
Manufacturing (man)	6.34	3.65	2.66	6.35	1.76	4.52	4.55	1.23	3.28
Transport and comm. (tsc)	6.50	4.56	1.71	5.24	1.98	3.22	3.05	0.81	2.22
Trade (wrr)	5.80	5.54	0.23	3.02	1.21	1.85	2.29	1.51	0.77
Total economy (sum)	5.48	4.46	1.17	3.75	1.98	1.74	2.38	1.00	1.36

Cumulative labour productivity index (1960-2050)

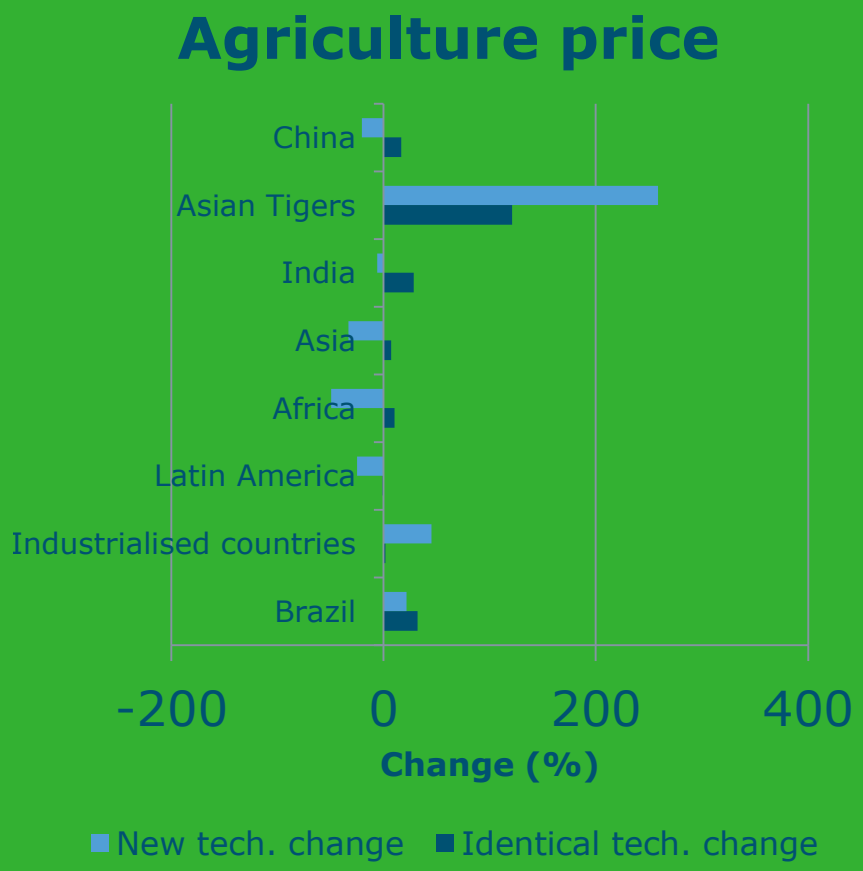








Experiment: Implications for agricultural prices and total trade (2007-2030)



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Conclusions

- First attempt to construct productivity projections as input to CGE models.
- Productivity change, technical change and catching up patterns differ across sectors and countries.
- Assumptions on technical change have major impact on outcomes of CGE models that are used for the assessment of future food security, land use and climate change.
- Hence, it is important that such models devote more attention to proper specification of technical change at the sectoral level.

Future research/Key issues

- How to deal with regions that are falling behind?
- Probably better to use more detailed projections from Ludena et al (2007) for agriculture. Such estimations are not available for other sectors.
- Projections can be improved by using more detailed information (new database being constructed) and sector specific PPPs.

Thank you

Questions?

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