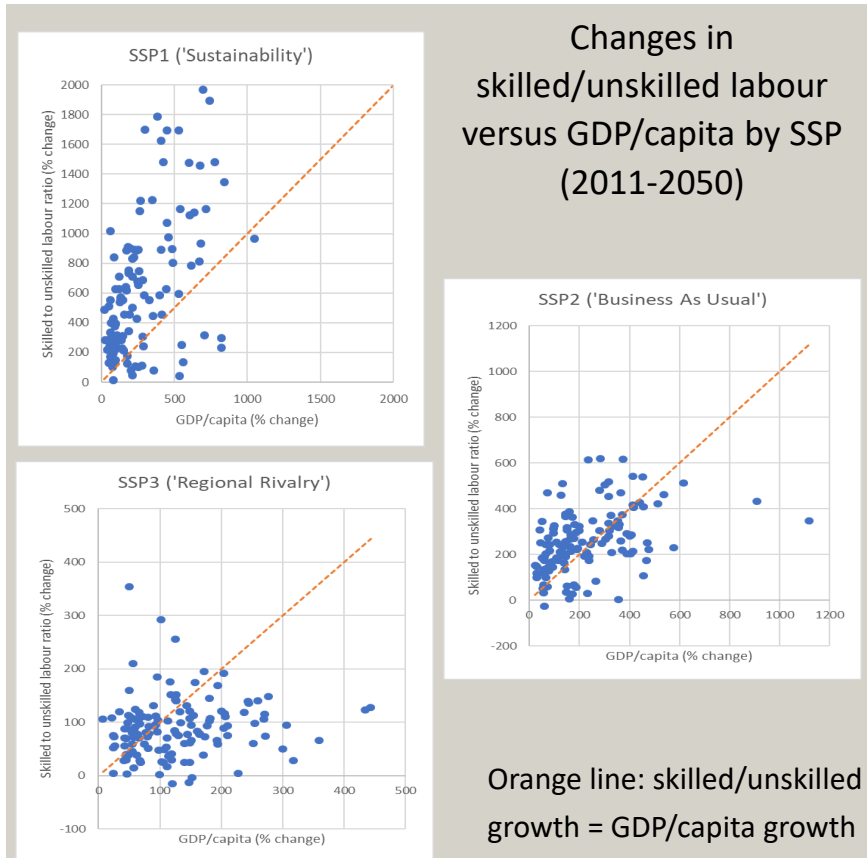# Calibrating relative wages induced by changed skill rates in long run projections

Marijke Kuiper, Caitlyn Carrico & Andrzej Tabeau

Wageningen Economic Research
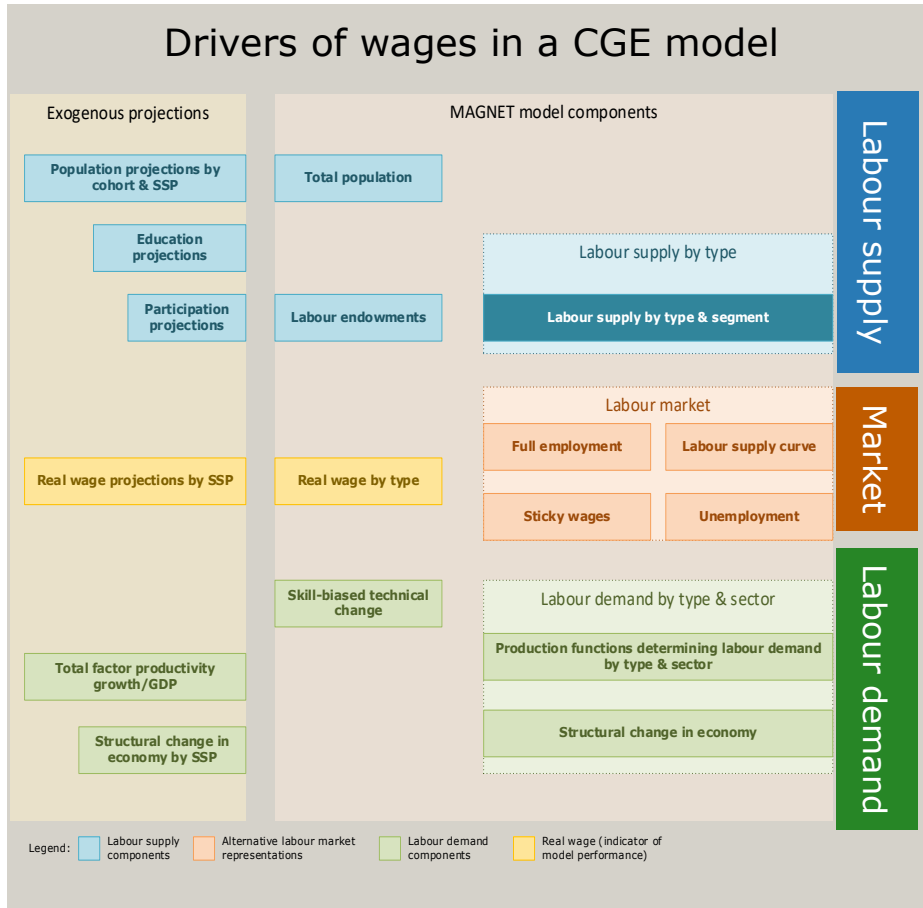
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Skilled vs unskilled employment & wages are key for income distribution

Changes in skilled/unskilled labour versus GDP/capita by SSP (2011-2050)

Orange line: skilled/unskilled growth = GDP/capita growth

- **Employment & wages of skilled versus unskilled labour are key outcomes** of shocks and policies and core part of income inequality

- **Ratio of skilled to unskilled labour expected to change** with economic growth, especially in current low income countries

- **Skill rates generally fixed in projections** inconsistent with any SSP scenario of educational attainment

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Wages provide a mixed signal with no clear calibration point

Drivers of wages in a CGE model

Exogenous projections

- Population projections by cohort & SSP
- Education projections
- Participation projections
- Real wage projections by SSP
- Total factor productivity growth/GDP
- Structural change in economy by SSP

MAGNET model components

- Total population
- Labour endowments
- Real wage by type
- Skill-biased technical change

Labour supply
- Labour supply by type
- Labour supply by type & segment

Market
- Labour market
  - Full employment
  - Labour supply curve
  - Sticky wages
  - Unemployment

Labour demand
- Labour demand by type & sector
- Production functions determining labour demand by type & sector
- Structural change in economy

Legend:
- ■ Labour supply components
- ■ Alternative labour market representations
- ■ Labour demand components
- ■ Real wage (indicator of model performance)

2 key challenges:

- **Are global projections of wages (and employment) on target?**
  No global dataset projecting wages, piece story together from existing studies (*literature*) and new *estimation*

- **What button to push in a CGE to alter wage developments?**
  Wages result from interplay of core assumptions on *labour supply*, *demand* and *market mechanisms*. *Which one to alter?*

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Contribution of this study: past finds, projected wage ratios & new indicators

Key past finds (literature)

- **Wages may trail behind TFP** in low & high income regions [1]

- **Technical progress outpaced education** increase (1950-2010)[2]

- **Structural change important for wage increase** & dominated in SSA (1990-2010)[3]

Projected wage ratio

Estimate **change in skilled to unskilled wage ratio** with variables for which projections are available:
- real GDP
- working age population
- skilled & unskilled working age population

New indicators

- **Number of workers** by sector

- Average **real wage** (not normalized) for value-added variants comparable to literature

- **Decompose wage changes** in productivity & structural change

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Projecting wage ratio (1) – Jones human capital equation

Squaring effective constant Mincer private return to education (10% for 1 year of schooling)[2] with existence of widely varying skilled and unskilled wages across countries

ε = labour substitution elasticity

$$\frac{h_s}{h_u} = \left[\frac{w_s}{w_u}\right]^{\frac{\epsilon}{\varepsilon-1}} \left[\frac{L_s}{L_u}\right]^{\frac{1}{\varepsilon-1}}$$

Skilled (s) to unskilled (u) human capital (h)

Wage ratio

Labour ratio

- Jones (2019)[4] - generalization of Mincer human capital equation accounting for **ratio of skilled to unskilled labour** & **imperfect substitutability** of skilled and unskilled labour.

- Stable gains of education (Mincer) now operate on different shares of skilled/unskilled population by region → diverging wage developments

- Endogenous growth rationale – increasing number of skilled people propels (skill-biased) economic development

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Projecting wage ratio (2) – estimated wage equation

$$ln\left[\frac{w_s}{w_u}\right] - ln\left[\frac{O}{A}\right] = \frac{1}{\varepsilon}\left(ln\left[\frac{L_u}{L_s}\right] - ln\left[\frac{O}{A}\right]\right)$$

ε = labour substitution elasticity

Wage ratio	Real GDP (O) to working age (A)	Labour ratio	Real GDP (O) to working age (A)

Data sources [1983-2008]:

- **Wages**: Occupational Wages around the World
- **Real GDP**: World development Indicators
- (**Labour payments**: Penn World Table)
- **Working age** population skilled & unskilled: Wittgenstein Centre Human Capital Data Explorer

- **Linearized wage equation providing an estimate of the labour substitution elasticity:**
  - Human capital of unskilled normalized to 1
  - Human capital skilled proxied by (1) GDP or (2) labour payments / working age population
  - Elasticity from literature (1.5) used to check this leap of faith

- **Allows projections of future wage ratio**: data by SSP available for real GDP & working age population (by skill)

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Projecting wage ratio (3) – estimated wage equation results

Estimated labour supply elasticity

Human capital proxy:	GDP/ working age		Labour payments/ working age	
Total sample:	**1.89**		**1.86**	
By region				
Low income:		2.27		2.32
Lower-middle:		3.28		3.32
Upper-middle:		2.03		2.13
High-income:		1.68		1.57
R²	0.88	0.91	0.88	0.91
N	1200	1200	1000	1000

All coefficients highly significant (p<0.001)

- Estimation for whole sample & country grouped by income

- Total sample estimate of labour supply elasticity:
  - **Higher than literature average** (1.5) but well **below upper bound** (2)
  - Changing **measure of human capital has no strong impact**

- Regional estimates of elasticity:
  - **inverted U link to income**
  - Linked to structural change & sector specific substitution possibilities?

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MAGNET model & scenario set-up

Sub-Sharan Africa, GDP and alternative labour drivers
(% change 2011-2050)
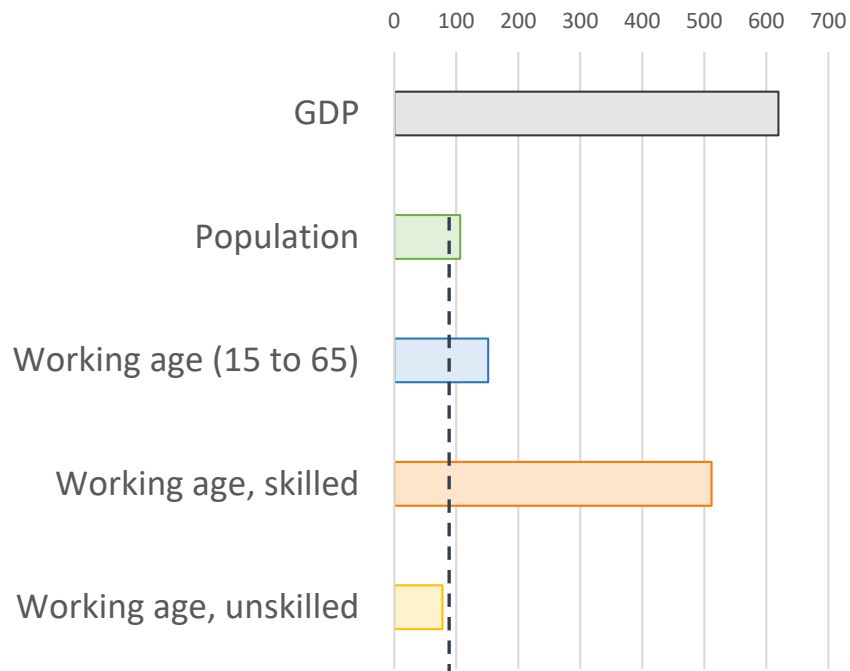
- **Model & data**: MAGNET using 2011 V9 data & two types of labour (skilled & unskilled), 2011-2050

- **Basic drivers**: SSP2 with GDP exogenous & TFP adjusts (in addition to other macro drivers)

- **Scenarios:** varying **labour endowment growth** rates & production structures

- **First results** focus on Sub-Saharan Africa (SSA), extreme case of demographic/skill change

TFP appears overestimated with current fixed skill rate assumption

SSA TFP change, 2011-2050 (%)
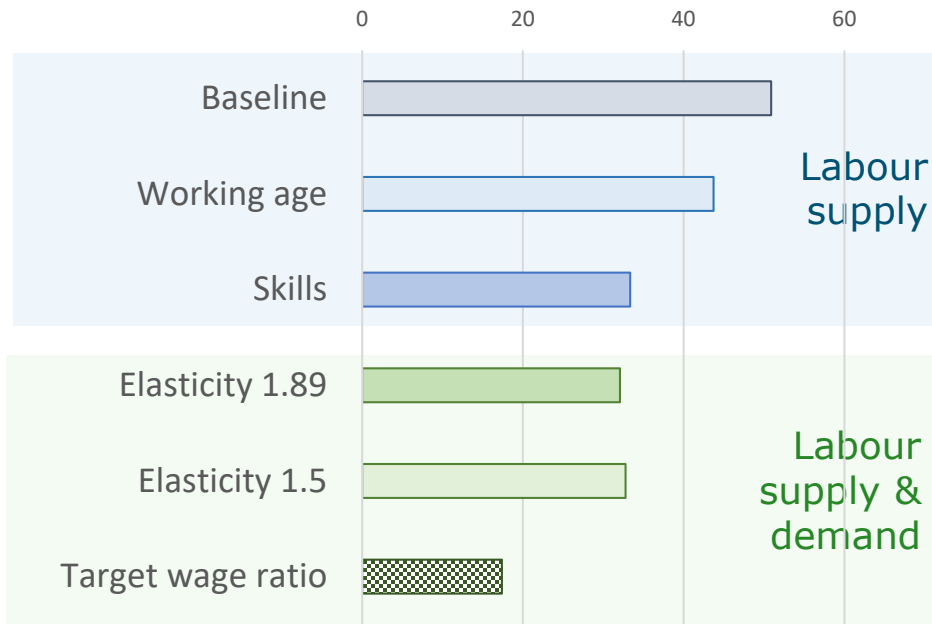
Assumptions on labour endowments:
- Baseline = population growth
- Working age = working age 15-65
- Skills = working age by skill and unskilled
- Elasticity = Skills + labour nest (1.89 & 1.5)
- Target wage ratio = Elasticity 1.89 + skill biased tech change to follow Jones wage ratio projection

- Current TFP projections with **fixed skill rate overestimate TFP growth** as skilled labour grows much faster than population and working age

- As regional TFP is adjusted by main sectors (derived from historic trends in diverging TFP growth by sector) this overestimation **affects projected structural change** in the economy

- **Targeting** Jones wage rate projection **reduces calibrated TFP** (skill-biased technical change)

Judging **skilled/unskilled wage** developments against Jones wage equation

SSA skilled/unskilled wage ratio, % change 2011-2050
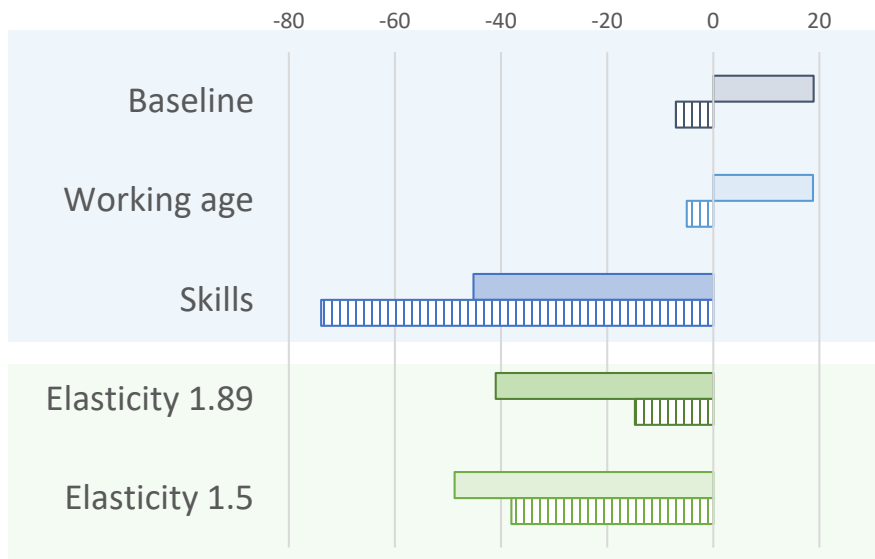

- Skilled/unskilled wage
- || Jones wage equation

- Projections with **fixed skill rates** (baseline & working age) have **increase** in skill premium, while **Jones** wage equation projects a **decrease**

- **Current average worker-weighed labour elasticity in SSA is low:** 0.86 in 2011, up to 1.11 in 2050 in Skills; follow GTAP ESUBVA but contradict estimations

- Higher substitution elasticities:
    - reduce Jones' projections
    - modest impact on model wages

Decomposing wage changes in productivity & structural change components – **total VA**

SSA total value-added/worker (average % change per decade, 2011-2050)
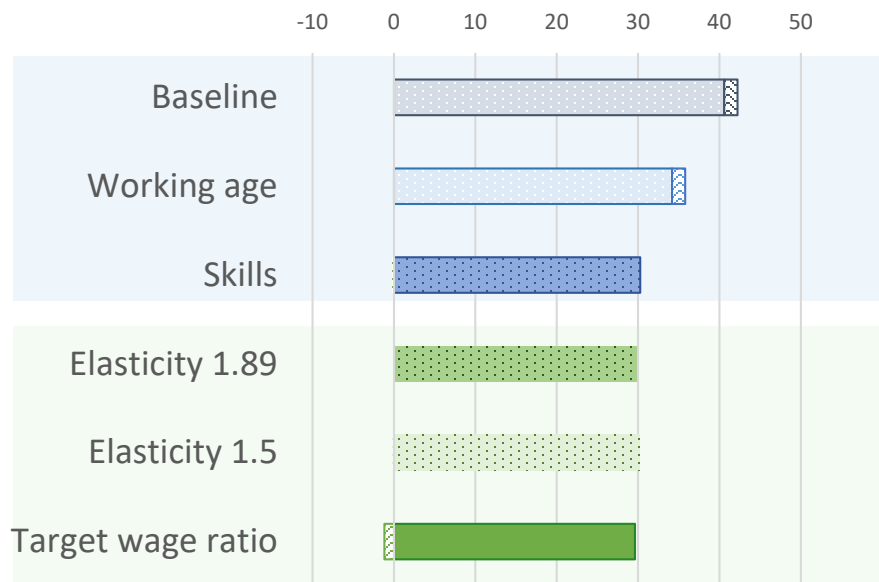
Legend: ▪ Within sector productivity change ▪ Structural change in employment

- Diao et al.[3]: in SSA structural change dominated wage increase:
  1990-1999: 0.00 vs 0.67%
  2000-2010: 0.54 vs 1.25%

- Projections of total value-added per worker (average per decade to compare to Diao):
  o extremely **large within sector productivity** change
  o **tiny** (fixed skill rate) **or even negative contribution structural change** (adjusted skill rates)

Decomposing wage changes in productivity & structural change components – **labour VA**

SSA labour value-added/worker (average % change per decade, 2011-2050)

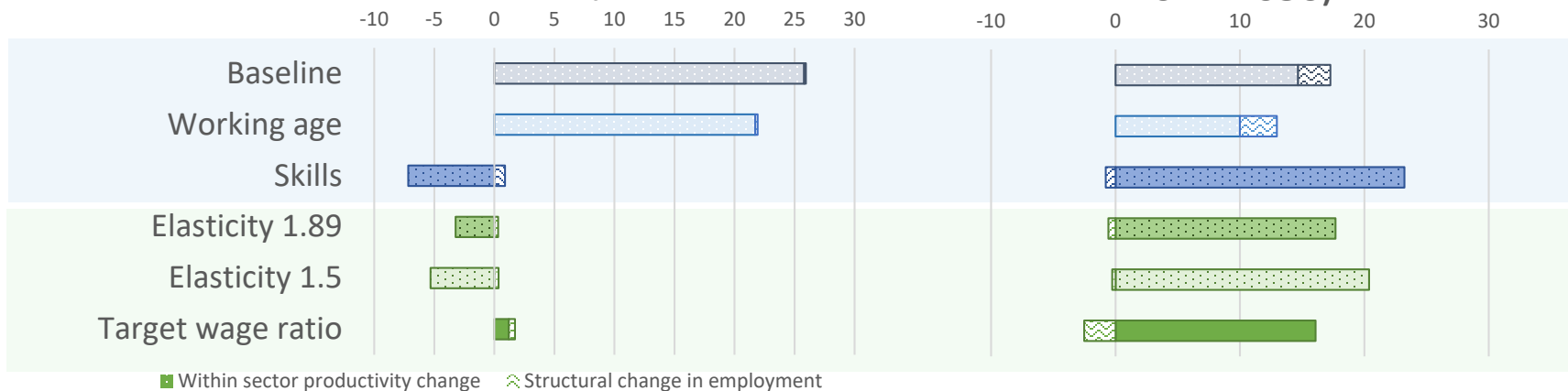Legend: Within sector productivity change ⋮⋮ Structural change in employment

- Labour value-added per worker **increases relative contribution from structural change**

- **Within sector productivity** (value-added) changes **still dominate** in contrast to Diao et al. (1999-2010)

- **Overall increase** (23-33%) **appears extremely large** given past observations:
  - Asia has highest total value-added/worker in Diao et al. of 6.58% for 2000-2010 period

Decomposing wage changes in productivity & structural change – **wage by skill**

SSA skilled wage
(average % change per decade, 2011-2050)

SSA unskilled wage
(average % change per decade, 2011-2050)

	-10	-5	0	5	10	15	20	25	30
Baseline									
Working age									
Skills									
Elasticity 1.89									
Elasticity 1.5									
Target wage ratio									

■ Within sector productivity change   ⌇ Structural change in employment

- **Skilled wages:**
  - ○ drop when skill rates are adjusted
  - ○ drop less with elasticities adjusted
  - ○ increase with targeting wages

- **Unskilled wages**:
  - ○ increase in all scenarios
  - ○ structural change component is larger (sector wages vary more)
  - ○ dominate overall wages as more unskilled workers in SSA

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Conclusions & future work

Conclusions

- **Little direct guidance from literature** on what to expect from wages & employment in long run

- **Labour elasticities** (GTAP ESUBVA) not well aligned with no explicit treatment

- **Including changes in skills** of labour force (1) **reduces projected TFP** changes in baseline; (2) **better aligns skilled/unskilled wage change** with Jones projection; (3) **reduces already low structural change component** in total value-added by worker (Diao et al.)

Directions for future work

- Labour projections:
  - include **participation rates**
  - expand to **5 occupations**

- Improve **labour substitution elasticities** by sector in production functions (data source?)

- Improve capturing **structural change**, possibly capturing changes in aggregate labour elasticity over course of economic growth

- **Expand labour market segmentation** beyond agriculture / non-agriculture (some evidence from trade literature)

Questions, comments, ideas?

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[1] Meager, Nigel, and Stefan Speckesser. 2011. 'Wages, Productivity and Employment: A Review of Theory and International Data'. Brighton: Institute for Employment Studies.

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[3] Diao, Xinshen, Kenneth Harttgen, and Margaret McMillan. 2017. 'The Changing Structure of Africa's Economies'. The World Bank Economic Review 31 (2): 412–33. https://doi.org/10.1093/wber/lhw070.

[4] Jones, Benjamin F. 2019. 'The Human Capital Stock: A Generalized Approach: Reply'. American Economic Review 109 (3): 1175–95. https://doi.org/10.1257/aer.20181678.