# Accounting for Growth in Global Agriculture

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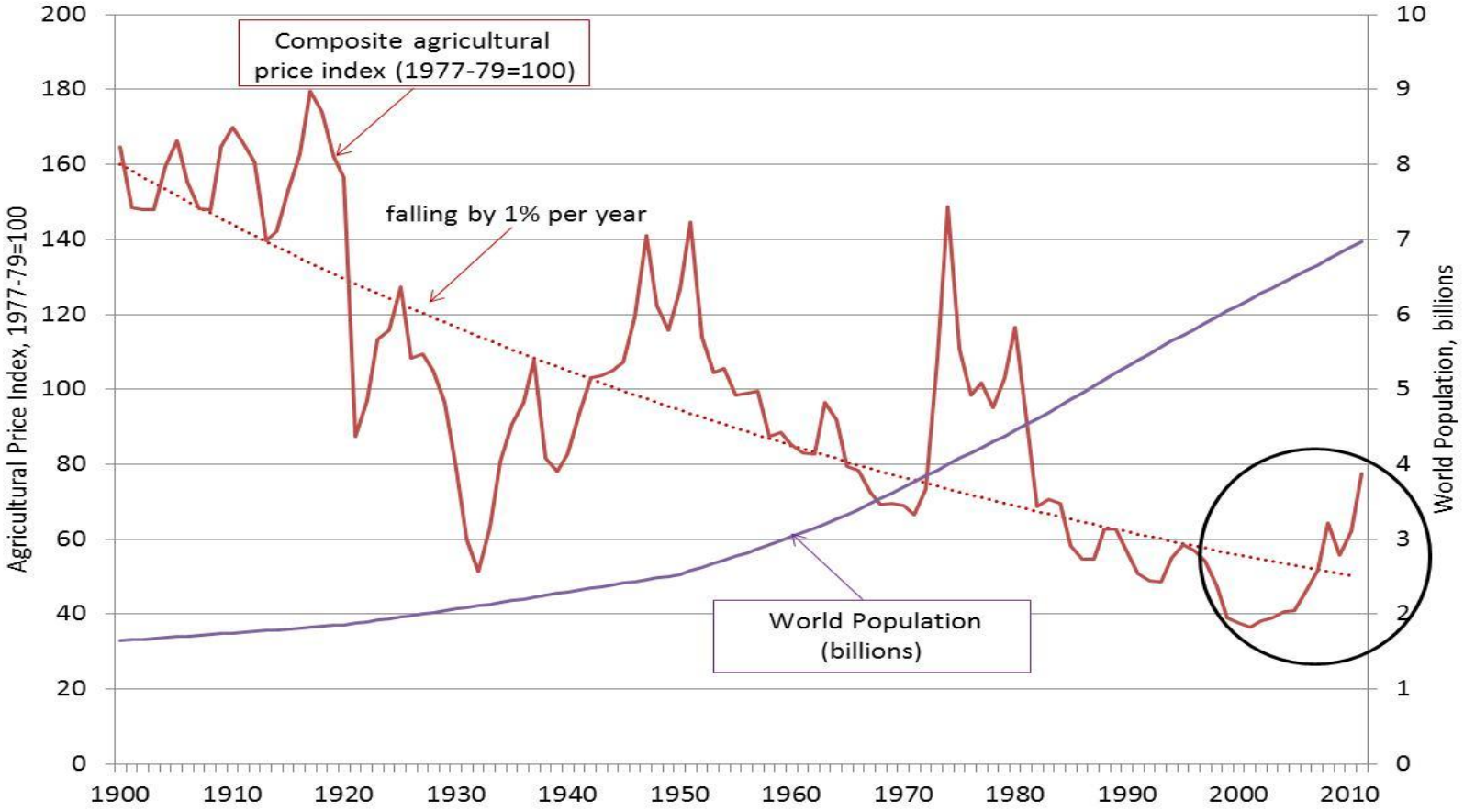
USDA

United States Department of Agriculture, Economic Research Service

# 20th Century: Growing agricultural abundance despite population growth due to productivity gains
# 21st Century: Is productivity growth slowing down?

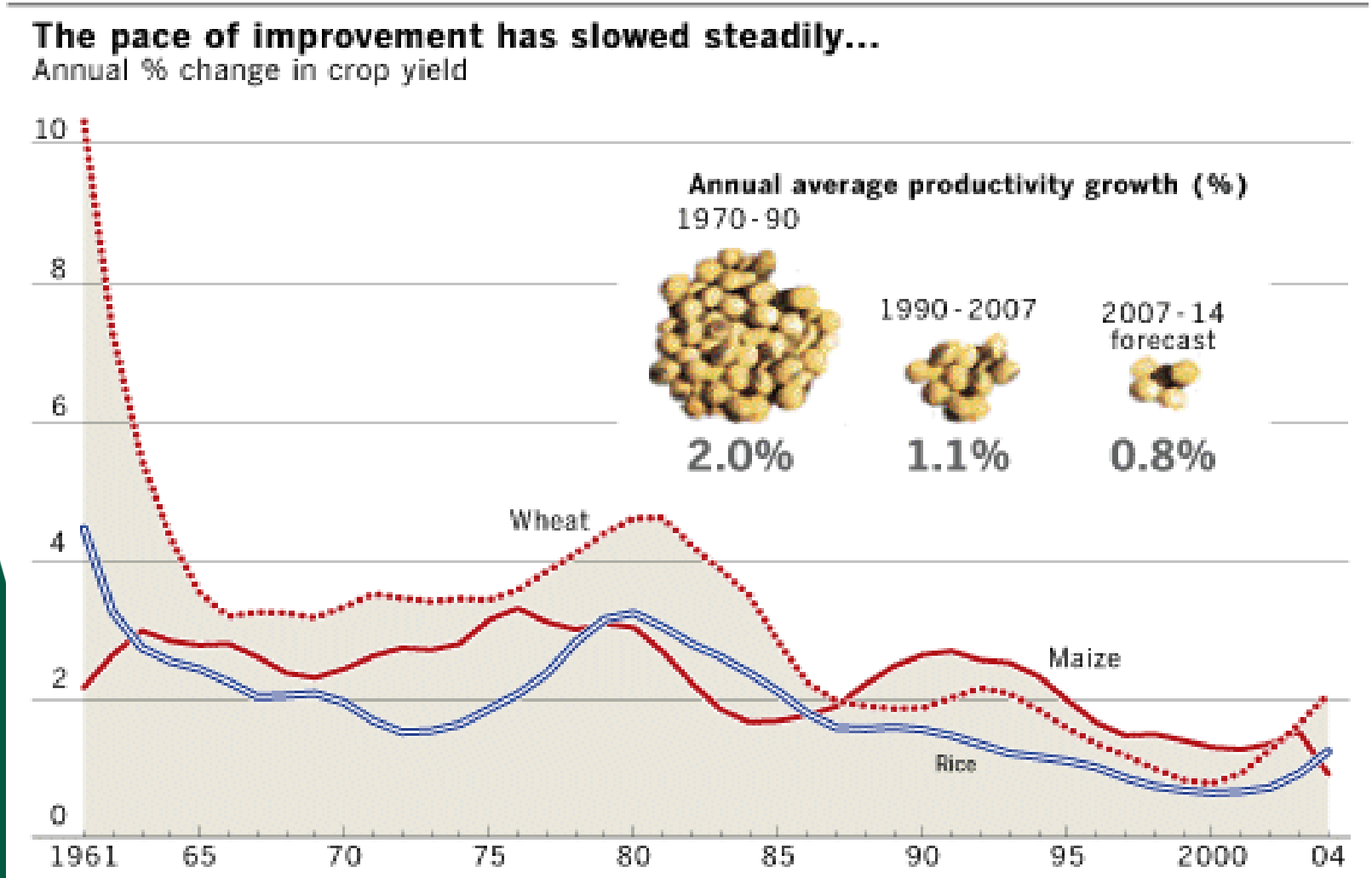






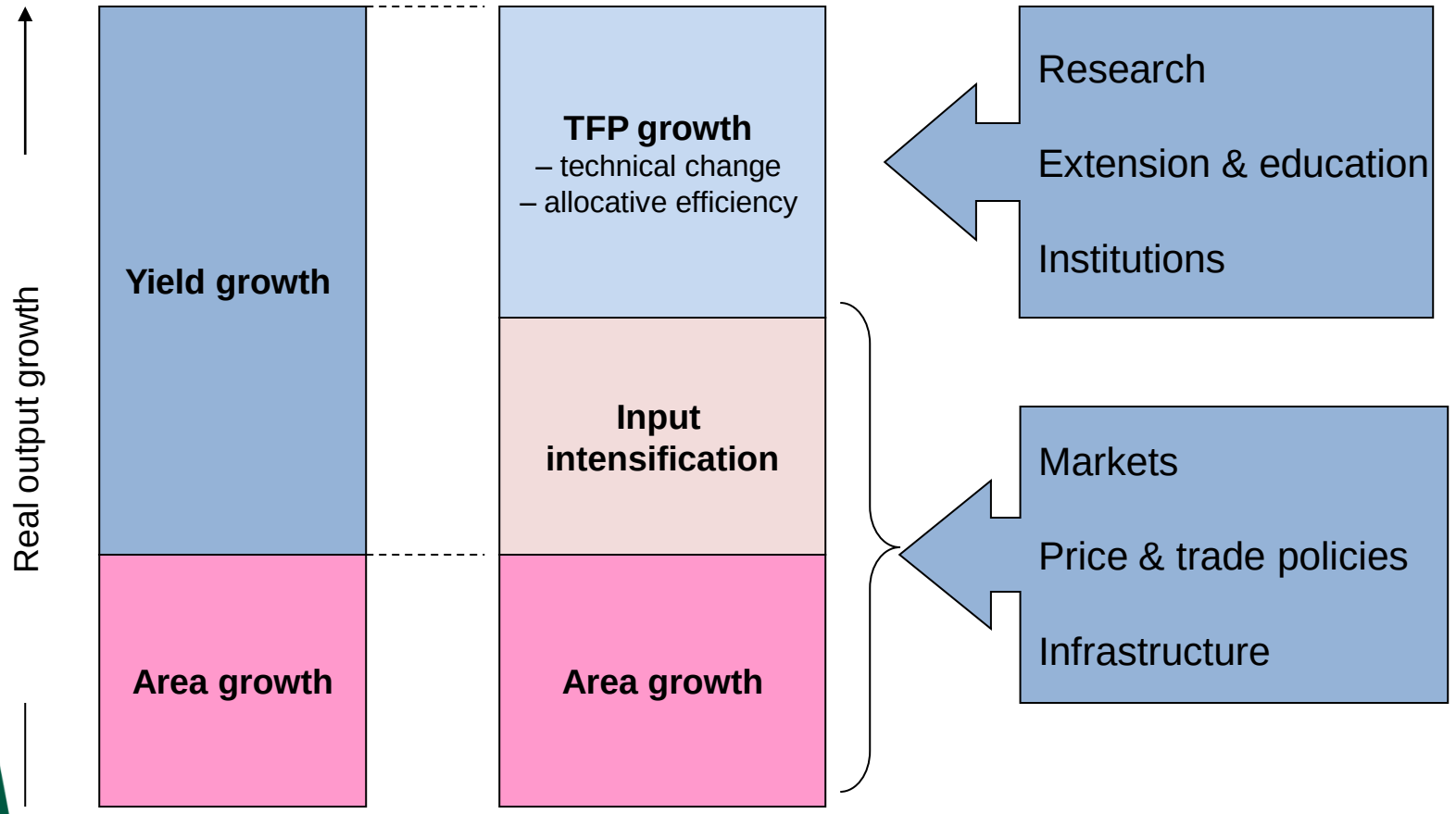
Source: ERS

# Rate of growth in cereal crop yield has slowed




Source: World Bank Development Report 2008

# Toward a more complete assessment of productivity growth: **Total factor productivity**



# Measuring national and global ag TFP growth

- Previous studies: Malmquist Distance function
  - Arnade (1997), Coelli & Rao (2005), Nin-Pratt & Yu (2010)
  - Uses only input and output ***quantity*** data
  - Results sensitive to data quality & dimensionality issue
  - Inconclusive findings on rate of global ag TFP growth
- ERS approach: use Solow-type growth accounting method
  - TFP growth is difference between output growth and input growth

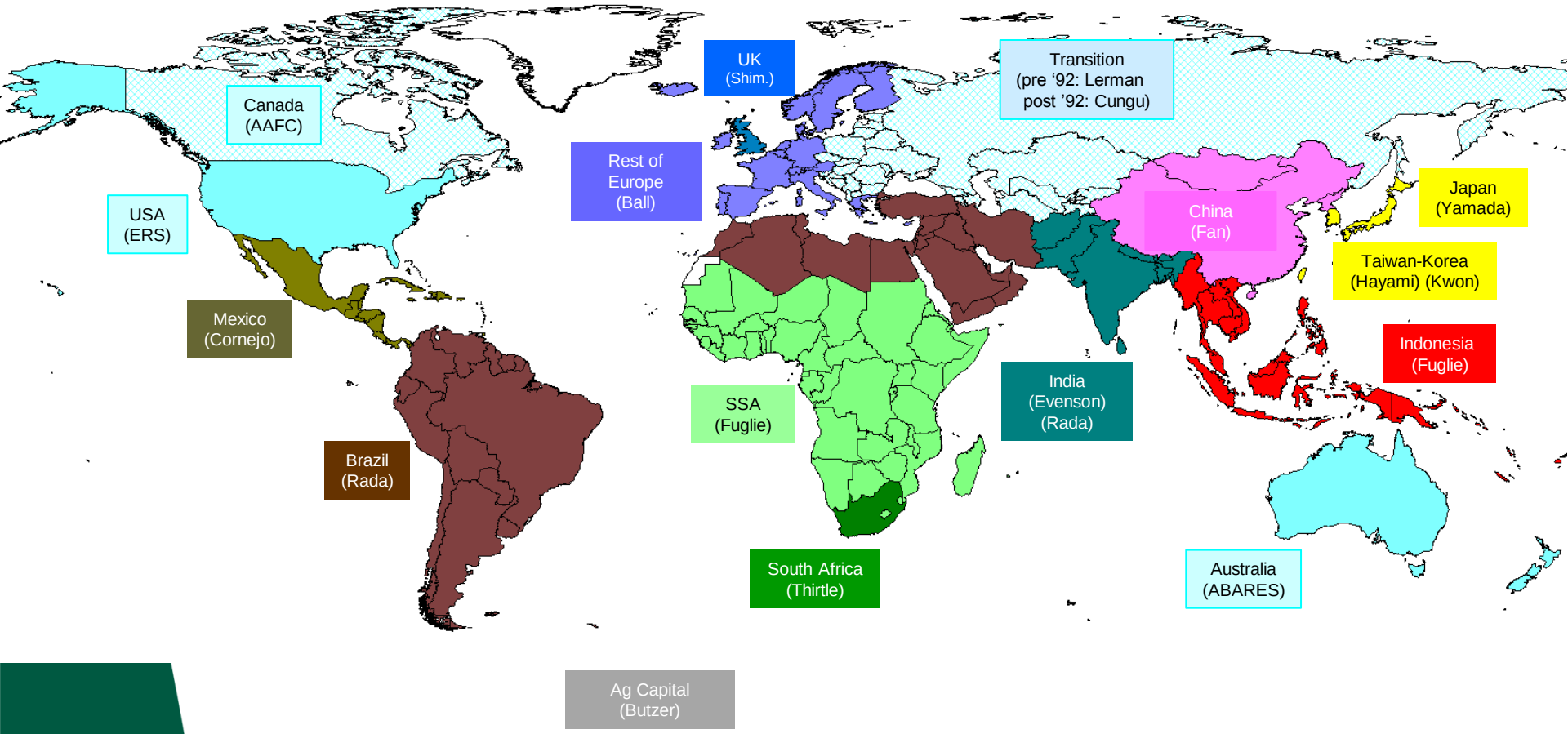
$$\Delta TFP = \sum_{i}^{N} r_i \Delta Y_i - \sum_{j}^{M} s_j \Delta X_j$$

  - Only compare TFP growth, not TFP levels, among countries and regions
  - Tornqvist-Thiel index adjusts revenue and cost shares to account for changing composition of outputs and inputs

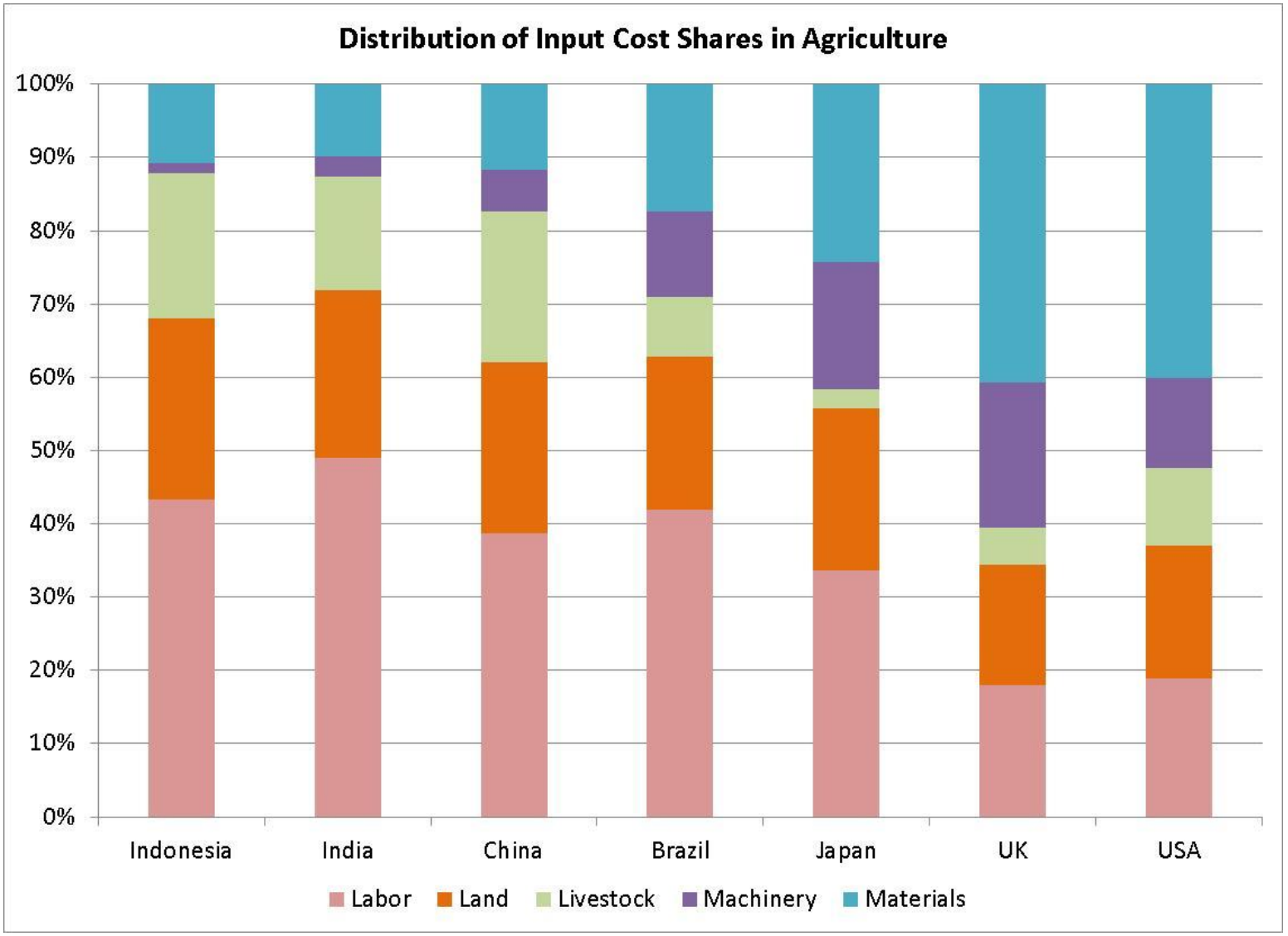
# Empirical implementation

- Output: FAO Gross Agricultural Output series to create Output Index
  - Aggregates 190 crop and livestock farm outputs using fixed global prices from 2004-2006
- Input: aggregate FAO input quantities to create Input Index using cost shares from published studies
  - Cost shares vary over time (if observed)
  - If not available, assign cost share from “similar” country

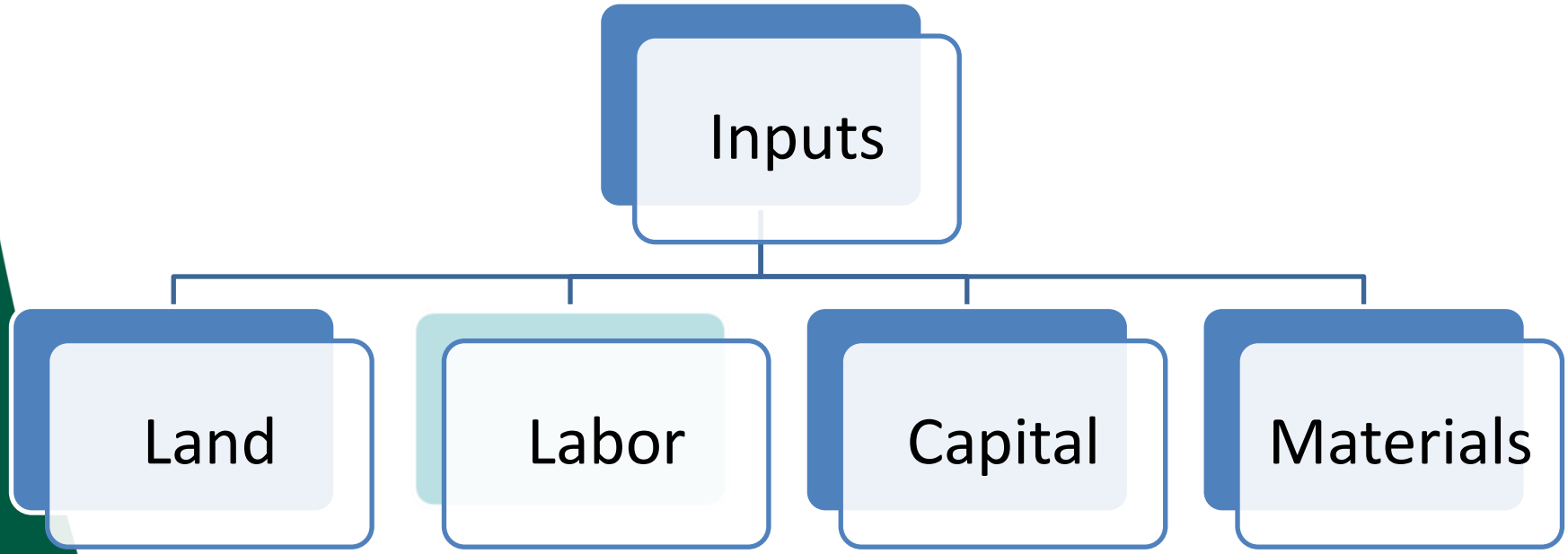
# Observations on agricultural cost shares and their application to regions



# Congruence of input cost shares
# - use of modern inputs increases with development

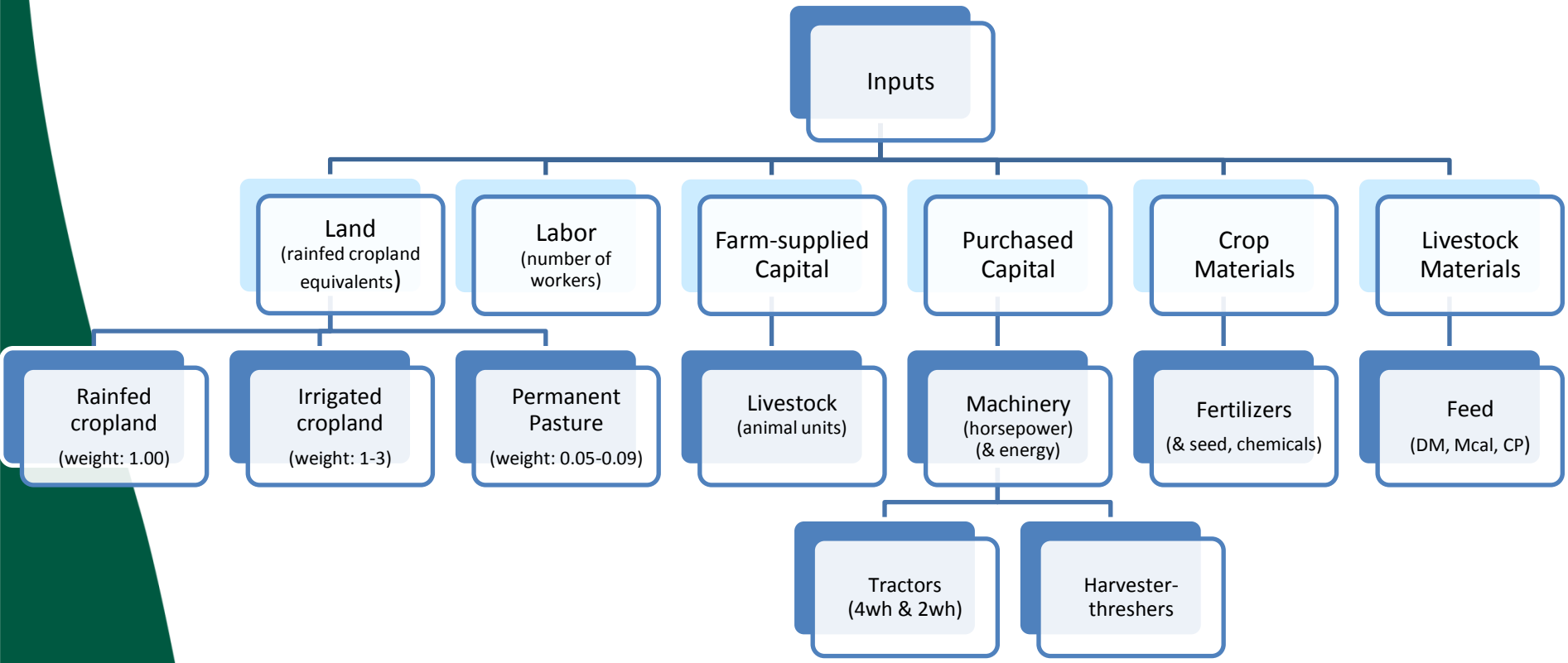


# Constructing an input index



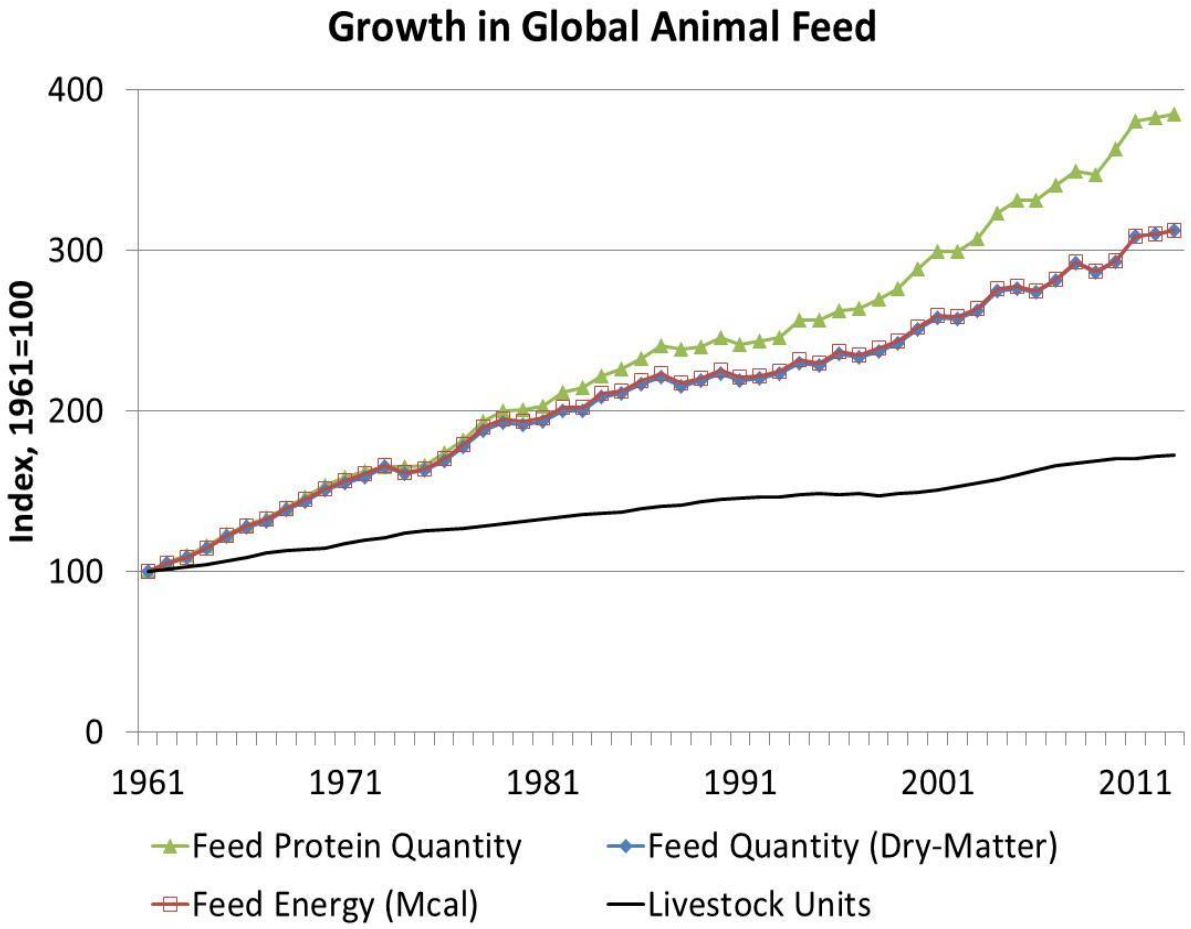

Growth rate of aggregate input is the weighted average of growth in Land, Labor, Capital and Materials, where weights are their (fixed or varying) cost shares.

# Constructing an input index from FAO input data



# Feed Use Rising Faster than Livestock Population

- rations include higher proportion of protein



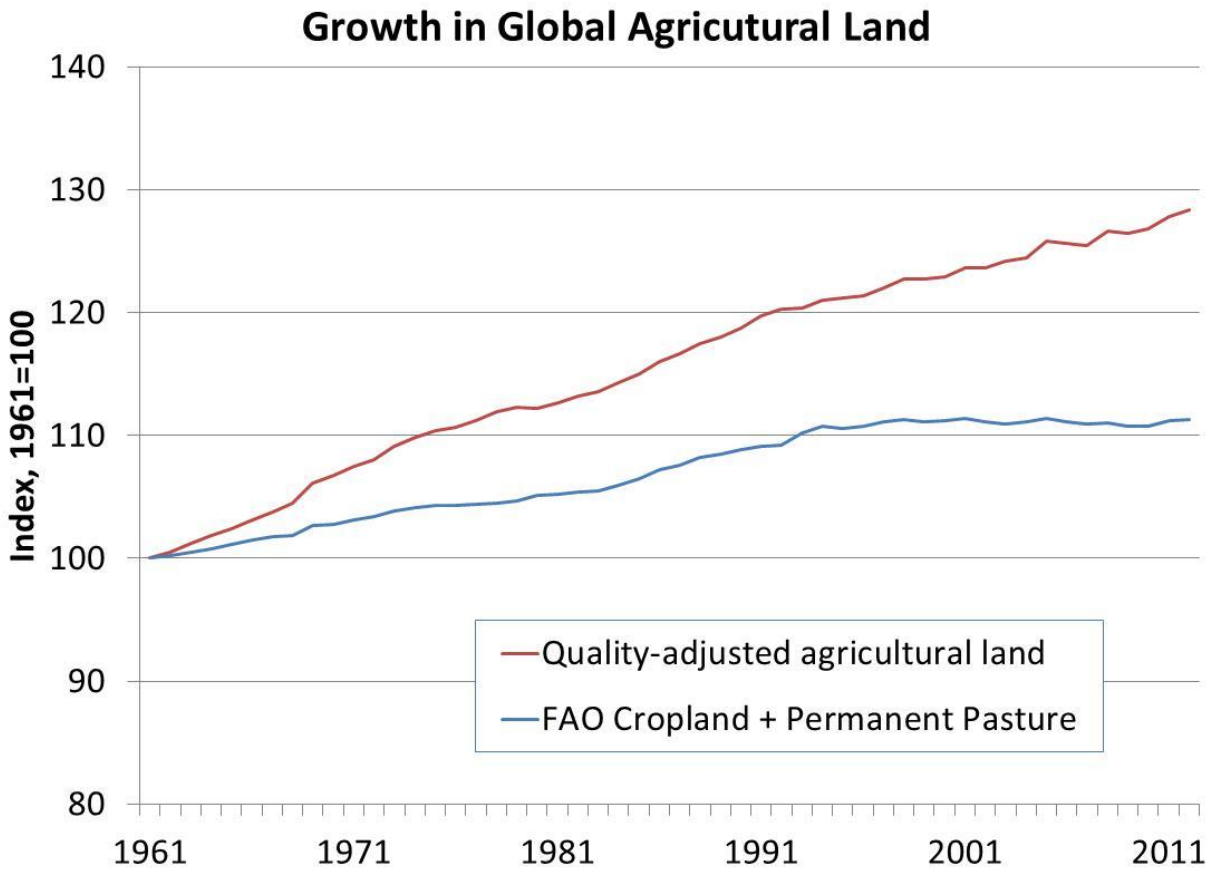




Source: ERS

# Quality-adjusting agricultural land

-use different weights for irrigated, rainfed cropland and permanent pasture



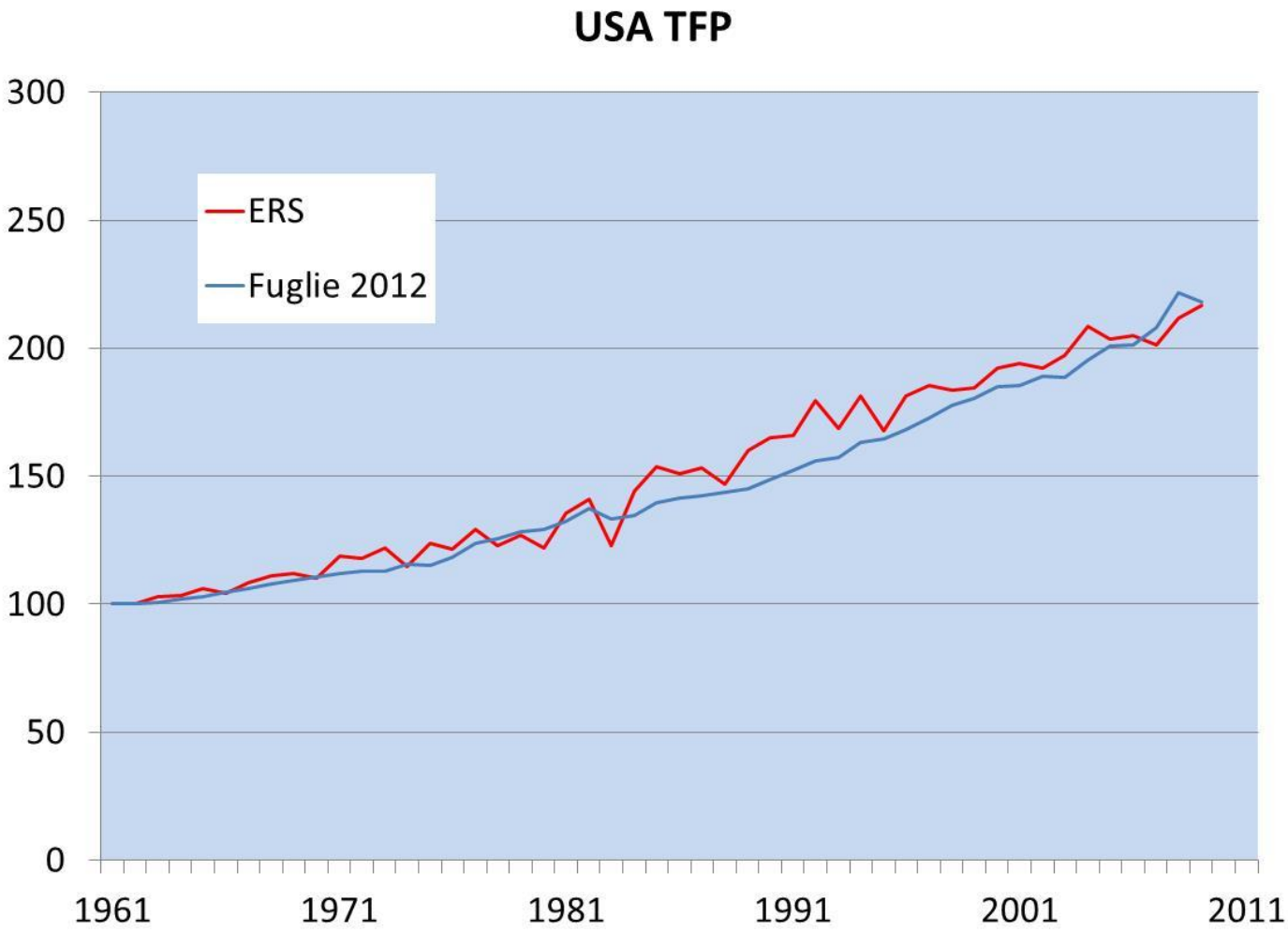


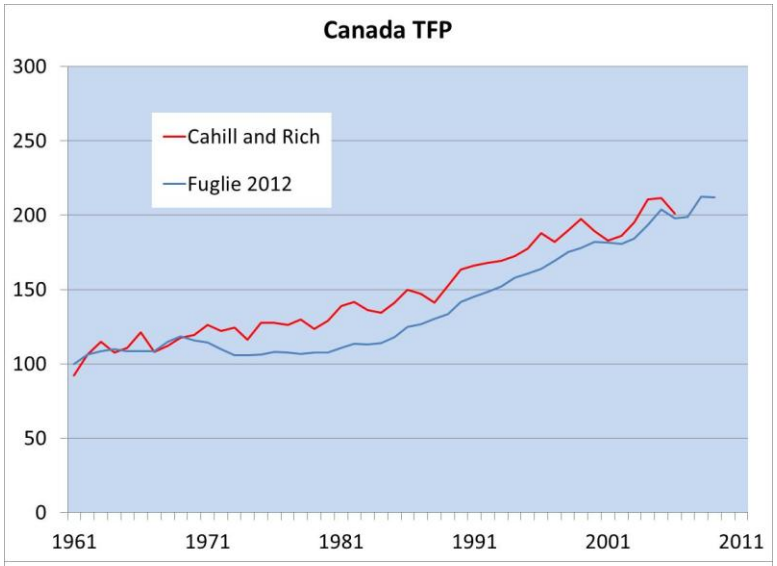


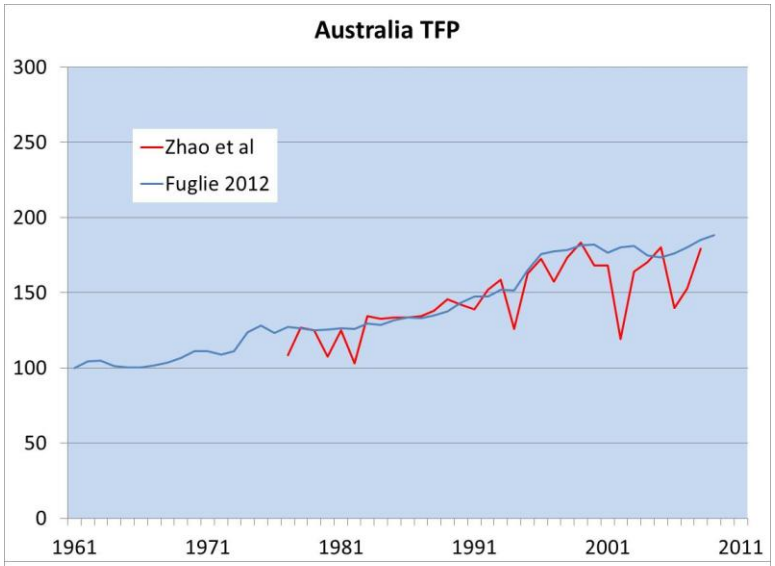
Source: ERS

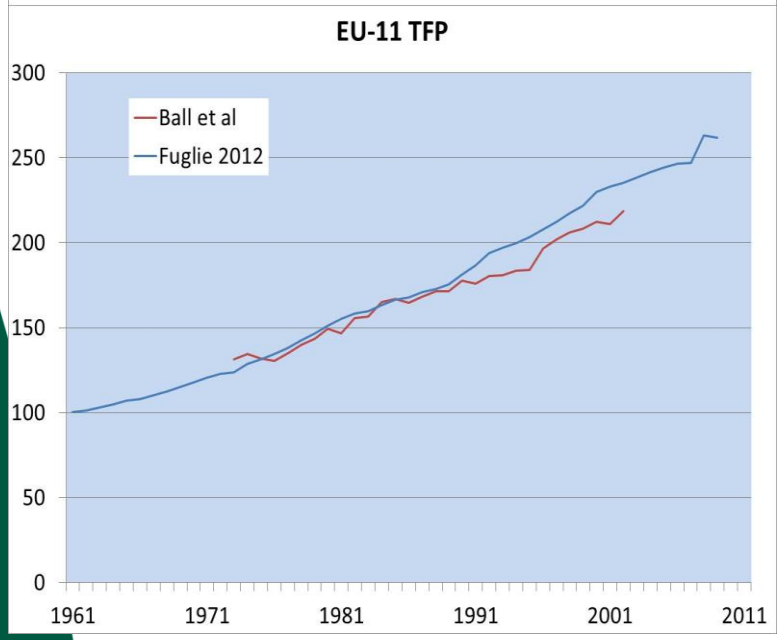
# How good is this method?

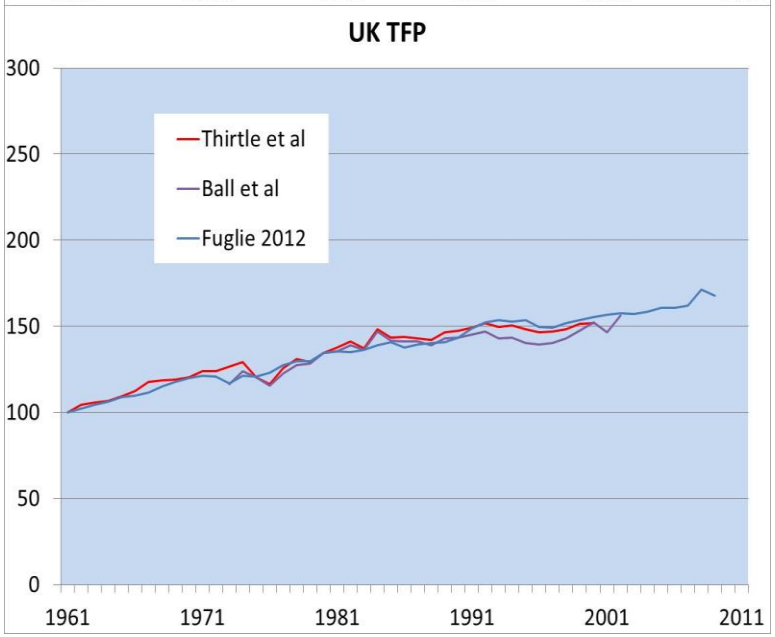
- Limitations
  - Cost shares extrapolated from countries to region
  - Global average, not local, prices used for output
  - Not all inputs directly measured (seed, pesticide, energy)
- Country studies constructing Tornqvist-Thiel productivity indexes use more detailed and complete input and output quantity and price data
- Country studies may also quality-adjust inputs (e.g., ERS quality-adjusts labor, land, chemical, machinery inputs in measuring US ag TFP)
- Comparing ERS TFP indexes against country- or region-specific studies serves as a check on this approach

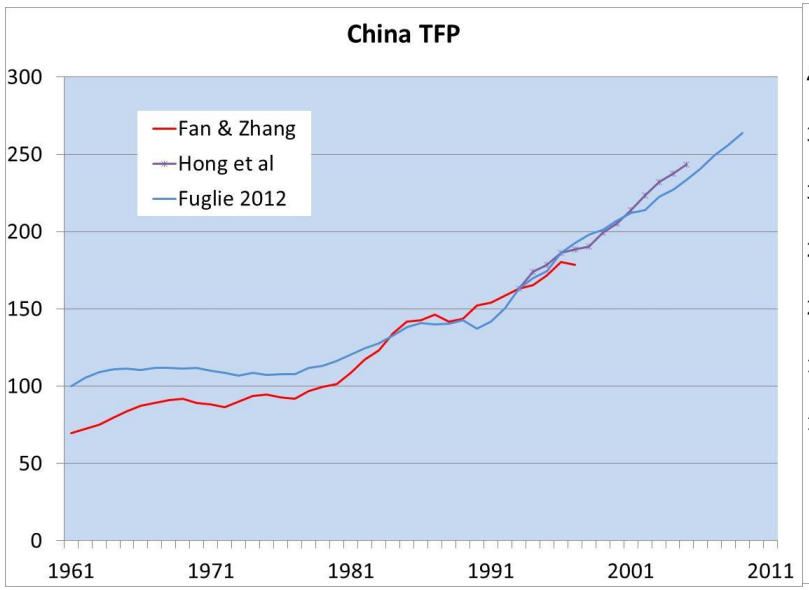


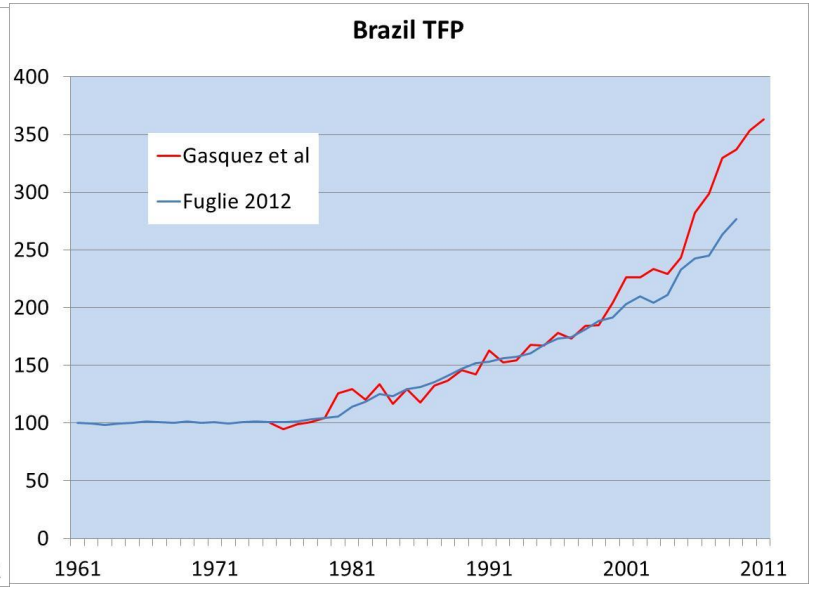


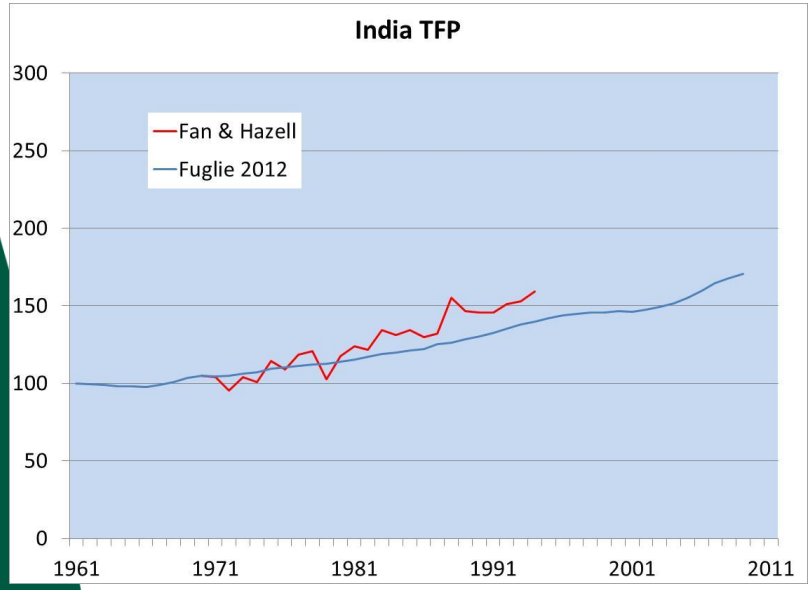



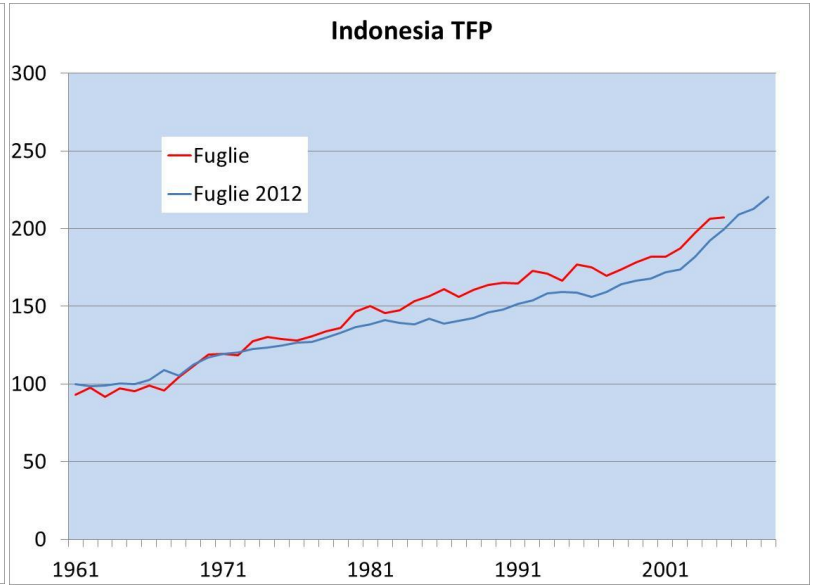





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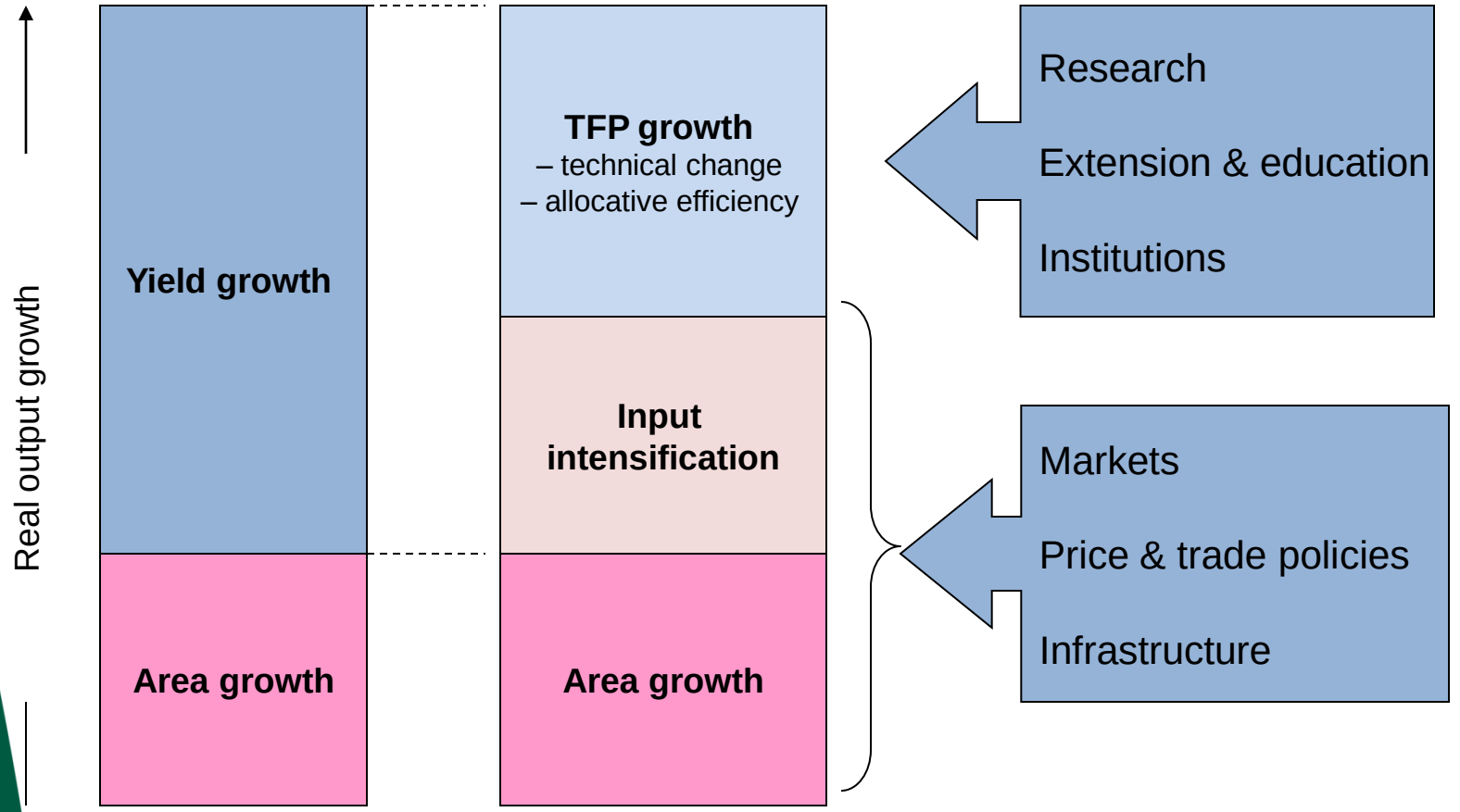
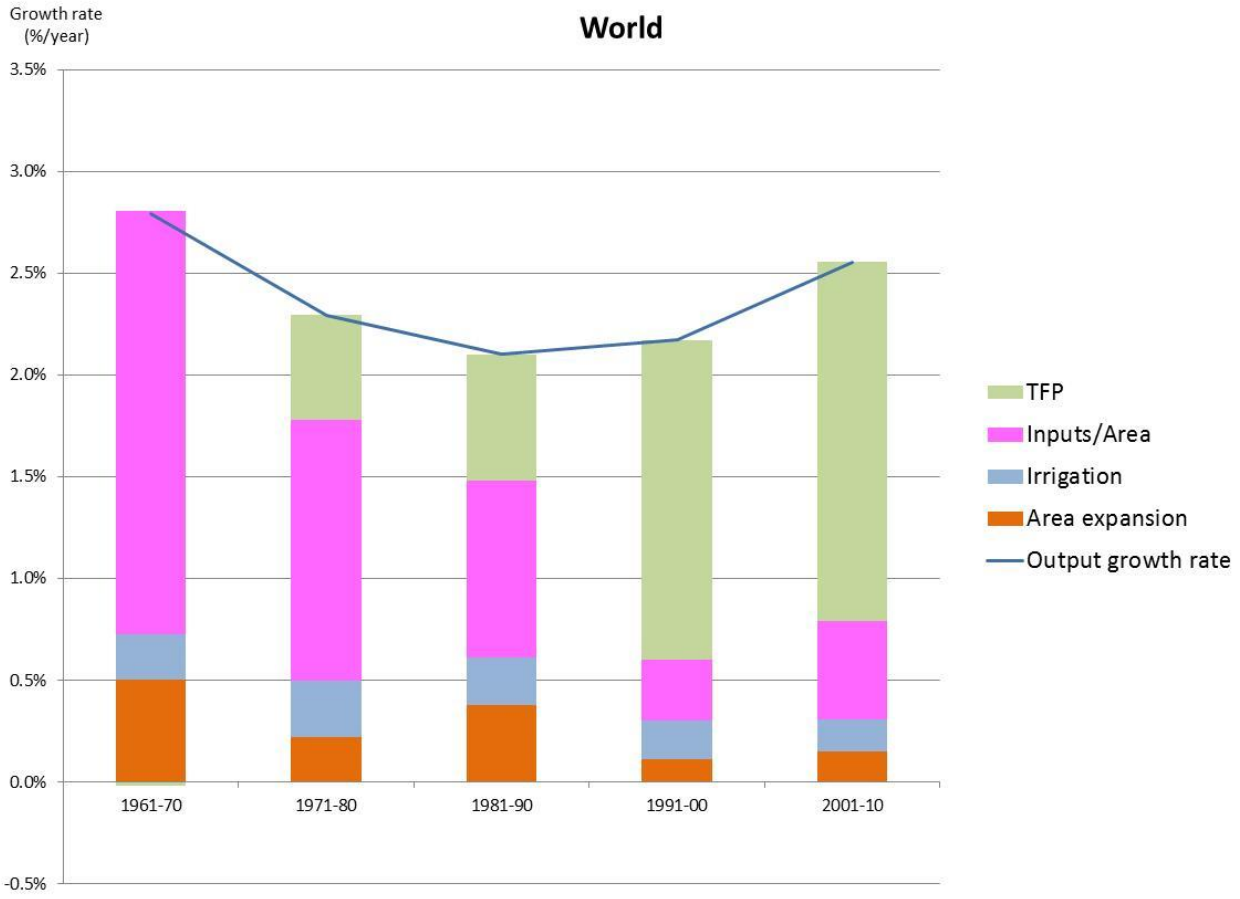


# Agricultural growth accounting: declining input and rising TFP

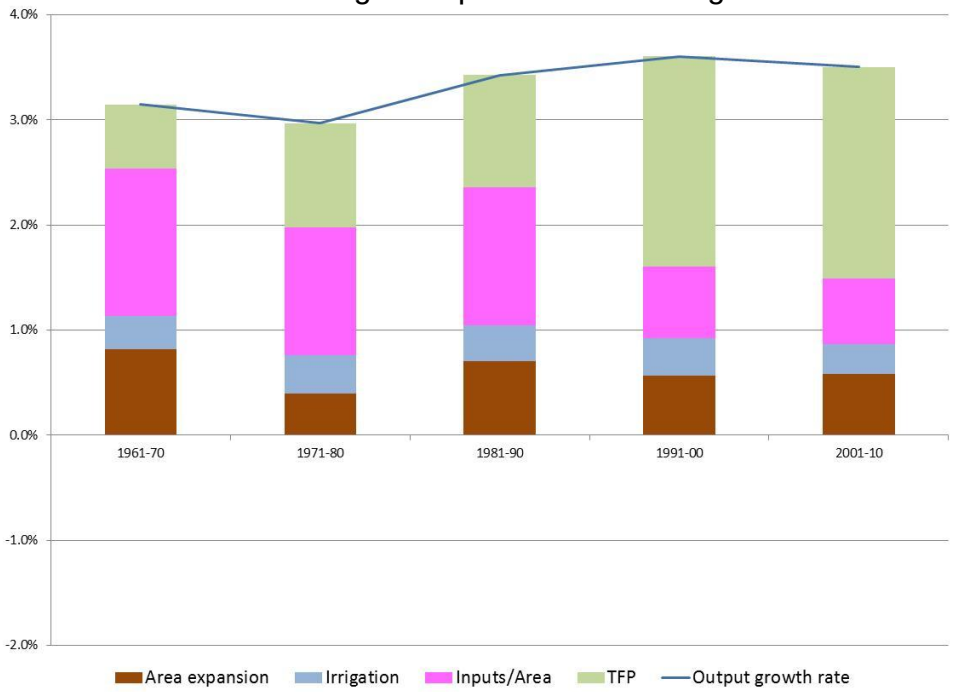



Source: ERS

# Patterns of agricultural growth vary widely across global economy

Industrialized market economies:
TFP enables output to grow even as resources leave sector

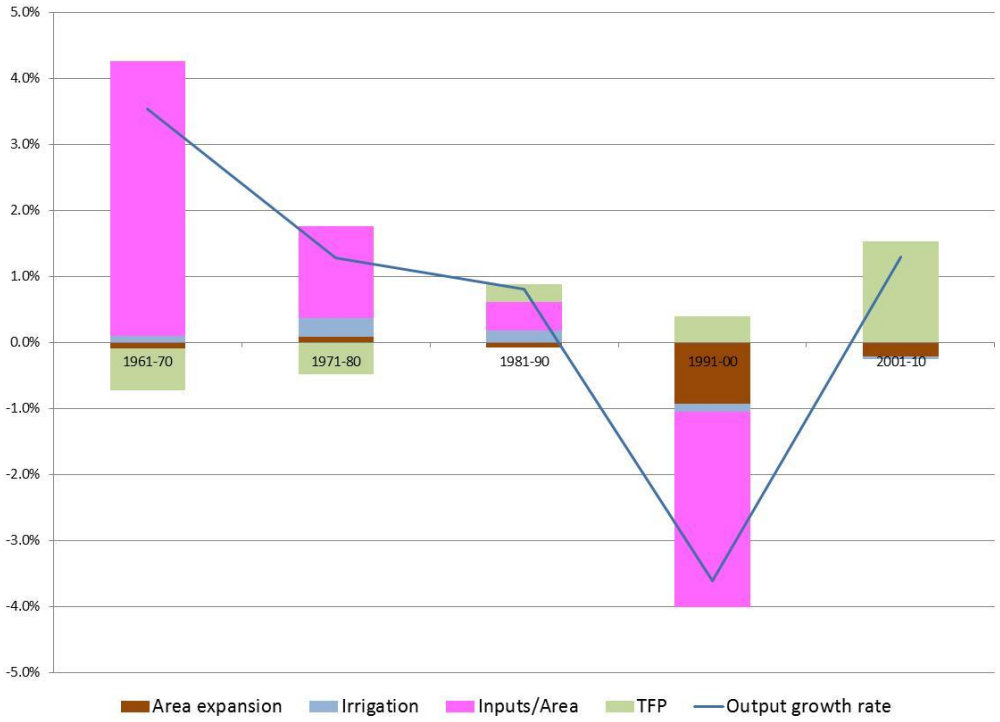

Developing countries:
TFP becoming an important source of growth




Source: ERS

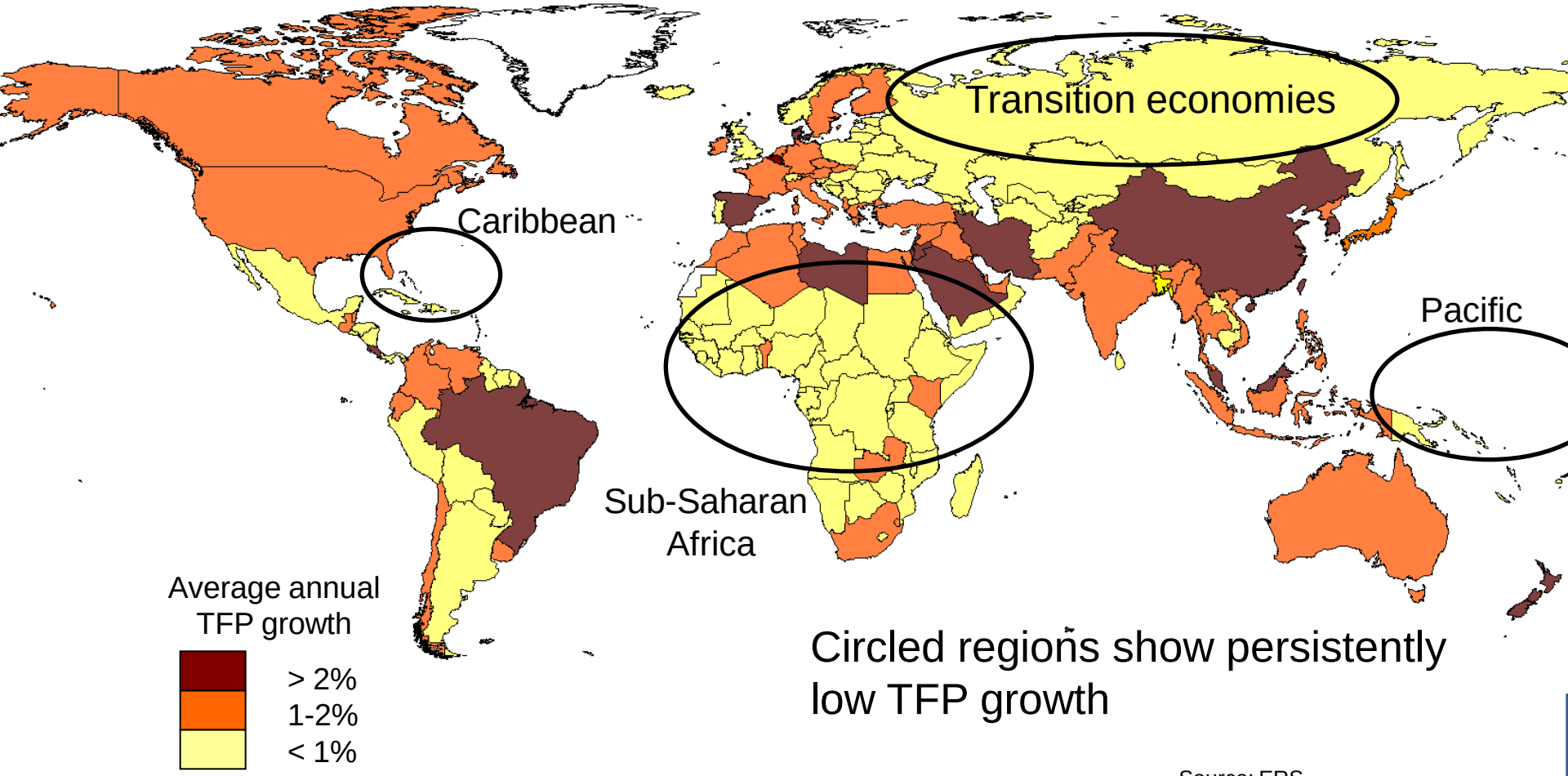
# Patterns of agricultural growth vary widely across global economy

Transition economies:
Little evidence of long-term TFP growth




Source: ERS

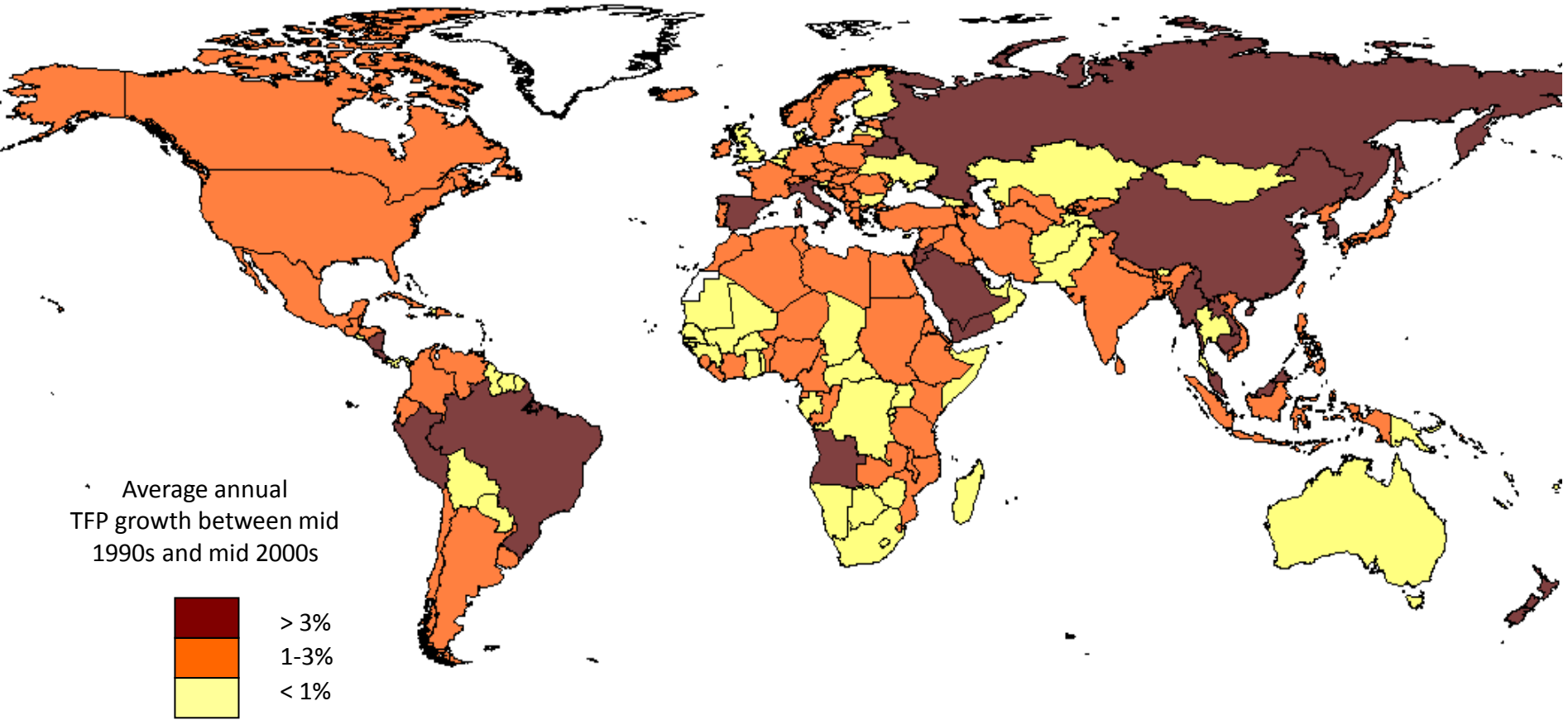
# Long-run average agricultural TFP growth, 1961-2010




Circled regions show persistently low TFP growth

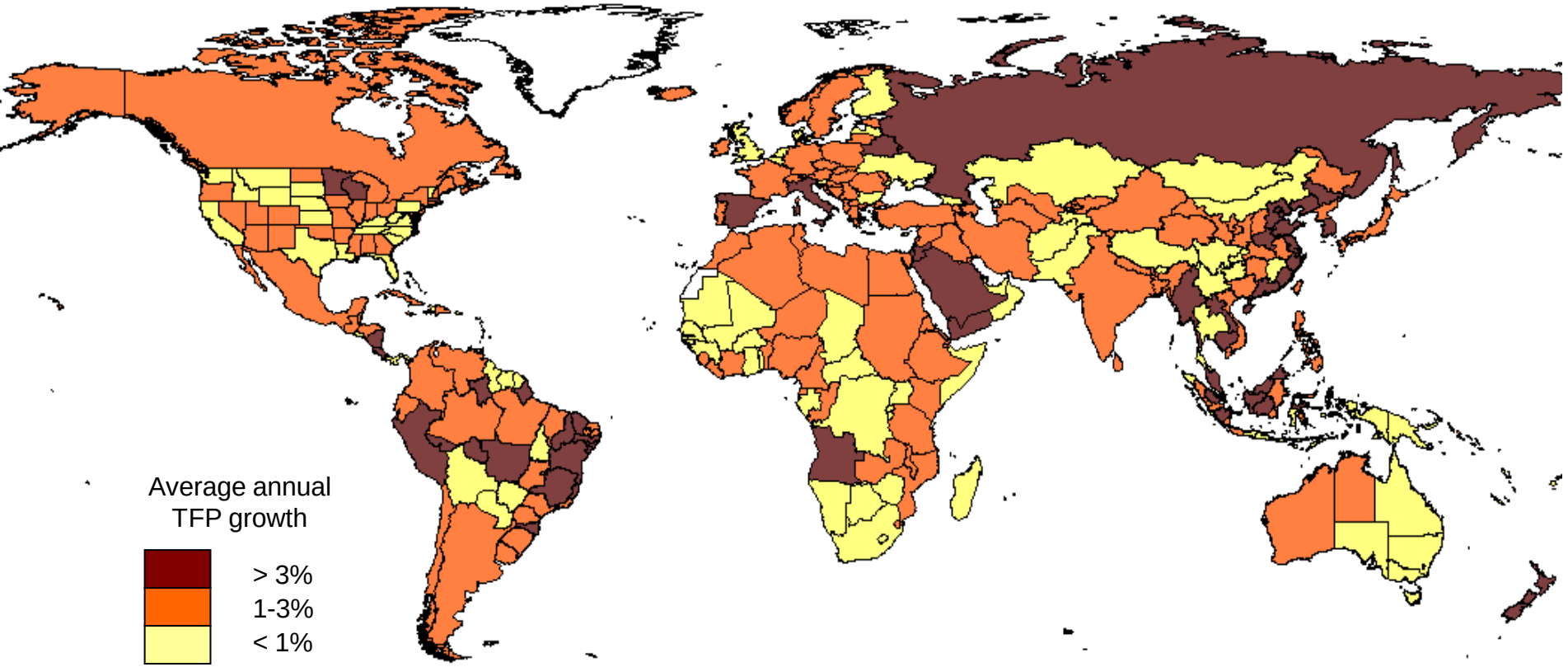
Source: ERS

# Agricultural TFP growth has spread more widely, but remains uneven across countries



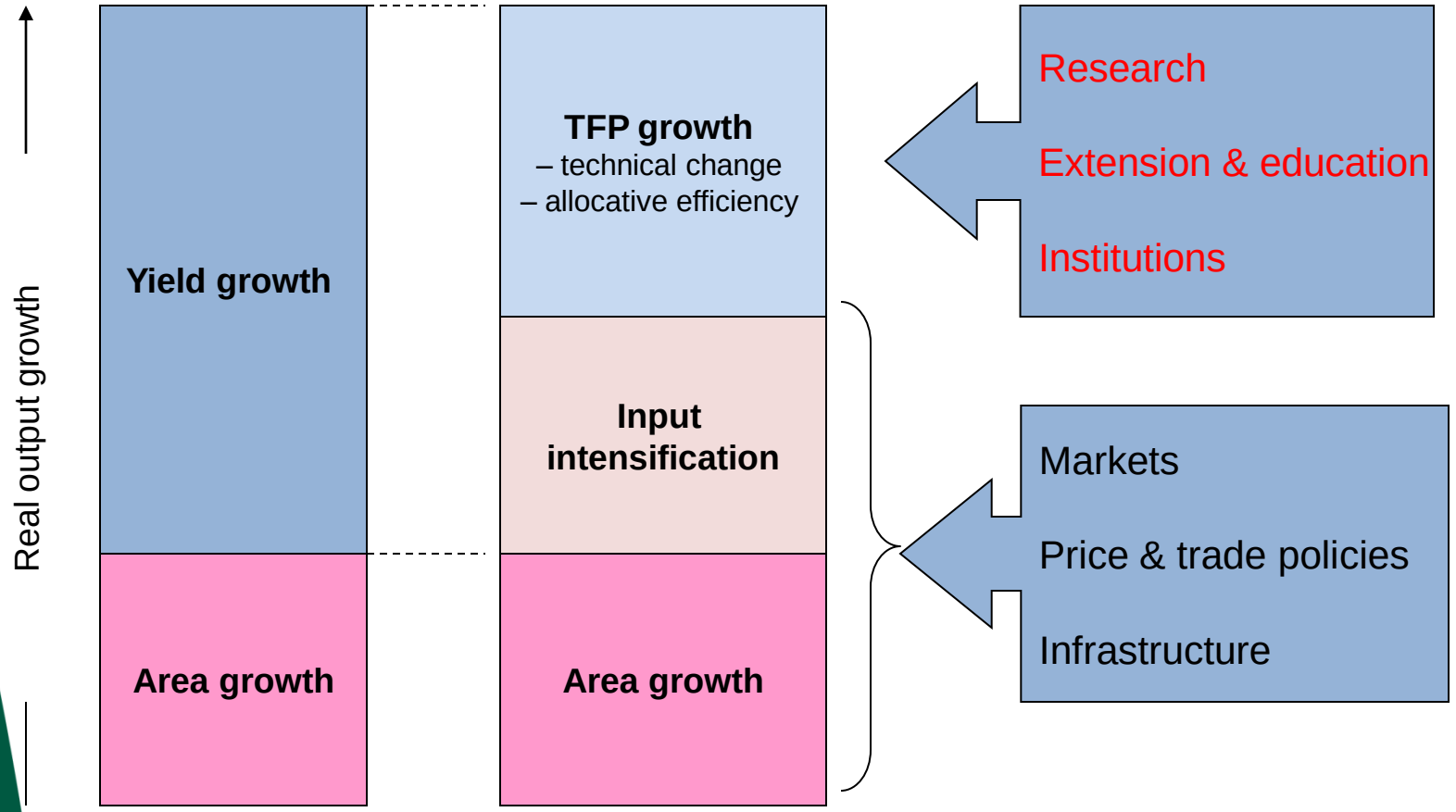

Source; Fuglie, Wang, Ball (2012)

# Agricultural TFP growth varies even within countries

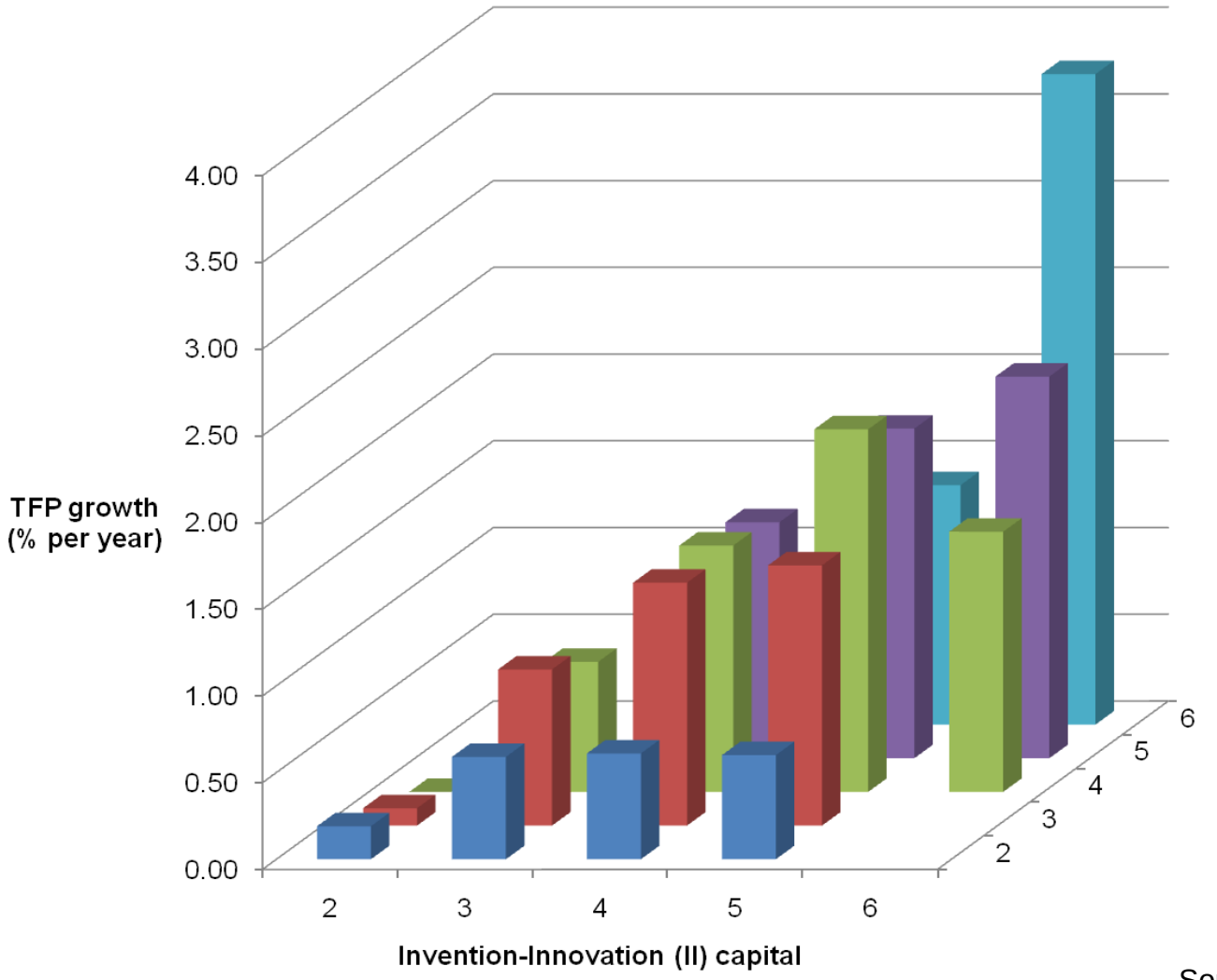



Source; Fuglie, Wang, Ball (2012)

# What about the ***drivers*** of TFP growth?



# National indexes of “technology capital” strongly associated with agricultural TFP growth




Evidence from 90 developing countries over 1970-2010

Source: Evenson & Fuglie

# Some conclusions

- Global agricultural TFP growth not slowing but accelerating
  - Led by large developing countries (China, Brazil)
  - Rise in global food prices due primarily to other factors (demand and input price shocks)
- 'Technology capital' is major driver of long-run TFP growth
  - Evidence strong except for sub-Saharan Africa
  - Enabling environment for innovation also important
- Resource degradation may offset TFP
  - Water constraints
  - Climate change