Development Accounting

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Development Accounting: Basics

- How much of cross-country income differences are "due to":
  - Factor inputs (capital, education)
  - Efficiency
- First step in understanding cross-country income differences
  Doesn't attempt to explain why inputs differ
- Levels analog to growth accounting
  (sometimes called levels accounting)
- Goes back to Denison (1967), Christensen, Cummings, and Jorgenson (1981).
  Modern literature starts with King and Levine (1994) and particularly
  Klenow and Rodrigez-Claire (1997) and Hall and Jones (1999)

Causes of Income Differences

Research on income differences can arguably be classified into one or more arrows in the following chain of causality:

$$\begin{aligned}
&\textit{Geography}, \textit{Climate}, \textit{Luck} \Rightarrow \textit{Human Capital}, \textit{Physical Capital}, \textit{TFP} \Rightarrow \textit{Income} \\
&\quad \Downarrow \\
&\textit{Institutions}, \textit{Culture} \Rightarrow \textit{Human Capital}, \textit{Physical Capital}, \textit{TFP} \Rightarrow \textit{Income} \\
&\quad \Downarrow \\
&\textit{Policies}, \textit{Rule of Law}, \textit{Corruption} \Rightarrow \textit{Human Capital}, \textit{Physical Capital}, \textit{TFP} \Rightarrow \textit{Income}
\end{aligned}$$

- Development accounting is about right-most arrows

Source: Hsieh and Klenow (2010)

Development Accounting: Basics

- Following Hall and Jones (1999):

$$Y_i = K_i^{\alpha}(A_i H_i)^{1-\alpha}$$

where

$$H_i = e^{\phi(E_i)} L_i$$

  - H_i denotes human capital (quality-adjusted labor)
  - L_i denotes "raw" labor
  - E_i denotes education (years of schooling)

Measurement: Output

- Main data source: Penn World Tables

  (Modern incarnation of Summers and Heston (1991) dataset)

- Output: GDP per worker at PPP

- Penn World Tables:
  - Basic idea: Correct GDP for difference in prices across space

    (analogous to adjusting for inflation over time)
  - Done using International Comparisons Program (ICP) price data
  - Has undergone substantial methodological changes over time

    (Major change between V7 and V8)
  - Many older results in literature not robust to these changes
  - See Feenstra, Inklaar, Timmer (2015) for description of "modern" version

Measurement: Capital

- Early versions: Capital constructed from investment:

$$K_{it} = I_{it} + (1 - \delta)K_{i,t-1}$$

With an initial capital stock of:

$$K_{i,0} = \frac{I_{i,0}}{g + \delta}$$

where

  - g is the average growth rate of investment before 1970
  - $\delta = 0.06$

- More recent versions of PWT include capital series

(which is constructed "more carefully" using perpetual inventory method)

Measurement: Human Capital

$$H_i = e^{\phi(E_i)}$$

- Use average years of schooling as a proxy for E_i
- Data on average years of schooling from Barro and Lee (2013)
- With competitive factor markets, workers are paid their marginal product
- Use wages to inform $\phi(E_i)$ (Mincerian wage regressions)
- Assume $\phi(E_i)$ is piecewise linear with slopes:
  - 0.134 for $s \leq 4$
  - 0.101 for $4 < s \leq 8$
  - 0.068 for $8 < s$

  where s is average years of schooling
- Based on Psacharopoulos's (1994) survey of returns-to-schooling estimates

Measurement: α and Robustness

- Typical to assume $\alpha = 1/3$ for all countries
- Gollin (2002) suggests this is reasonable

  (but Feenstra, Inklaar, Timmer (2015) disagree)
- Caselli (2005) shows results are quite sensitive to this choice

- In contrast, Caselli argues that results are not very sensitive to:
  - Depreciation rate
  - Initial capital stock
  - Reasonable variation in returns to schooling
  - Mismeasurement of years of schooling
  - Variation in hours worked per person

Flavors of Development Accounting

- Hall and Jones (1999) / Jones (2016):

$$\log\left(\frac{Y_i}{L_i}\right) = \frac{\alpha}{1-\alpha}\log\left(\frac{K_i}{Y_i}\right) + \log\left(\frac{H_i}{L_i}\right) + \log A_i$$

- Caselli (2005):

$$\log\left(\frac{Y_i}{L_i}\right) = \alpha\log\left(\frac{K_i}{L_i}\right) + (1-\alpha)\log\left(\frac{H_i}{L_i}\right) + \log A_i$$

$$\log\left(\frac{Y_i}{L_i}\right) = \log\left(\frac{Y_i}{L_i}\right)_{KH} + \log A_i$$

$$\log y_i = \log y_{i,KH} + \log A_i$$

(Notice in Hall-Jones flavor it is K/Y that shows up rather than K/L. See Growth Accounting lecture for details. Caselli starts with $Y_i = A_i K_i^{\alpha} H_i^{1-\alpha}$.) L is workers.

TABLE I

PRODUCTIVITY CALCULATIONS: RATIOS TO U. S. VALUES

Country	Y/L	Contribution from $(K/Y)^{\alpha/(1-\alpha)}$	Contribution from H/L	Contribution from A
United States	1.000	1.000	1.000	1.000
Canada	0.941	1.002	0.908	1.034
Italy	0.834	1.063	0.650	1.207
West Germany	0.818	1.118	0.802	0.912
France	0.818	1.091	0.666	1.126
United Kingdom	0.727	0.891	0.808	1.011
Hong Kong	0.608	0.741	0.735	1.115
Singapore	0.606	1.031	0.545	1.078
Japan	0.587	1.119	0.797	0.658
Mexico	0.433	0.868	0.538	0.926
Argentina	0.418	0.953	0.676	0.648
U.S.S.R.	0.417	1.231	0.724	0.468
India	0.086	0.709	0.454	0.267
China	0.060	0.891	0.632	0.106
Kenya	0.056	0.747	0.457	0.165
Zaire	0.033	0.499	0.408	0.160
Average, 127 countries:	0.296	0.853	0.565	0.516
Standard deviation:	0.268	0.234	0.168	0.325
Correlation with Y/L (logs)	1.000	0.624	0.798	0.889
Correlation with A (logs)	0.889	0.248	0.522	1.000

Source: Hall and Jones (1999). Comparison year: 1988

Hall and Jones (1999)

- Comparing richest 5 and poorest 5:
  - Difference in output per worker: factor of 31.7
  - Difference in capital intensity: factor of 1.8
  - Difference in human capital per worker: factor of 2.2
  - Difference in productivity: factor of 8.3
- Productivity explains the bulk of cross-country income differences

Table 6 Basic development accounting, 2010

	GDP per worker, y	Capital/GDP $(K/Y)^{\alpha/(1-\alpha)}$	Human capital, h	TFP	Share due to TFP
United States	1.000	1.000	1.000	1.000	–
Hong Kong	0.854	1.086	0.833	0.944	48.9%
Singapore	0.845	1.105	0.764	1.001	45.8%
France	0.790	1.184	0.840	0.795	55.6%
Germany	0.740	1.078	0.918	0.748	57.0%
United Kingdom	0.733	1.015	0.780	0.925	46.1%
Japan	0.683	1.218	0.903	0.620	63.9%
South Korea	0.598	1.146	0.925	0.564	65.3%
Argentina	0.376	1.109	0.779	0.435	66.5%
Mexico	0.338	0.931	0.760	0.477	59.7%
Botswana	0.236	1.034	0.786	0.291	73.7%
South Africa	0.225	0.877	0.731	0.351	64.6%
Brazil	0.183	1.084	0.676	0.250	74.5%
Thailand	0.154	1.125	0.667	0.206	78.5%
China	0.136	1.137	0.713	0.168	82.9%
Indonesia	0.096	1.014	0.575	0.165	77.9%
India	0.096	0.827	0.533	0.217	67.0%
Kenya	0.037	0.819	0.618	0.073	87.3%
Malawi	0.021	1.107	0.507	0.038	93.6%
Average	0.212	0.979	0.705	0.307	63.8%
1/Average	4.720	1.021	1.418	3.260	69.2%

Source: Jones (2016)

Development Accounting: Mexico vs. U.S.

- Output per worker in Mexico is 33.8% of U.S.
- Capital-output ratio of Mexico is 87% of U.S.
  - $0.87^{\alpha/(1-\alpha)} = 0.87^{1/2} = 0.931$
- Schooling: 8.8 year in Mexico vs. 13.2 years in U.S.
  - Difference: 4.6 years
  - $0.068 \times 4.6 = 0.32$
  - $0.76 = 1/1.32$
- TFP is $0.338/(0.931 \times 0.760) = 0.477$ of U.S. level

Development Accounting: Mexico vs. U.S.

- Inputs explain a factor of

$$\frac{1}{0.931} \times \frac{1}{0.760} = 1.4$$

- TFP explains the rest

$$\frac{1}{0.338} \times \frac{1}{1.4} = 2.1$$

- Fraction explained by TFP:

$$\frac{2.1}{1.4 + 2.1} = 0.597$$

(Not sure this makes sense. Think of factors explaining 1.0.)

Development Accounting: Mexico vs. U.S.

Alternative Decomposition:

- Total difference $1/0.338 = 2.96$. In logs: 1.08
- Log difference explained by capital: $\log(1/0.931) = 0.07$
- Log difference explained by schooling: $\log(1/0.760) = 0.27$
- Log difference explained by TFP: $\log(1/0.477) = 0.74$
- Fraction explained by TFP: $0.74/1.08 = 0.68$

Hall and Jones (1999) vs. Jones (2016)

- In Hall and Jones (1999) K/Y explains factor of 2
- In Jones (2016) K/Y explains essentially nothing
- Not totally clear why the difference
- One possibility: Jones (2016) uses PWT capital series which is constructed "more carefully" than Hall-Jones capital series
  - Capital price series lower in poor countries than investment price series (used by Hall and Jones) because structures are more important in capital than in investment (because they depreciate slower) and structures are cheap in poor countries (see Feenstra, Inklaar, Timmer (2015, p. 3178)
  - Lower capital prices in poor countries implies more capital [I think]

Caselli's Decomposition

- Question: What would cross-country income distribution look like if all countries had the same TFP?
- Consider:

$$\text{var}[\log y_i] = \text{var}[\log y_{i,KH}] + \text{var}[\log A_i] + 2\text{cov}[\log y_{i,KH}, \log A_i]$$

- If A_i the same in all countries:

$$\text{var}[\log A_i] + 2\text{cov}[\log y_{i,KH}, \log A_i] = 0$$

- Motivates using

$$\text{success}_1 = \frac{\text{var}[\log y_{i,KH}]}{\text{var}[\log y_i]}$$

to measure role of factors

Table 1
Baseline success of the factor-only model

$\text{var}[\log(y)]$	1.297	y^{90}/y^{10}	21
$\text{var}[\log(y_{KH})]$	0.500	y_{KH}^{90}/y_{KH}^{10}	7
$success_1$	0.39	$success_2$	0.34

Source: Caselli (2005)

Table 2
Success in sub-samples

Sub-sample	Obs.	var[log(y)]	var[log(y_{KH})]	$success_1$
Above the median	47	0.172	0.107	0.620
Below the median	47	0.624	0.254	0.407
OECD	24	0.083	0.050	0.606
Non-OECD	70	1.047	0.373	0.356
Africa	27	0.937	0.286	0.305
Americas	25	0.383	0.179	0.468
Asia and Oceania	25	0.673	0.292	0.434
Europe	17	0.136	0.032	0.233
All	94	1.297	0.500	0.385

Source: Caselli (2005)

Development Accounting: Basic Findings

- Capital-Output ratio explains very little
  - Depends on version of analysis (up to factor 2 (i.e., 20%) in older versions)
- Years of schooling explains a substantial amount
  - Perhaps about 1/3 across rich vs. poor countries
- TFP explains at least half

Interpretation of Basic Findings

- Helps point to type of "friction" that plagues poor countries
- If K/Y is low: problems associated with capital accumulation?
  - Taxes on capital (implicit or explicit)
  - Financial repression
  - Restrictions of international capital flows
- If education is low: problem in education sector?
  - Insufficient supply of education (by government?)
  - Low quality of education
  - Low demand for education (culture/beliefs/high prices?)

Four Strands of Subsequent Literature

1. Is MPK larger for poor countries?
   (Lucas 90, Caselli-Feyrer 07, Hsieh-Klenow 07, Gerding-Henriksen-Simonovska 23)

2. Quality of schooling
   (Hendricks 02, Schoellman 12, Hendricks-Schoellman 18, 21, Lagakos et al. 18)

3. Agricultural productivity gap
   (Caselli 05, Restuccia-Yang-Zhu 08, Gollin-Lagakos-Waugh 14, Boppart-Kiernan-Krusell-Malmberg 23)

4. Misallocation
   (Restuccia-Rogerson 08, Hsieh-Klenow 09, Moll 12, Midrigan-Xu 14)

Why Doesn't Capital Flow to Poor Countries?

Lucas (1990):

- Two countries with same Cobb-Douglas production function:

$$y = Ak^{\alpha}$$

  where y is output per person and k is capital per person

- Marginal product of capital is:

$$r = \alpha Ak^{\alpha-1}$$

- Using production function to plug in for k

$$r = \alpha A^{1/\alpha} y^{(\alpha-1)/\alpha}$$

Why Doesn't Capital Flow to Poor Countries?

- Taking a ratio of this equation for India vs. US:

$$\frac{r^{\text{India}}}{r^{\text{US}}} = \left(\frac{y^{\text{India}}}{y^{\text{US}}}\right)^{(\alpha-1)/\alpha}$$

- Suppose

$$\alpha = 0.4 \quad \text{and} \quad \frac{y^{\text{India}}}{y^{\text{US}}} = \frac{1}{15}$$

- Then we have that

$$\frac{r^{\text{India}}}{r^{\text{US}}} = 15^{1.5} = 58$$

- Marginal product of capital in India is 58 times higher than in the U.S.

Why Doesn't Capital Flow to Poor Countries?

- If the MPK is 58 times higher in India than U.S., why doesn't more capital flow to poor countries?
- Maybe because MPK is not 58 times higher in India
  (and since Lucas' paper was published, India has grown a lot)
- Calculation assumes India and U.S. have same productivity
- Development accounting suggests this is not the case

Marginal Product of Capital

- Let's combine

$$r = \alpha A k^{\alpha-1} \quad \text{and} \quad y = A k^{\alpha}$$

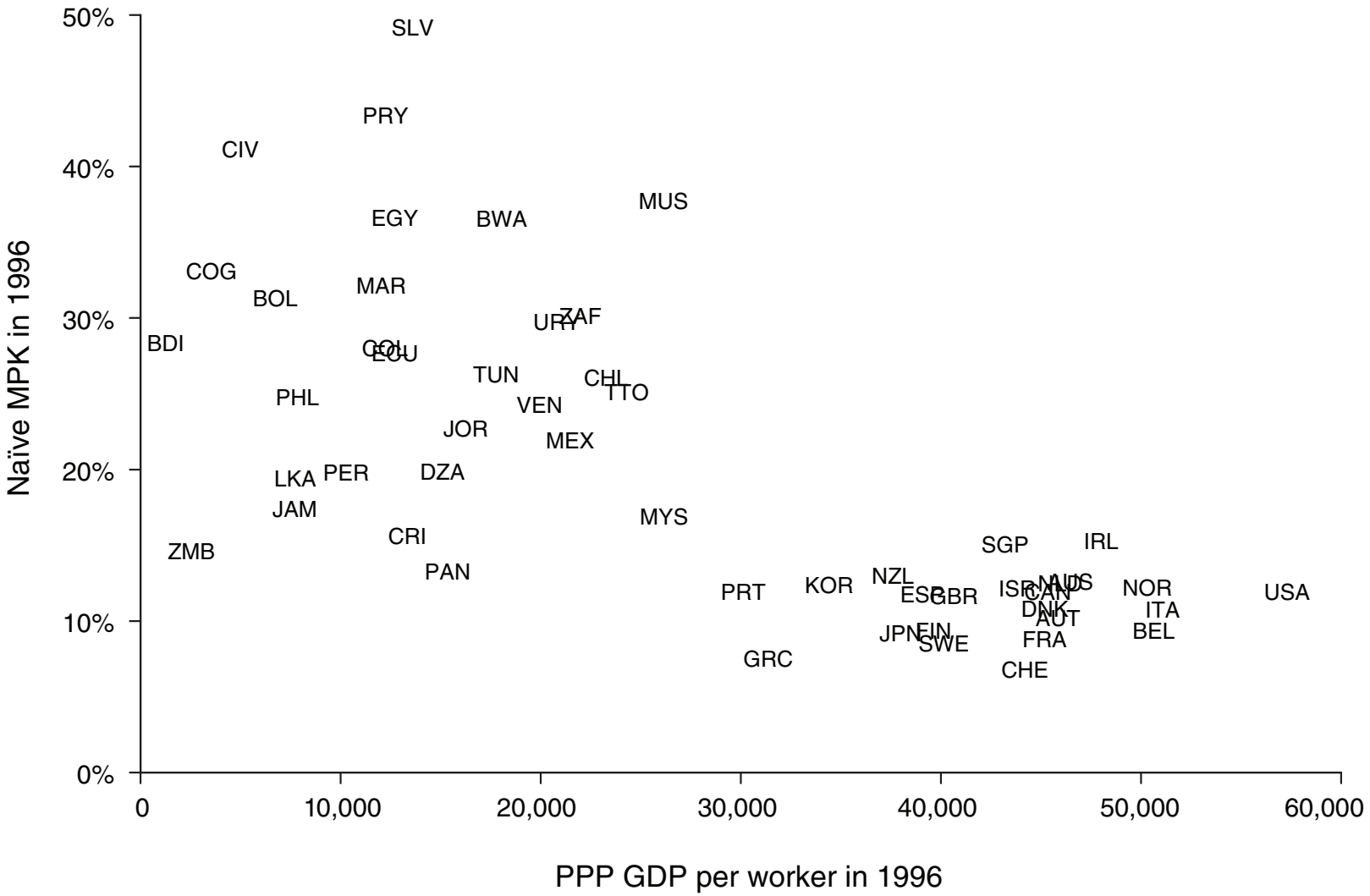
  to eliminate A:

$$r = \alpha \left(\frac{k}{y}\right)^{-1}$$

- Hall-Jones 99 results have India's k/y at 50% of U.S. level
- Implies MPK is twice as high in India

  (Jones 16 results don't imply this. But let's ignore that for now.)
- Significant focus of literature in 1990s (see, e.g., Mankiw 95)

Naive Marginal Product of Capital



Source: Hsieh and Klenow (2010) using data from Caselli and Feyrer (2007)

Caselli and Feyrer (2007)

Make two adjustments to naive MPK calculation:

1. Adjust for non-reproducable capital (land and natural resources)

2. Adjust for high price of capital relative to consumption in poor countries

Caselli and Feyrer (2007)

- Naive marginal product of capital:

$$\text{MPK} = \alpha \frac{Y}{K}$$

  where α is capital share of income
- Usual way to measure capital share of income:
  - One minus labor share of income
- But that includes income to non-reproducable capital

  (land and natural resources)
- While K is only reproducable capital

  (constructed from perpetual inventory method)

Caselli and Feyrer (2007)

- So naive:

$$\text{MPK} = \alpha \frac{Y}{K}$$

  yields an estimate of MPK that is too high

- This bias is bigger for poor countries since non-reproducable capital is a larger share of capital in poor countries

- Makes MPK look higher for poor countries

- Counterpoint: Existence of land and natural resources my raise MPK if these resources are under-exploited.

Land and Natural Resources

TABLE I
PROPORTION OF DIFFERENT TYPES OF WEALTH IN TOTAL WEALTH IN 2000

Variable	Mean	St dev	Median	Weighted mean*	Corr w/ log(GDP)**
Subsoil resources	10.5	16.4	1.5	7.0	−0.13
Timber	1.7	2.6	0.8	0.9	−0.34
Other forest	2.2	5.4	1.1	0.3	−0.49
Cropland	11.4	15.2	5.1	3.2	−0.73
Pasture	4.5	5.4	2.7	1.9	−0.00
Protected areas	1.9	2.5	0.3	1.4	0.01
Urban land	13.1	4.6	13.5	16.5	0.70
Reproducible capital	54.8	19.2	56.3	68.6	0.70

* Weighted by the total value of the capital stock.
** GDP is per worker.
Source: Authors calculations using data from World Bank [2006].

Source: Caselli and Feyrer (2007)

Price of Capital Relative to Output

- In "one-good" model, price of capital is the same as the price output
- In reality, this is not necessarily the case
- Recognizing this, return to capital is

$$\frac{P_y(t)MPK(t) + P_k(t+1)(1-\delta)}{P_k(t)}$$

- Ignoring capital gains, frictionless international capital markets imply

$$\frac{P_y MPK}{P_k} = R^* - (1-\delta)$$

- This is what should be equal across countries

Price of Capital Relative to Output

- Earlier estimate:

$$MPK = \alpha \frac{Y}{K}$$

- Adjusted estimate:

$$\frac{P_y MPK}{P_k} = \alpha \frac{P_y Y}{P_k K}$$

Price of Output Relative to Capital

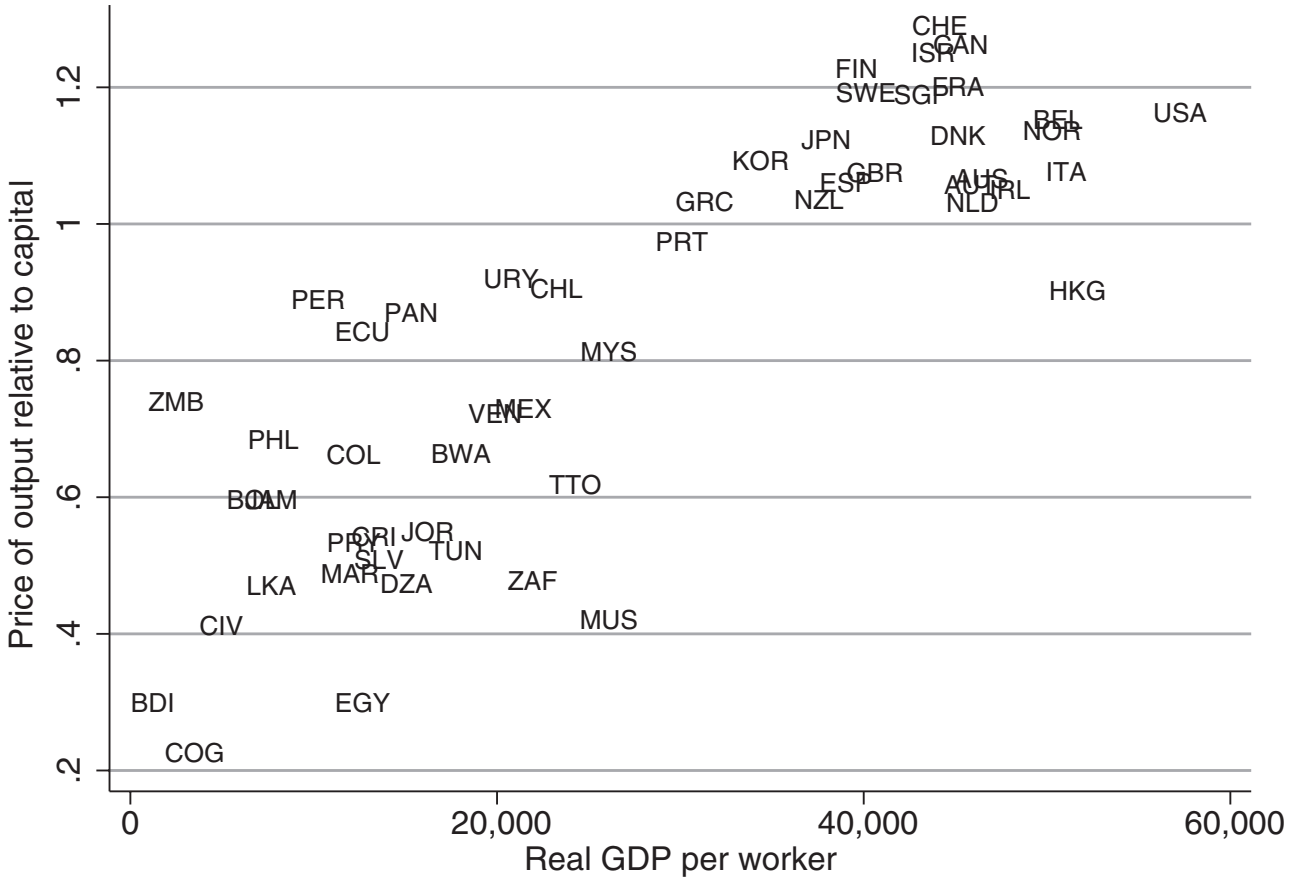


Figure II
Relative Prices

Source: Penn World Tables 6.1.

Source: Caselli and Feyrer (2007)

Equipment Prices Across Countries

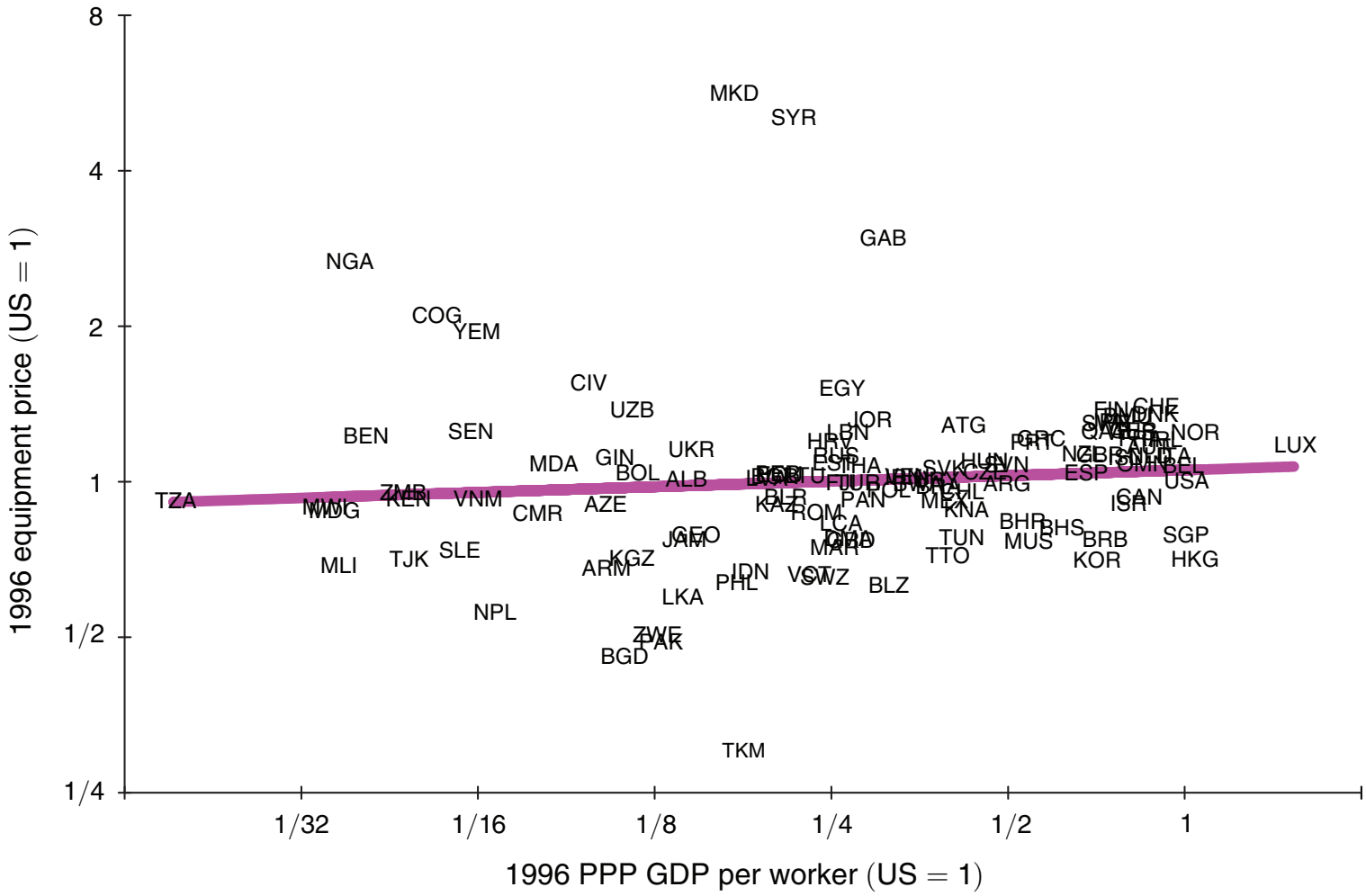


Figure 5. Equipment Prices versus Income Levels

Source: Hsieh and Klenow (2010)

Consumption Prices Across Countries

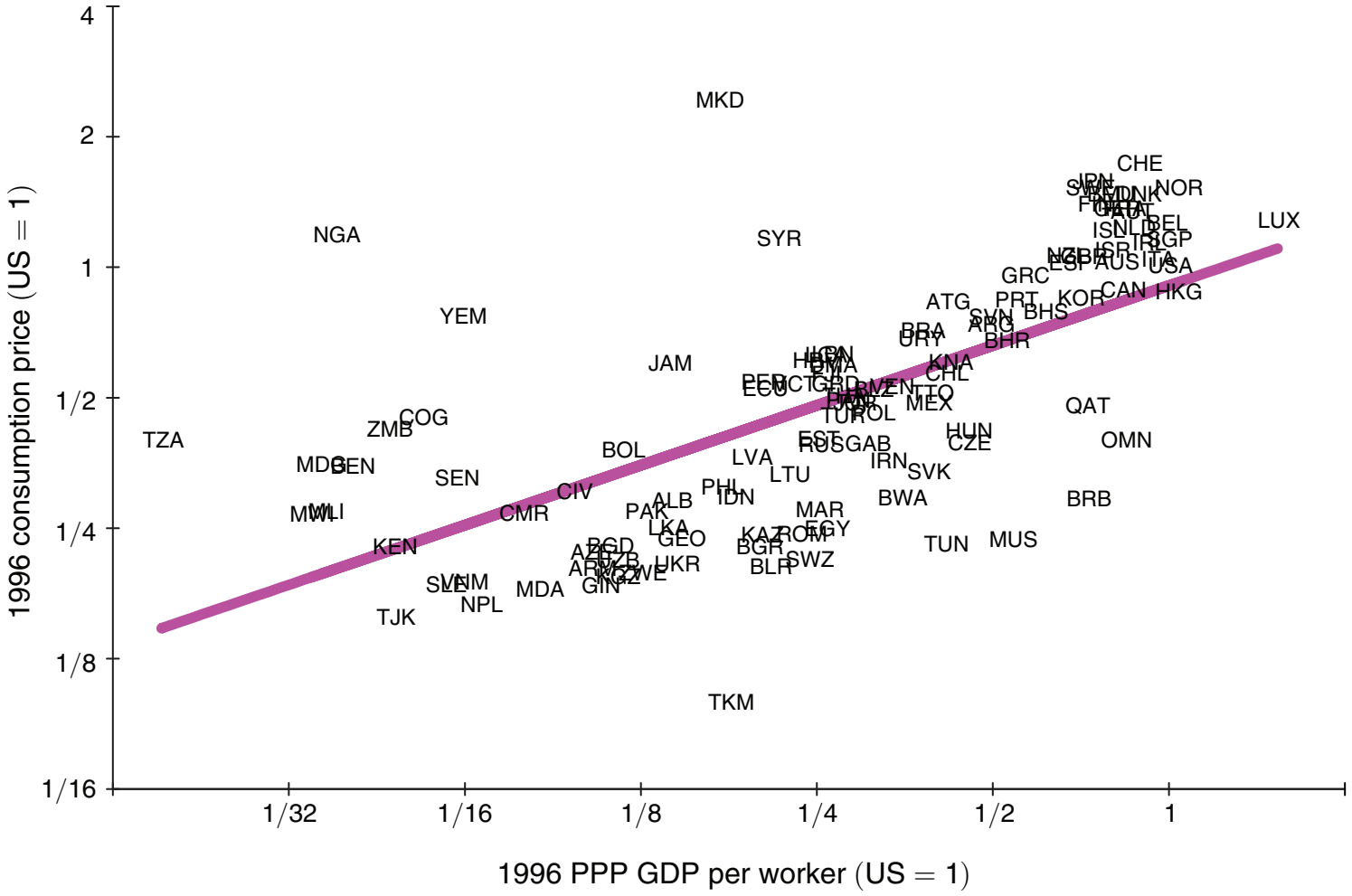
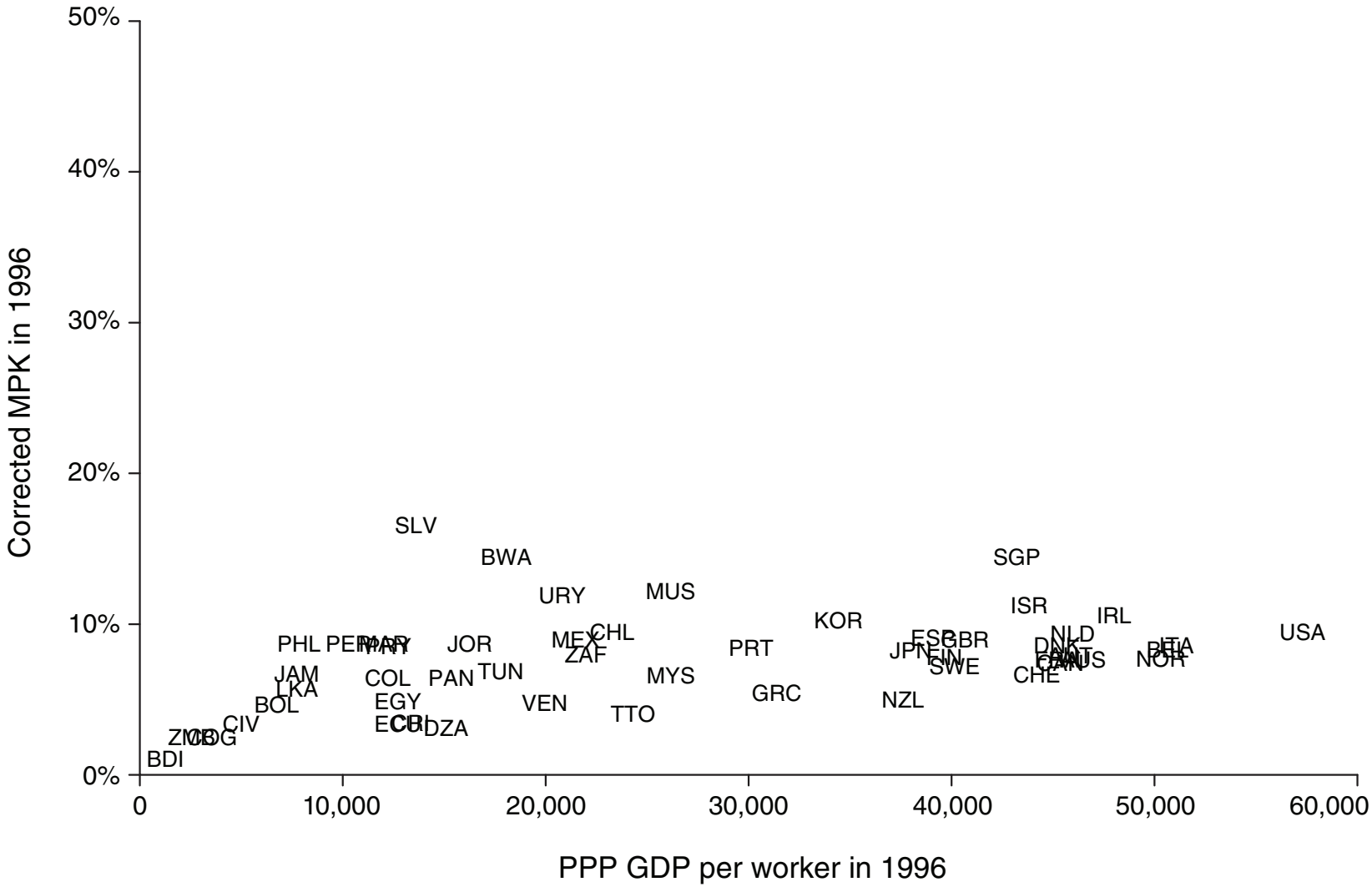


Figure 6. Consumption Prices versus Income Levels

Source: Hsieh and Klenow (2010)

Adjusted Marginal Product of Capital



Source: Hsieh and Klenow (2010) using data from Caselli and Feyrer (2007)

Caselli and Feyrer (2007)

Conclusion:

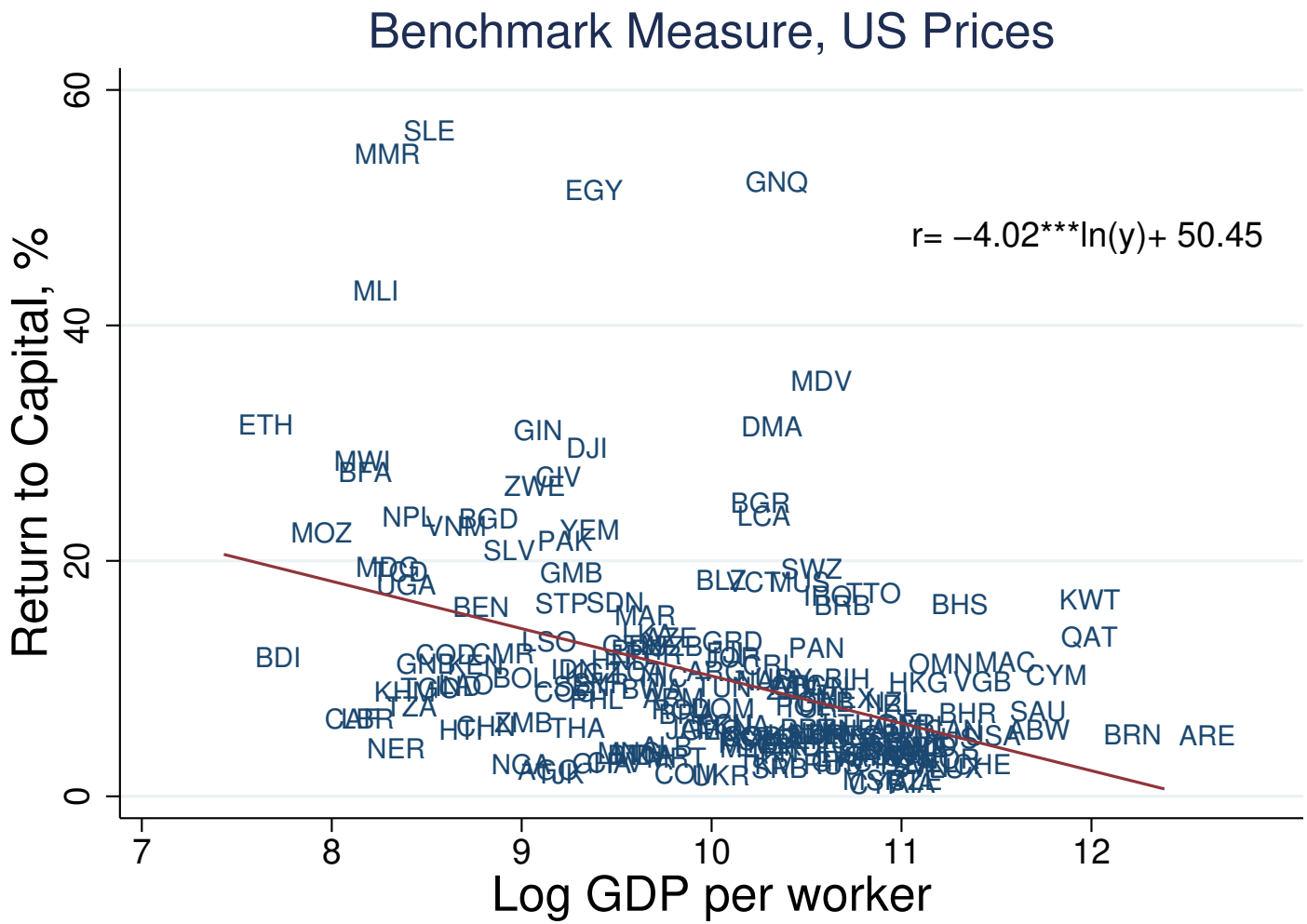
- "There is no *prima facie* support for the view that international credit frictions play a major role in preventing capital flows from rich to poor countries"
- Low K/L in poor countries due to:
  - low endowments of complementary factors to capital
  - low efficiency (TFP)

Capital may be misallocated **within** country. Misallocation literature following Hsieh and Klenow (2009)

Gerding, Henriksen, Simonovska (2023)

- Caselli-Feyrer results special to 1996
- Analyze average over 70 years (1950-2019)
- Find MPK is higher in poor countries

Marginal Product of Capital



Source: Gerding, Henriksen, Simonovska (2023). Adjusts for relative price of output but not for non-reproducable capital.

Marginal Product of Capital

Table 13: Income and Returns to Capital, Various Measures

	(1) r	(2) r_{P_j}	(3) r_{α_j}	(4) $r^b_{\alpha_j}$	(5) r_{α_j,P_j}	(6) $r_{\alpha_{jr}}$	(7) $r^b_{\alpha_{jr}}$	(8) r_{α_{jr},P_j}
ln y	-1.782***	-0.806**	-1.443*	-1.37***	-0.932*	-1.856***	-1.234***	-0.617*
	(0.4)	(0.24)	(0.62)	(0.42)	(0.56)	(0.51)	(0.45)	(0.38)
con	26.72***	14.73***	26.87***	21.03***	20.04***	30.05***	20.28***	14.75***
	(4)	(2.41)	(6.21)	(4.23)	(5.61)	(5.18)	(4.48)	(3.85)
r2	0.122	0.072	0.055	0.101	0.026	0.115	0.07	0.0245
N	143	143	95	95	107	105	105	107

Notes: Table reports the results of linear regressions of alternative measures of returns to capital on income per worker. r is the benchmark measure of returns under the assumption of price equalization of investment goods and uses the U.S. price of investment for all countries. r_{P_j} uses country-specific prices of investment, consumption and output. r_{α_j} uses country-specific labor shares. r_{α_j,P_j} makes both of the last two adjustments. $r_{\alpha_{jr}}$ adjusts labor shares for the share of natural resources. r_{α_{jr},P_j} makes both natural resource and price adjustment. Data is truncated at the 10th and 90th percentile, and all observations of returns above 25% are dropped. Data Source: PWT, 1950-2019. Natural resource data source: WDI, 1970-2019. standard errors statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Gerding, Henriksen, Simonovska (2023).

Marginal Product of Capital in 1996

Table 14: Income and Returns to Capital, Year 1996

	(1) P_{US}	(2) P_j	(3) α_j	(4) α_j, P_j	(5) α_{jr}	(6) α_{jr}, P_j
ln_y	-1.601***	1.050***	-1.495**	2.022***	-1.424***	2.485***
	(0.32)	(0.40)	(0.58)	(0.56)	(0.50)	(0.54)
_cons	20.83***	-6.999*	24.47***	-13.07**	21.82***	-19.09***
	(3.19)	(3.97)	(5.87)	(5.65)	(5.04)	(5.42)
r2	0.151	0.0471	0.0587	0.109	0.0746	0.173
N	142	142	108	108	104	104

Notes: Table reports the results of linear regressions of alternative measures of returns to capital on income per capita for the set of countries data is available in the year 1996. Data is truncated at the 10th and 90th percentile, and all observations of returns above 25% are dropped. Data Source: PWT. standard errors statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Gerding, Henriksen, Simonovska (2023). P_j denotes country-specific price of investment. α_{jr} denotes adjustment for non-reproducable capital.

Human Capital: Evidence from Migration

- Measure of human capital in standard development accounting very crude (average years of schooling from Barro-Lee 13 times estimate of returns to schooling)
- How can we do better?

Human Capital: Evidence from Migration

- Measure of human capital in standard development accounting very crude (average years of schooling from Barro-Lee 13 times estimate of returns to schooling)
- How can we do better?
- How about looking at wage gains of migrants?
- Migrant wage gains a measure of country component of income differences
- Residual due to human capital

Hendricks and Schoellman (2018)

- Production function in per worker terms:

$$y_c = \left(\frac{K_c}{Y_c}\right)^{\frac{\alpha}{1-\alpha}} A_c h_c$$

- Country component:

$$z_c = \left(\frac{K_c}{Y_c}\right)^{\frac{\alpha}{1-\alpha}} A_c$$

- Take logs:

$$\log y_c = \log z_c + \log h_c$$

- Subtract one country from another and divide by income difference:

$$1 = \frac{\log z_c - \log z_{c'}}{\log y_c - \log y_{c'}} + \frac{\log h_c - \log h_{c'}}{\log y_c - \log y_{c'}} = \text{share}_{\text{country}} + \text{share}_{\text{human capital}}$$

Human Capital: Evidence from Migration

- Two problems with evidence on migrants:
  - Migrants are highly selected
  - Human capital transfers imperfectly across countries
- Data on pre- and post-migration wages of migrants addresses selection
- Trickier to address transferability of human capital

  (e.g., accreditation, licensure, discrimination)

Human Capital's Role in Income Differences

- Suppose labor is homogeneous and labor markets are competitive
- Then firms solve

$$\max_{H_c} K_c^{\alpha}(A_c H_c)^{1-\alpha} - \omega_c H_c$$

  where ω_c is the wage per unit of human capital
- This yields $\omega_c = (1-\alpha)z_c$ and

$$\log w_{i,c} = \log[(1-\alpha)z_c] + \log h_i$$

  where $w_{i,c}$ is the wage of a worker with human capital level h_i
- For migrants (assuming h_i is transferable) we have

$$\frac{\log w_{i,US} - \log w_{i,c}}{\log y_{US} - \log y_c} = \frac{\log z_{US} - \log z_c}{\log y_{US} - \log y_c} = \text{share}_{\text{country}}$$

Hendricks and Schoellman (2018): Data

TABLE I

Most Sampled Countries by Sample and Subsample

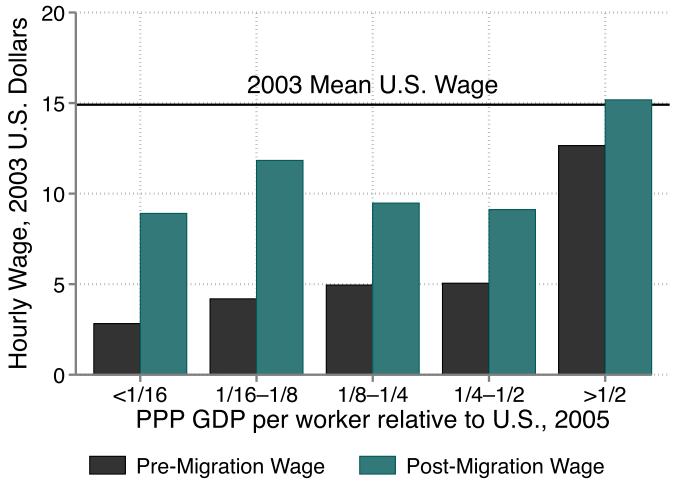
Country group	Most sampled countries	N
Panel A: NIS sample by GDP per worker category (relative to United States)		
$< \frac{1}{16}$	Ethiopia, Nigeria, Vietnam	281
$\frac{1}{16} - \frac{1}{8}$	India, Philippines, China	617
$\frac{1}{8} - \frac{1}{4}$	Dominican Rep., Ukraine, El Salvador	436
$\frac{1}{4} - \frac{1}{2}$	Mexico, Poland, Russia	263
$\frac{1}{2} - 1$	Canada, United Kingdom, Korea	409
Panel B: MP sample by subsample		
Mexican MP	Mexico	1,910
Latin American MP	Dominican Rep., El Salvador, Nicaragua	224

Note. Lists the three most common birth countries and sample size for immigrants from the respective subgroup of the NIS or MP samples.

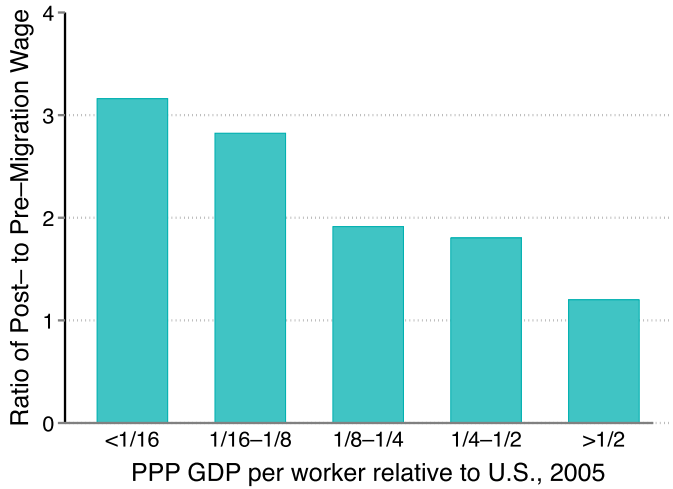
Source: Hendricks and Schoellman (2018). NIS is New Immigrant Survey (green card holders) MP are Mexican and Latin American Migration Projects. NIS is early 2000s.

Wage Gains at Migration

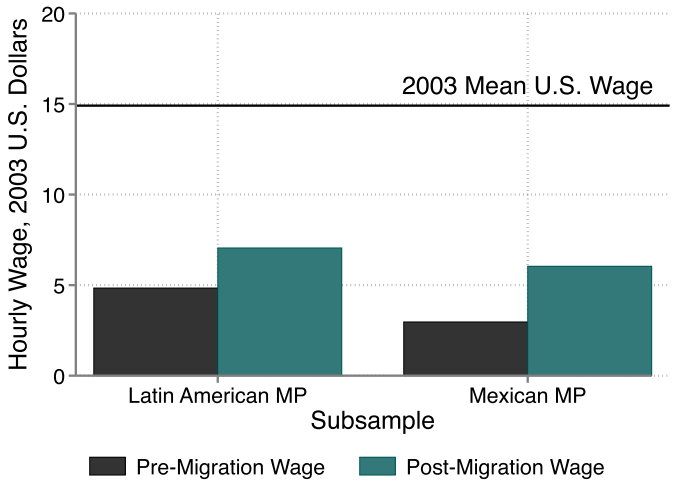
(A) NIS: Pre- and Post-Migration Wages



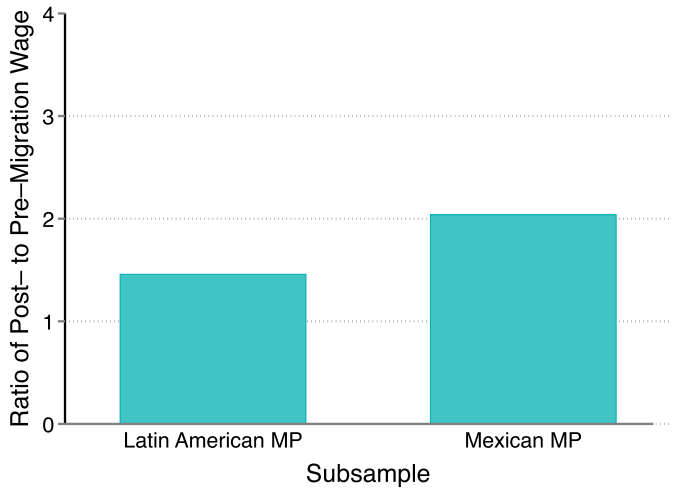
(B) NIS: Wage Gains at Migration



(C) MP: Pre- and Post-Migration Wages



(D) MP: Wage Gains at Migration



Source: Hendricks and Schoellman (2018).

Human Capital Share

TABLE II

Implied Human Capital Share in Development Accounting

Group	Hourly wage		Development accounting			
	Premig.	Postmig.	Wage gain	GDP gap	h share	95% C.I.
Panel A: NIS sample by GDP per worker category						
$< \frac{1}{16}$	\$2.82	\$8.91	3.2	31.8	0.66	(0.60, 0.73)
$\frac{1}{16} - \frac{1}{8}$	\$4.19	\$11.83	2.8	11.9	0.58	(0.54, 0.62)
$\frac{1}{8} - \frac{1}{4}$	\$4.95	\$9.48	1.9	5.6	0.63	(0.55, 0.71)
$\frac{1}{4} - \frac{1}{2}$	\$5.05	\$9.11	1.8	3.0	0.48	(0.34, 0.62)
$\frac{1}{2} - 1$	\$12.64	\$15.18	1.2	1.3	0.48	(−0.23, 1.19)
Panel B: MP sample by subsample						
Latin American MP	\$4.84	\$7.05	1.5	7.0	0.79	(0.71, 0.87)
Mexican MP	\$2.96	\$6.04	2.0	2.9	0.33	(0.29, 0.37)

Notes. Each row shows results for immigrants from the respective subgroup of the NIS or MP samples. Columns show the categories; the mean hourly pre- and postmigration wages, reported in 2003 U.S. dollars; the wage gain at migration; the average gap in GDP per worker, relative to United States; the implied human capital share; and the corresponding 95% confidence interval.

Source: Hendricks and Schoellman (2018).

TABLE VII

OCCUPATIONAL CHANGES AT MIGRATION

GDP category	Occupational switch (%)			Mean change (%)
	Lower-paying	Same occupation	Higher-paying	
$< \frac{1}{16}$	68	9	23	−17
$\frac{1}{16} - \frac{1}{8}$	61	16	22	−15
$\frac{1}{8} - \frac{1}{4}$	67	6	26	−16
$\frac{1}{4} - \frac{1}{2}$	60	10	30	−13
$> \frac{1}{2}$	49	25	26	0

Notes. Columns show the fraction of immigrants who switched to a lower-paying job, stayed at the same job, or switched to a higher-paying job at migration, as well as the average change in job pay at migration, where average pay is measured using the mean wage of natives. Rows show those results for different PPP GDP per worker groups. All results constructed from the NIS sample.

Source: Hendricks and Schoellman (2018).

Human Capital Transferability

TABLE VIII

Development Accounting and Skill Transfer

Robustness check	Human capital share	95% C.I.
Baseline	0.62	(0.58, 0.65)
Employment visa	0.56	(0.50, 0.62)
Job offer before migrating	0.45	(0.36, 0.55)
Same narrow occupation	0.56	(0.48, 0.64)
English at work	0.59	(0.54, 0.63)
Skill transfer: mean wage	0.55	(0.52, 0.59)

Notes. Each column shows the implied human capital share in development accounting (1 minus the wage gain at migration relative to the GDP per worker gap) and the 95% confidence interval. Each row shows the result from constructing these statistics for a different sample or using different measures of postmigration wages. All results constructed from the NIS sample.

Source: Hendricks and Schoellman (2018). NIS sample from countries with <1/4 US GDP per capita.

Agriculture and Development

- A classic view is that development is about reallocation out of agriculture into “modern” sectors
  (Rosenstein-Rodin 43, Nurkse 53, Lewis 55, Rostow 60)
- Most people work in agriculture in poor countries
- Productivity is low in agriculture, especially in poor countries
  (Lewis 55, Kuznets 71)

Importance of Agriculture

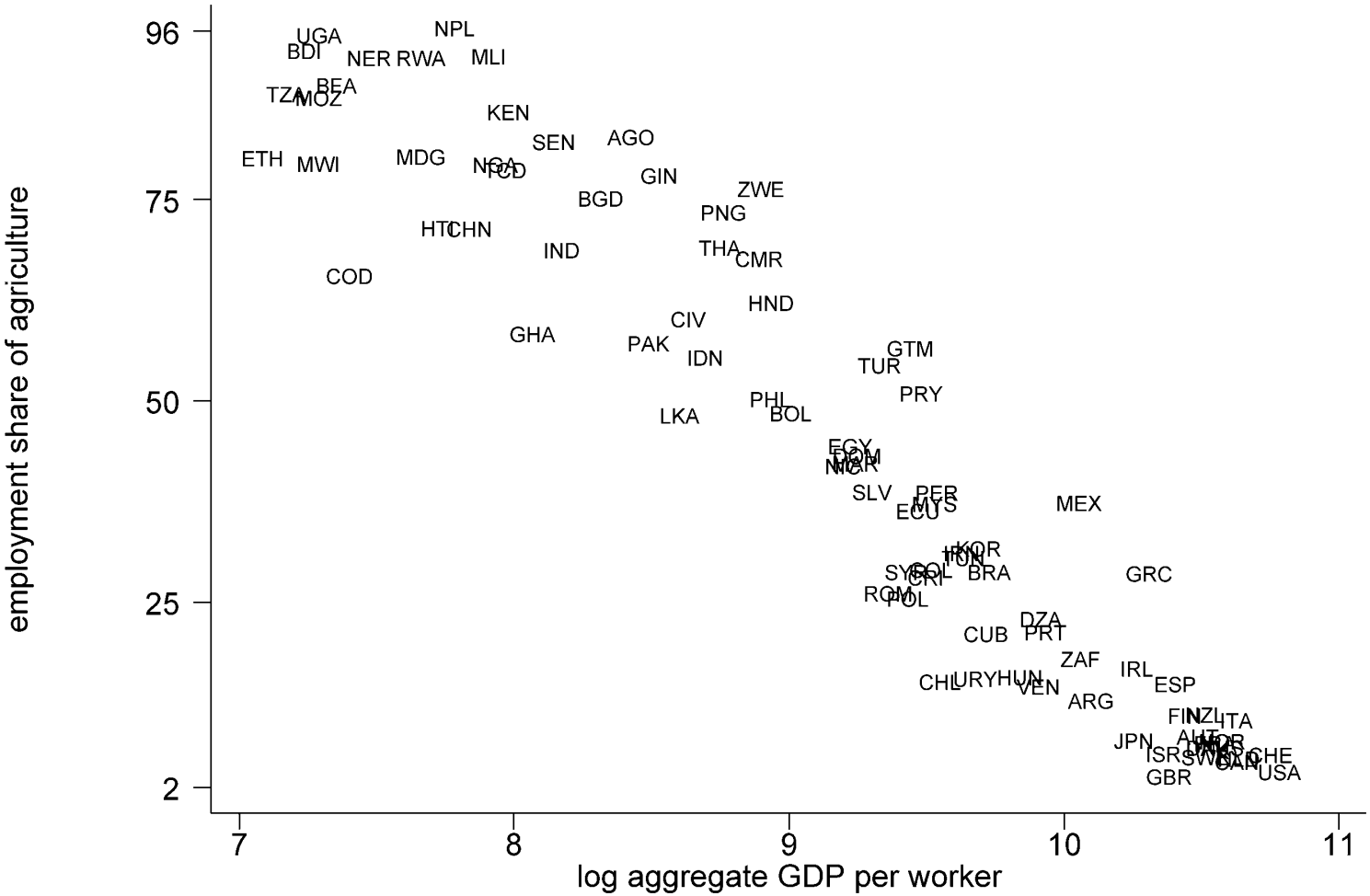


Figure 15. The importance of agriculture.

Source: Caselli (2005)

Agriculture and Development: Two Views

1. Unproductive urban sector is the problem
   - Urban sector can't absorb labor
   - Unproductive or can't grow fast enough
   - People in country-side are "army of surplus labor"
   - This is – I think – the more common view
2. Unproductive agricultural sector is the problem
   - Labor needed to produce food ("food problem")
   - Agricultural sector can't shed labor
   - Timmer (1988), Gollin, Parente, Rogerson (2002, 2007)

Not clear which of these stories is more important

A Two Sector Model

- Perfect labor mobility across sectors
- Competitive labor markets
- Production functions:

$$Y_a = A_a L_a^{\theta} K_a^{1-\theta} \qquad Y_n = A_n L_n^{\theta} K_n^{1-\theta}$$

- Price of non-ag good is numeraire
- Price of ag good is p_a

(See Gollin, Lagakos, and Waugh (2014) for more details)

A Two Sector Model

- Labor mobility implies common wage w
- Labor demand in each sector:

$$p_a \theta \frac{Y_a}{L_a} = w \qquad \theta \frac{Y_n}{L_n} = w$$

- Combining these implies

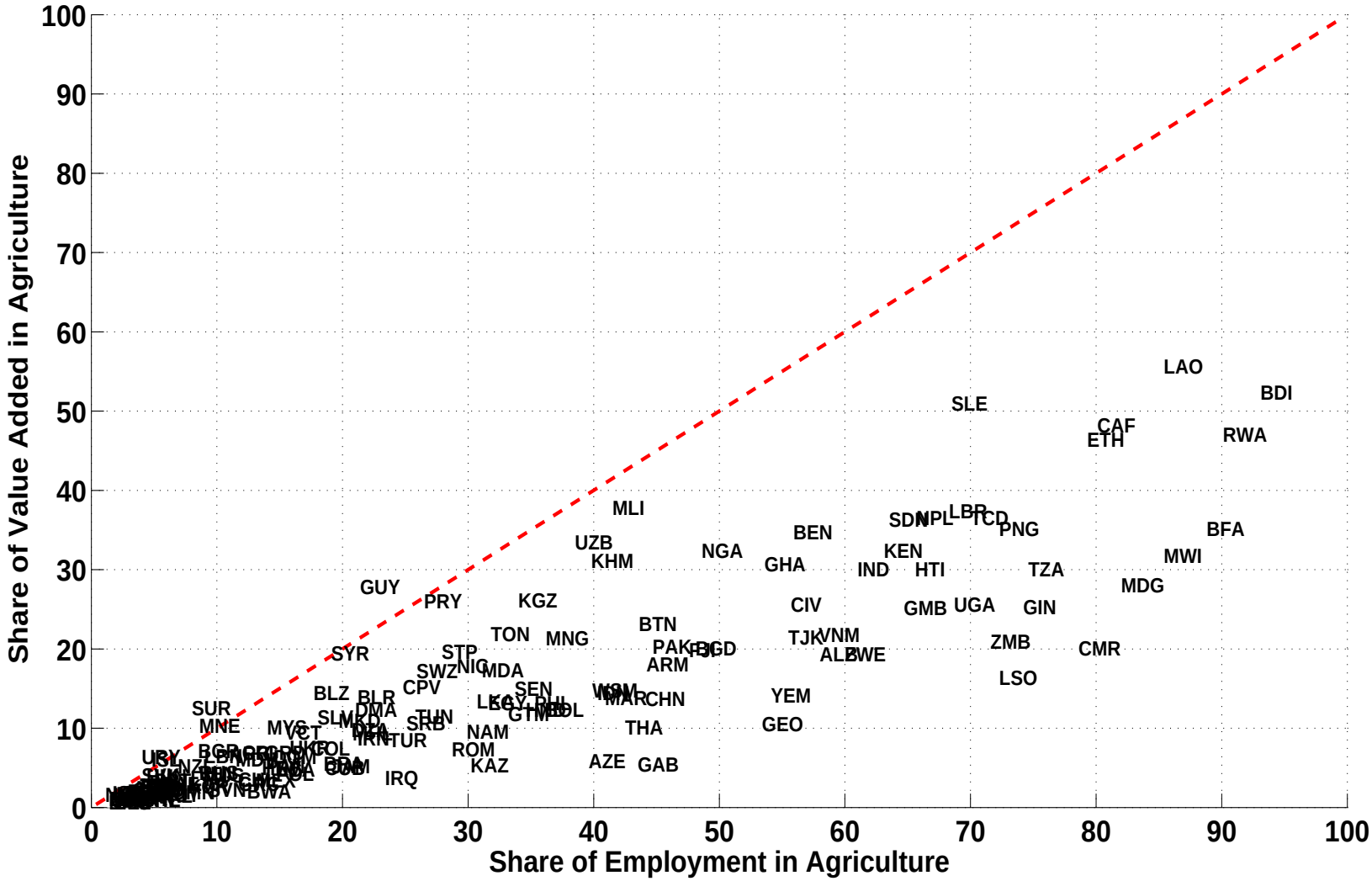
$$\frac{p_a Y_a / L_a}{Y_n / L_n} = \frac{VA_a / L_a}{VA_n / L_n} = 1$$

- Value added per worker should be the same in both sectors

$$\frac{VA_a}{L_a} = \frac{VA_n}{L_n}$$

- True whether growth bottleneck is low A_a or low A_n

Agricultural Productivity Gap



Source: David Lagakos

Agricultural Productivity Gap

- Employment share in agriculture is larger than value added share
- Particularly so in poor countries
- Agricultural productivity gap:

$$APG = \frac{VA_n/L_n}{VA_a/L_a}$$

- Frictionless model implies $APG = 1$

Raw Agricultural Productivity Gap

TABLE I

Raw Agricultural Productivity Gaps

		Quartile of income distribution			
	All countries	Q1	Q2	Q3	Q4
10th percentile	1.3	1.0	1.3	1.0	1.2
Median	2.6	1.7	2.7	2.8	4.3
Mean	3.5	2.0	3.2	3.4	5.6
90th percentile	6.8	4.0	6.6	7.1	12.5
Number of countries	151	38	38	38	37

Note: Income quartiles are determined using 2005 PPP GDP per capita. Q1 is the richest quartile and Q4 is the poorest quartile. The raw agricultural productivity gaps are defined as the ratio of value added per worker in the nonagricultural sector to value added per worker in the agricultural sector, without any adjustments to the underlying value added or employment data.

Source: Gollin, Lagakos, Waugh (2014)

Agricultural Productivity Gap

- Frictionless model implies $APG = 1$
- In practice, $APG = 3.5$ and even larger in poor countries
- Suggests large misallocation of labor across sectors

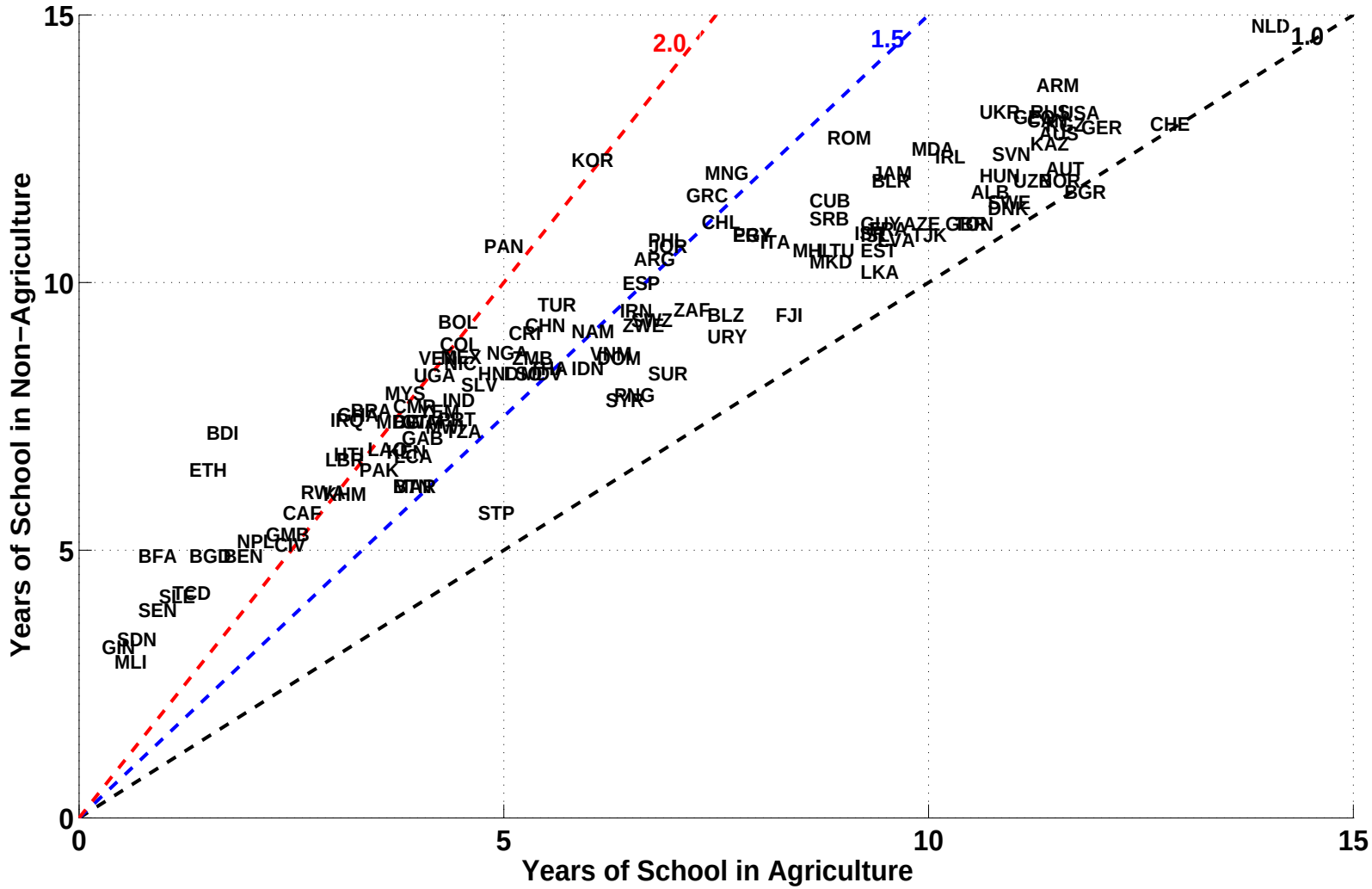
Is it Real or Mismeasurement?

- Agricultural workers may work fewer hours (lean season)
- Rural people may be misclassified as agricultural workers
- Agricultural output may be undermeasured due to home production
- Agricultural workers may have less human capital

Gollin, Lagakos, Waugh (2014)

- Gather database of population censuses and household surveys to better measure agricultural productivity gap
- Sector level data on:
  - Average hours worked
  - Average years of schooling
- Findings:
  - Non-ag workers work modestly more hours than ag workers
  - Average schooling higher in non-ag
- Can explain about 1/3 of agricultural productivity gap

Sectoral Human Capital Difference



Source: Gollin, Lagakos, Waugh (2014)

Adjusted Agricultural Productivity Gap

TABLE III

Agricultural Productivity Gaps and All Adjustments

			All adjustments by quartile			
Measure	Raw APG	All adjustments	Q1	Q2	Q3	Q4
10th Percentile	1.3	1.0	0.8	1.2	0.7	1.3
Median	3.1	1.9	1.4	2.0	2.1	2.3
Mean	3.5	2.2	1.7	2.1	1.9	3.0
90th percentile	6.4	4.3	3.3	2.8	4.3	5.6
Number of countries	72	72	18	16	18	20

Note: Income quartiles are determined using 2005 PPP GDP per capita. Q1 is the richest quartile and Q4 is the poorest quartile. The raw APG is defined as the ratio of value added per worker in the non-agricultural sector to value added per worker in the agricultural sector, without any adjustments to the underlying value added or employment data. The adjusted APG is defined as the the ratio of value added per worker in the nonagricultural sector to value added per worker in the agricultural sector after adjusting for average hours worked per worker and average human capital per worker.

Source: Gollin, Lagakos, Waugh (2014)

Gollin, Lagakos, Waugh (2014)

- Construct alternative measures of value added by sector using household surveys for 10 developing countries
- Measures output whether sold or consumed at home
- Result: Sectoral differences similar to NIPA data
- Mismeasurement of value added not likely to explain APG

Adjusted Agricultural Productivity Gap

TABLE IV

Micro and Macro Data and Agricultural Productivity Gaps

	Agriculture share of				
	Employment	Value added		APG	
	Micro	Macro	Micro	Macro	Micro
Armenia (1996)	34.2	36.8	32.8	0.9	1.1
Bulgaria (2003)	14.1	11.7	18.4	1.2	0.7
Cote d'Ivoire (1988)	74.3	32.0	42.1	4.7	4.0
Ghana (1998)	53.9	36.0	33.3	2.2	2.3
Guatemala (2000)	40.2	15.1	18.7	3.8	2.9
Kyrgyz Republic (1998)	56.9	39.5	39.3	2.0	2.0
Pakistan (2001)	46.9	25.8	22.6	2.5	3.0
Panama (2003)	27.0	7.8	11.8	4.4	2.7
South Africa (1993)	11.0	5.0	7.0	2.3	1.7
Tajikistan (2009)	41.0	24.7	30.1	2.1	1.6
Average	40.0	23.4	25.6	2.6	2.2

Note: "Micro" means calculated using LSMS household survey data. "Macro" means calculated using national accounts data. APGs are calculated using the shares of value added from micro and macro data, and the shares of employment from micro data.

Source: Gollin, Lagakos, Waugh (2014)

Agriculture and Development

- Poor countries employ most of their workers in a sector in which they are particularly unproductive (it seems)
- Why this apparent deviation from comparative advantage?

Agriculture and Development

- Poor countries employ most of their workers in a sector in which they are particularly unproductive (it seems)
- Why this apparent deviation from comparative advantage?
- Young (2013) and Hamory-Kleemans-Li-Miguel (2021) argue difference is due to selective migration of high skill workers
- Munshi and Rosenzweig (2016) argue for trade-off between higher earnings in the city and access to caste-based insurance in the village in India

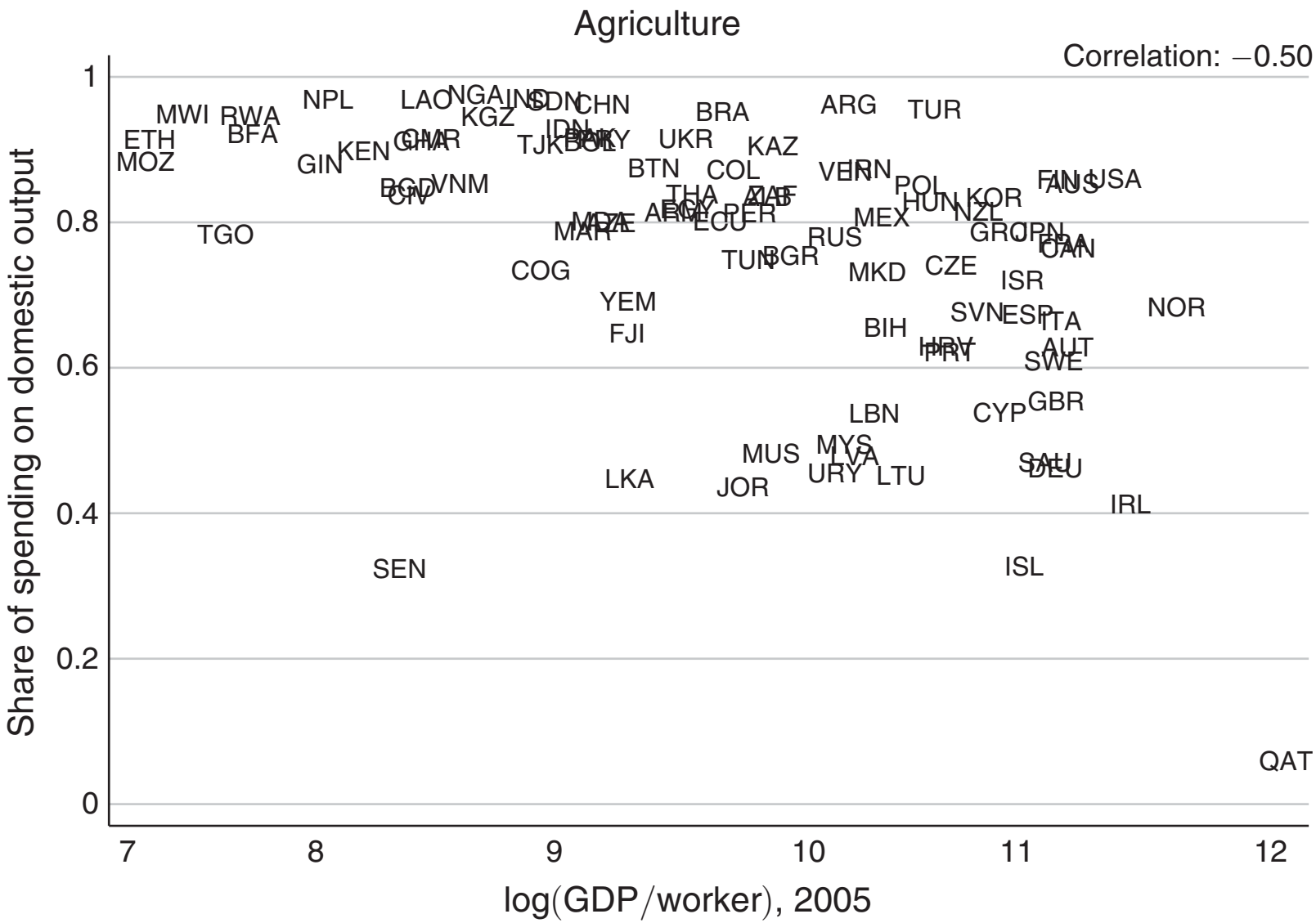
Is APG Driven by Selection?

Source: Hamory, Kleemans, Li, and Miguel (2021). FE denotes worker fixed effects.

Agriculture and Trade

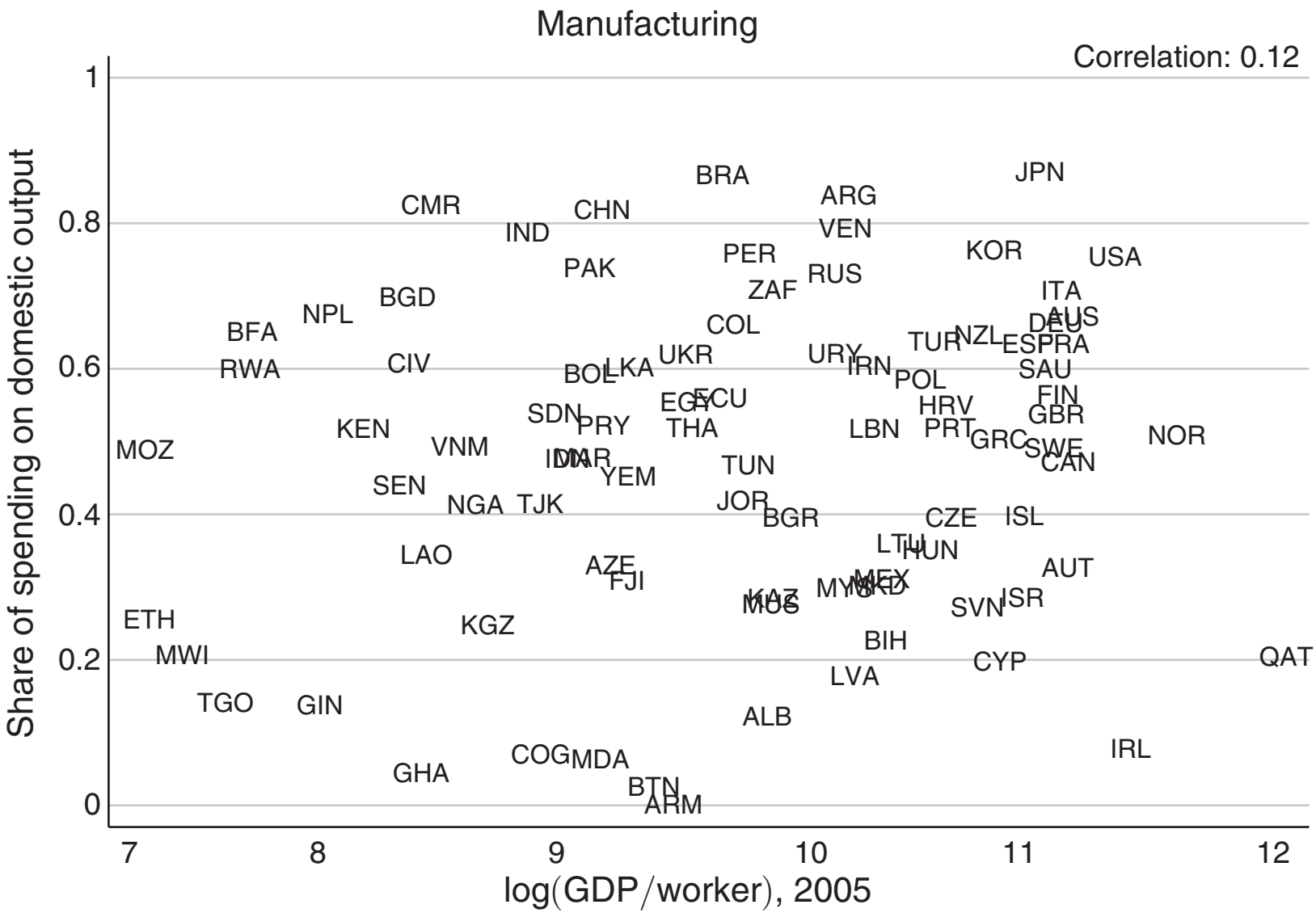
- If agriculture is the bottleneck, why not import food?
- Poor countries import very little food
- Modest tariffs, but huge tariff equivalent costs in time delay to import
- Cost of import delays (Hummels and Schaur, 2013):
  - 3.1% per day for agricultural goods
  - 2% for other consumer and capital goods
- To import food, need to export something else!

Little Agricultural Trade



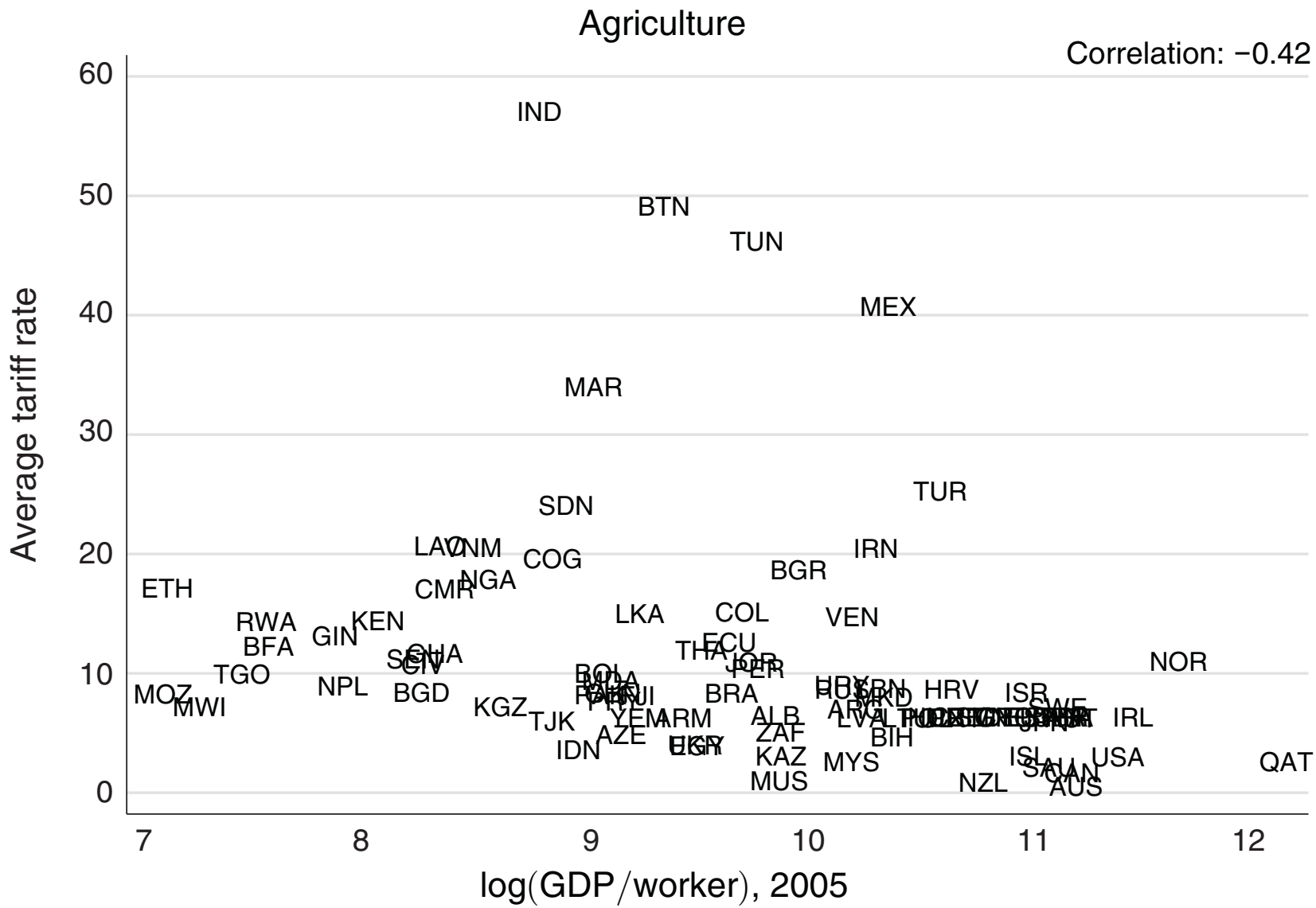
Source: Tombe (2015).

More Manufacturing Trade



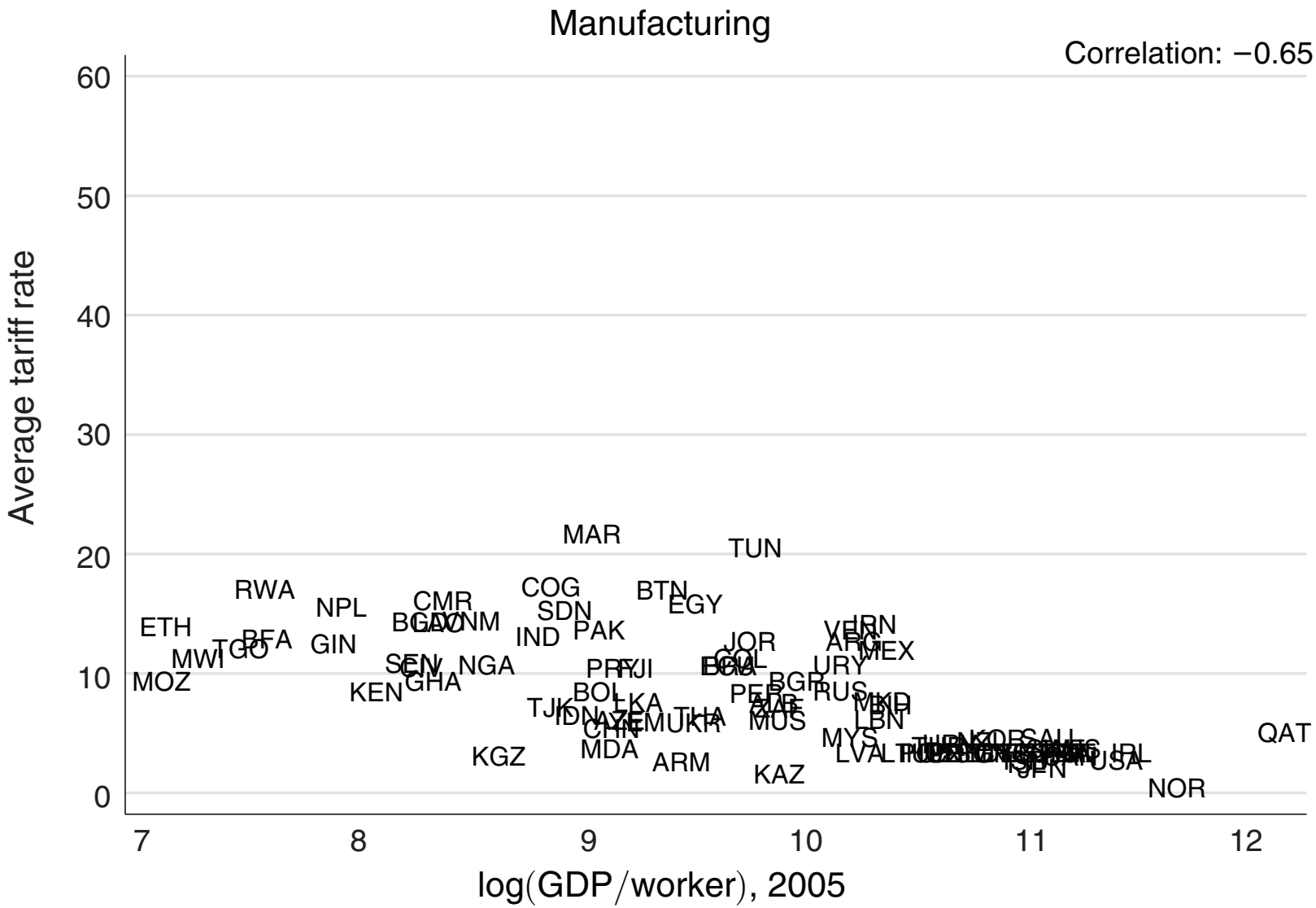
Source: Tombe (2015).

Agricultural Tariffs



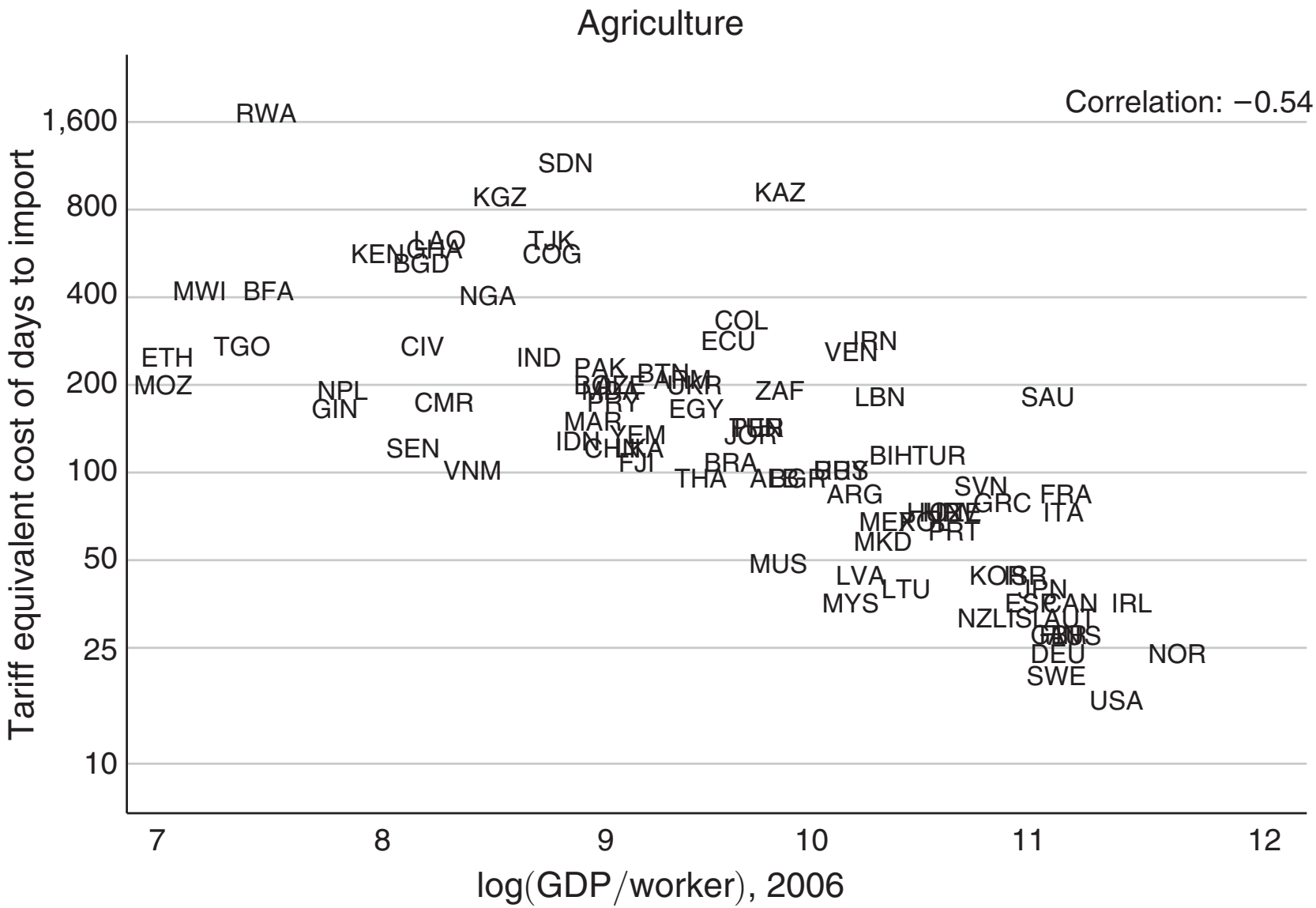
Source: Tombe (2015).

Manufacturing Tariffs



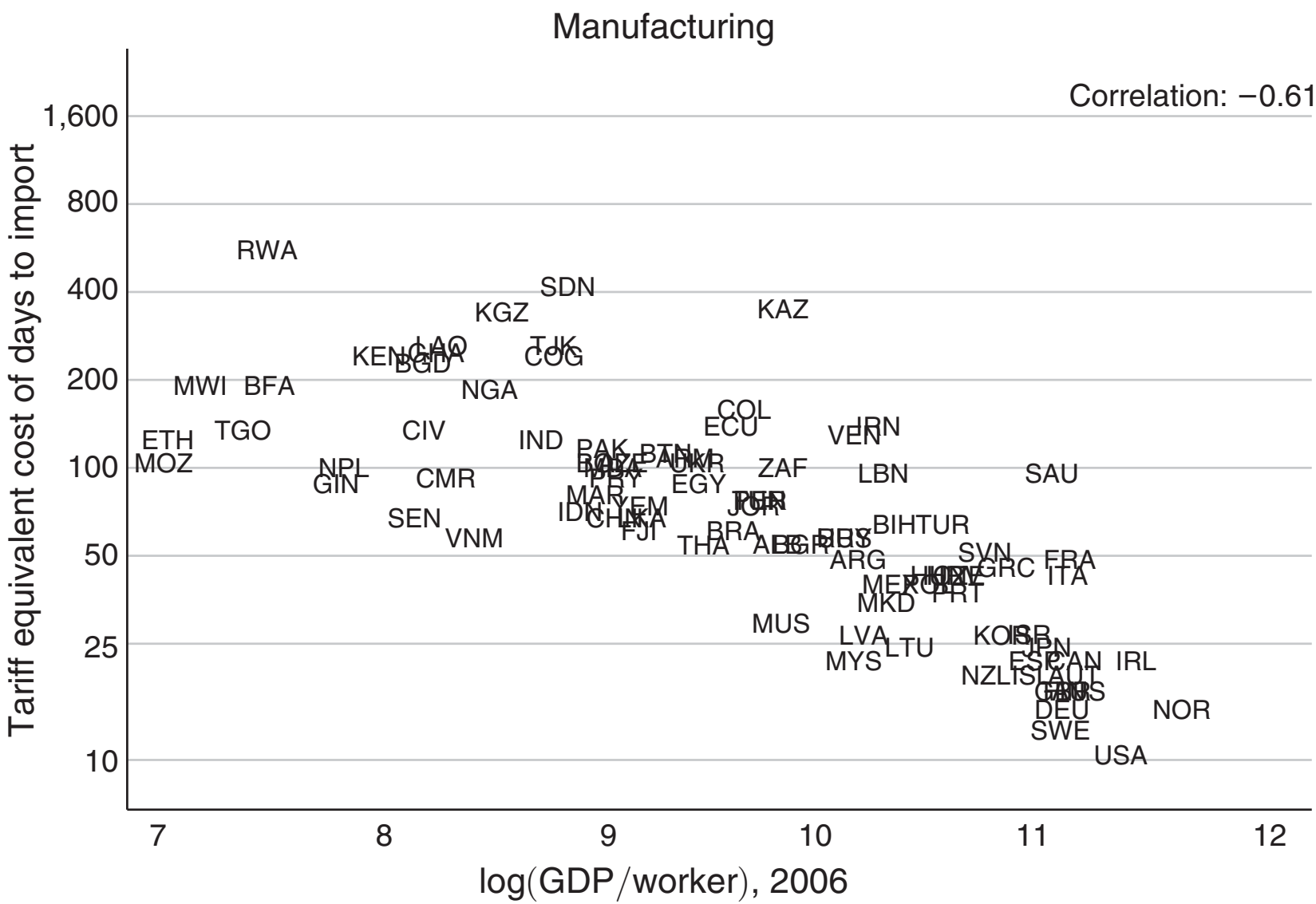
Source: Tombe (2015).

Delay Costs: Agriculture



Source: Tombe (2015).

Delay Costs: Manufacturing



Source: Tombe (2015).

Restuccia, Yang, Zhu (2008)

- Agriculture becomes productive by using modern inputs (tractors, fertilizer, better seeds, etc.)
- Barriers to input use can result in low productivity agriculture
  - Direct barriers: High cost inputs
  - indirect barriers: Low wage workers
- Build two sector model with barriers to explain low agricultural productivity

Restuccia, Yang, Zhu (2008)

- Production function in agriculture:

$$Y_a = X^{\alpha}(Z^{1-\sigma}(\kappa A L_a)^{\sigma})^{1-\alpha}$$

  Z is land (fixed), X is intermediate inputs, κ relative prod. of agriculture

- Production function in non-agriculture:

$$Y_n = AL_n$$

Restuccia, Yang, Zhu (2008)

- Price of non-agricultural goods is numeraire
- Price of intermediate inputs: $\pi > 1$ (direct barriers)
- Wages in non-agriculture: $w_n = A$
- Wages in agriculture: $w_a = (1 - \theta) w_n$ (indirect barriers)
- Demand for intermediate goods:

$$\frac{X}{Y_a} = \alpha \frac{p_a}{\pi}$$

- Low w_a will push down p_a and therefore intermediate input use

Restuccia, Yang, Zhu (2008)

- Stone-Geary preferences for food:

$$U = a \log(c_a - \bar{a}) + (1 - a) \log(c_n)$$

- Goods demand:

$$c_a = \bar{a} + a p_a^{-1} (y - p_a \bar{a})$$

$$c_n = (1 - a)(y - p_a \bar{a})$$

Restuccia, Yang, Zhu (2008)

Features:

- Two sectors
- Diminishing returns in agriculture due to land
- Intermediate input use in agriculture
- Subsistence demand for agricultural goods
- Direct ($\pi > 1$) and indirect ($w_a = (1-\theta)w_n$) barriers to input use in agriculture

Can these features explain cross-country differences in:

$$L_a/N \qquad Y_a/L_a \qquad Y/N$$

Restuccia, Yang, Zhu (2008)

- Messy to solve analytically
- With $a = 0$ (only subsistence demand for agriculture) less messy
- Intermediate input use:

$$\frac{X}{Y_a} = \left[\left(\frac{1-\theta}{\pi\kappa} \frac{\alpha}{(1-\alpha)\sigma} \right)^{\sigma} \left(\frac{\bar{a}}{(Z/N)} \right)^{1-\sigma} \right]^{(1-\alpha)/(\alpha+\sigma(1-\alpha))}$$

- Fraction of labor in agriculture:

$$\frac{L_a}{N} = \frac{1}{\kappa A} \left(\frac{\bar{a}}{(Z/n)^{1-\sigma} (X/Y_a)^{\alpha/(1-\alpha)}} \right)^{1/\sigma}$$

- Labor productivity in agriculture:

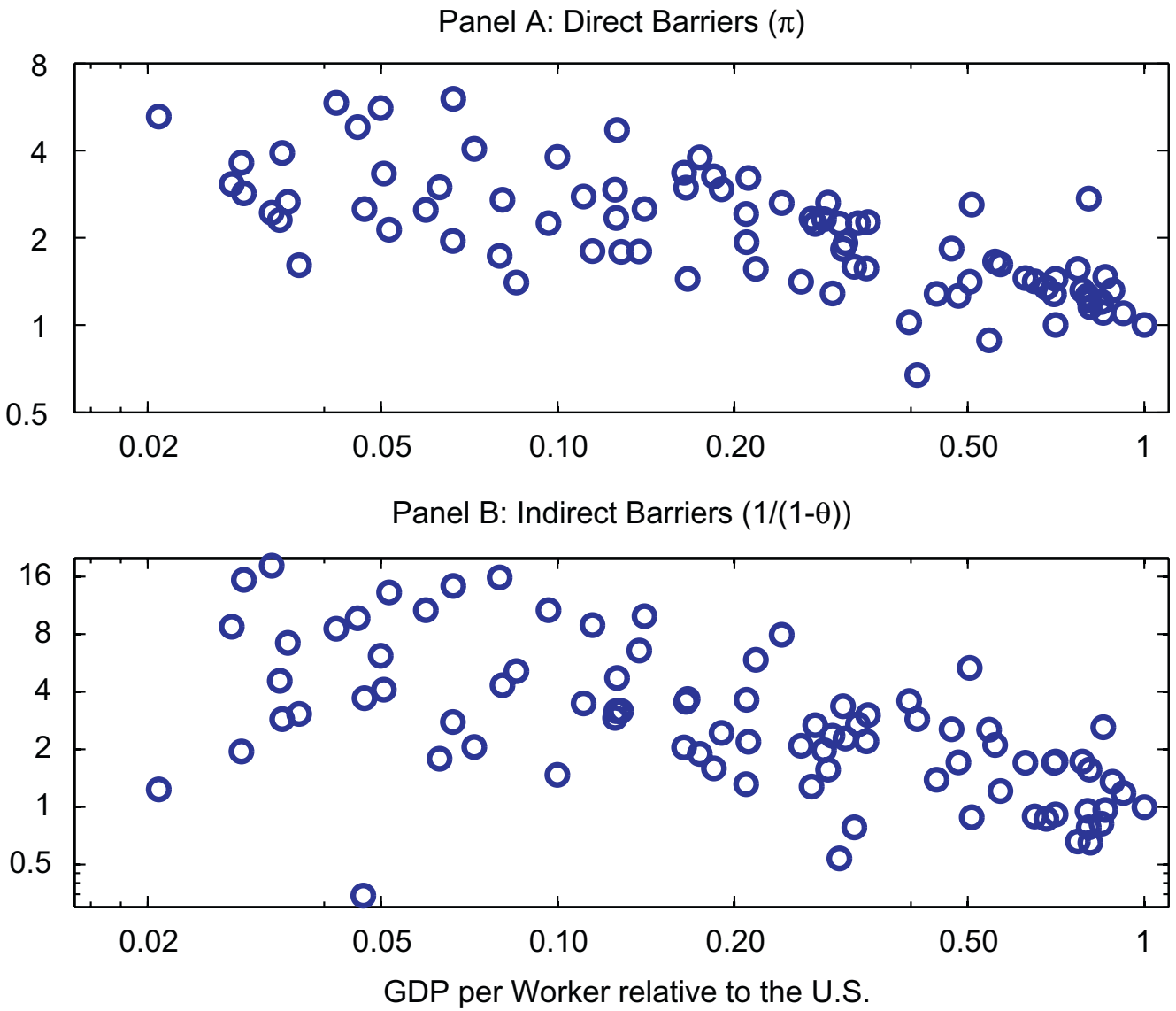
$$\frac{Y_a}{L_a} = \kappa A \left(\frac{(Z/N)^{1-\sigma} (X/Y_a)^{\alpha/(1-\alpha)}}{\bar{a}^{1-\sigma}} \right)^{1/\sigma}$$

Restuccia, Yang, Zhu (2008)

Calibration:

- Hold many parameters fixed across countries: a, $\bar{a}$, α, σ, κ
- Allow to vary across countries: A, π, $1-\theta$, Z/N
  - A: labor productivity in non-agriculture
  - π: Price of ag. inputs relative to non-ag goods
  - $1-\theta$: price of ag. goods times average product of labor in agriculture over average product of labor in non-agriculture (don't have sectoral wages)
  - Z/N: arable land per person
- This is all taken as exogenous. Not explained!

Direct and Indirect Barriers



Source: Restuccia, Yang, Zhu (2008).

How Much Do Barriers Explain?

Table 2
Effects of barriers and economy-wide productivity on equilibrium outcome variables

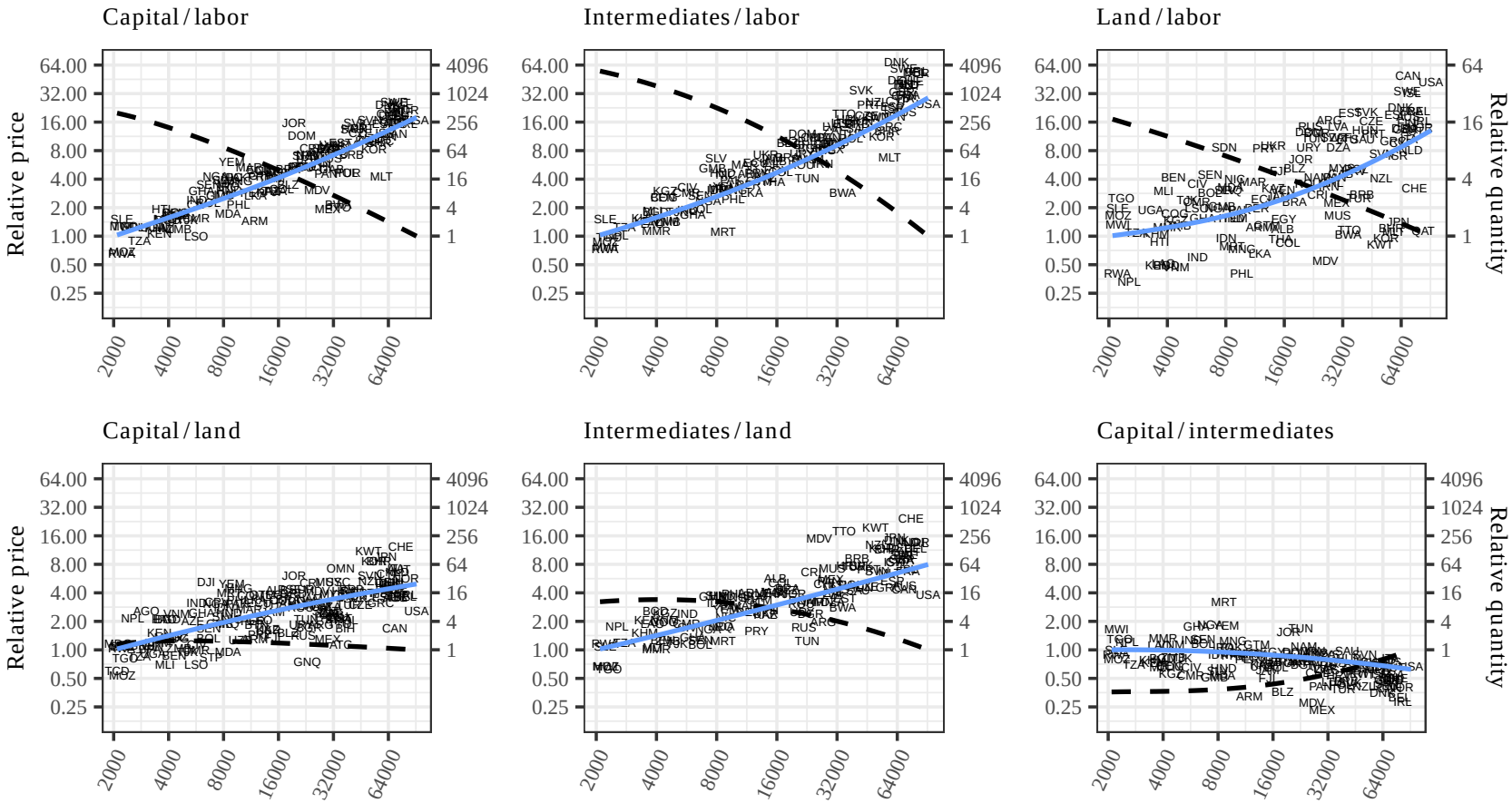
	L_a/N Rich/poor	X/Y_a Ratio of rich to poor countries	Y_a/L_a Ratio of rich to poor countries	Y/N Ratio of rich to poor countries
Data	0.04/0.86	3.1	109.1	34.3
(7) Baseline model	0.04/0.68	2.7	23.4	10.8
Decomposing the contribution of individual factors				
(6) Add direct barriers π only	0.04/0.39	1.5	10.2	6.2
(5) Add indirect barriers θ only	0.03/0.38	1.5	13.8	7.0
(4) Two-sector with $\{L_a, Z, X\}$	0.04/0.20	0.9	6.3	5.5
(3) Two-sector with $\{L_a, Z\}$	0.04/0.24	–	8.2	5.4
(2) Linear two-sector with $\{L_a\}$	0.04/0.17	–	5.0	5.0
(1) One-sector	–	–	–	5.0
Unexplained % or factor	0.00/0.18	1.1	4.7	3.2

Source: Restuccia, Yang, Zhu (2008).

Boppart, Kiernan, Krusell, Malmberg (2023)

- Production function in agriculture differs from non-agriculture
- Perhaps this can help explain low labor productivity in agriculture in poor countries
- Labor is particularly cheap in poor countries
- Perhaps this leads to very labor intensive agriculture (more so than in non-agriculture)

Agriculture: Price and Quantity Ratios



Note: Relative prices (dashed black lines) are reported on the left axis. Relative quantities (data clouds and solid blue lines) are reported on the right axis. Relative prices and quantities are normalized such that the fitted value of the relative price is one for the richest country and the fitted value of the relative quantity is one for the poorest country.

Figure 2: Agricultural inputs: quantity and price ratios

Source: Boppart, Kiernan, Krusell, Malmberg (2023).

Boppart, Kiernan, Krusell, Malmberg (2023)

- Slopes of relative quantities and prices do not sum to zero
- This implies that input share are not constant along the development spectrum

$$\Delta \log S(y) = \Delta \log Q(y) + \Delta \log P(y)$$

- Labor share in agriculture falls sharply as countries develop
  - Relative price of labor rises
  - Relative quantity of labor fall much more rapidly
- Notation: Instead of everything being a function of time t, they assume everything is a function of "level of development" y

Factor Shares in Agriculture

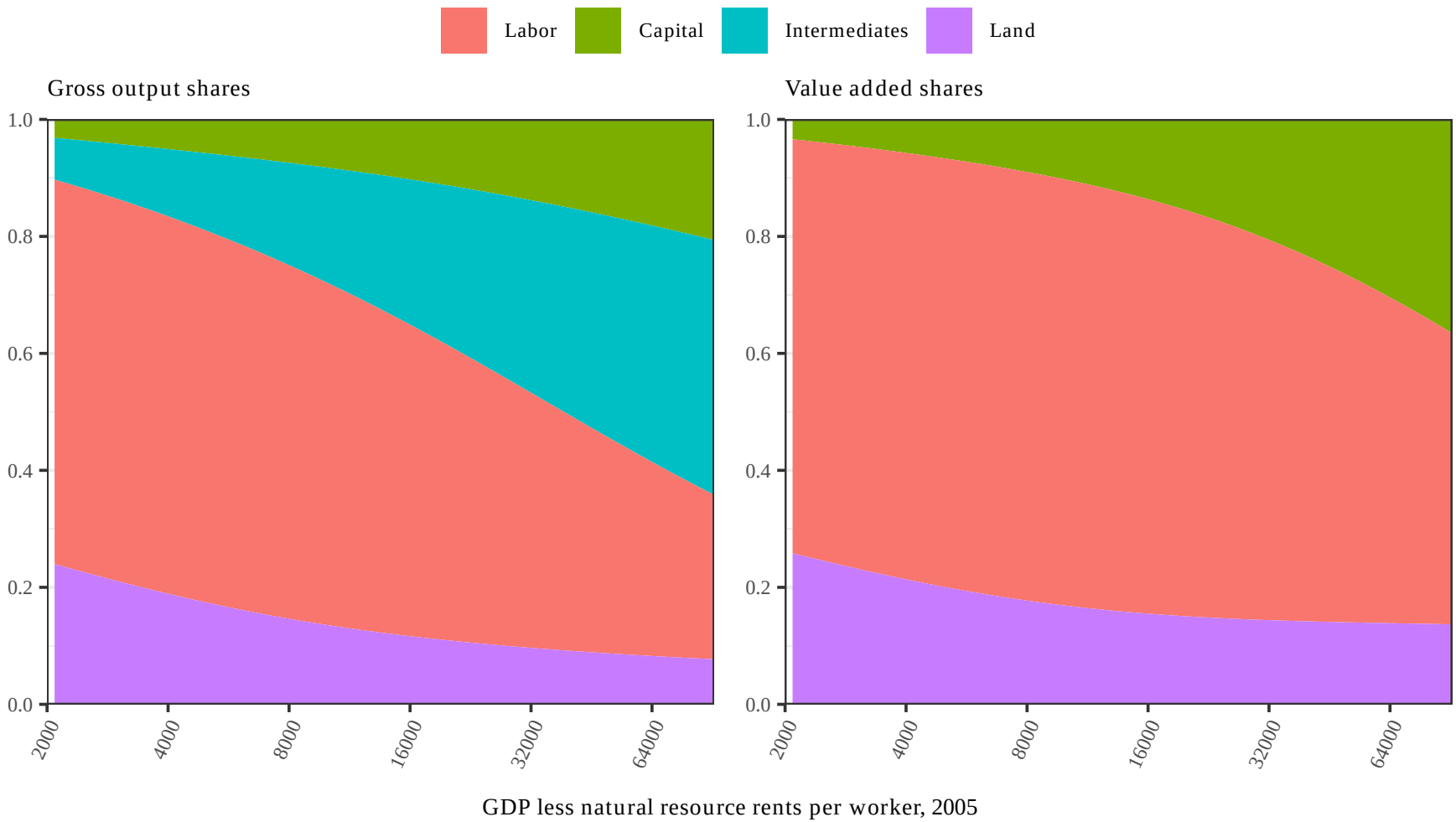


Figure 4: Input shares—gross output and value added

Source: Boppart, Kiernan, Krusell, Malmberg (2023).

Labor Productivity versus TFP

- Since labor share in agriculture falls with development, labor productivity rises more than TFP

$$w_y = (1 - \alpha_y)\frac{Y_y}{L_y} \qquad \rightarrow \qquad \frac{Y_y}{L_y} = \frac{w_y}{1 - \alpha_y}$$

- Use development accounting approach to back out TFP differences in agriculture (and non-agriculture)

Development Accounting in Agriculture

- Production function for agriculture:

$$\frac{y_a}{h_a}(y) = F\left(\frac{k_a}{h_a}(y), 1, \frac{x_a}{h_a}(y), \frac{l}{h_a}(y), y\right)$$

- Differentiate with respect to y (level of development):

$$\frac{\partial \log F(\cdot; y)}{\partial y} = \frac{\partial \log(y_a/h_a)(y)}{\partial y} - \epsilon_{F,k}(y)\frac{\partial \log(k_a/h_a)(y)}{\partial y} - \epsilon_{F,x}(y)\frac{\partial \log(x_a/h_a)(y)}{\partial y} - \epsilon_{F,l}\frac{\partial \log(l/h_a)(y)}{\partial y}$$

  where $\epsilon_{F,k}(y)$ is the elasticity of output with respect to k

- Use factor shares estimated above as measures of output elasticities

Non-Agricultural Production

- They assume three types of non-agricultural production:
  - Consumption goods
  - Investment goods (capital goods)
  - Intermediate inputs
- They assume production has the same shape for these three (same isoquants) but allow for differing Hicks neutral productivity:

$$y_n(y) = A_n(y)g(k_n(y), h_n(y))$$

$$y_k(y) = A_k(y)A_n(y)g(k_k(y), h_k(y))$$

$$y_x(y) = A_x(y)A_n(y)g(k_x(y), h_x(y))$$

- Differentiate these with respect to y to construct TFP as a function of y just as in agriculture

TFP by Sector

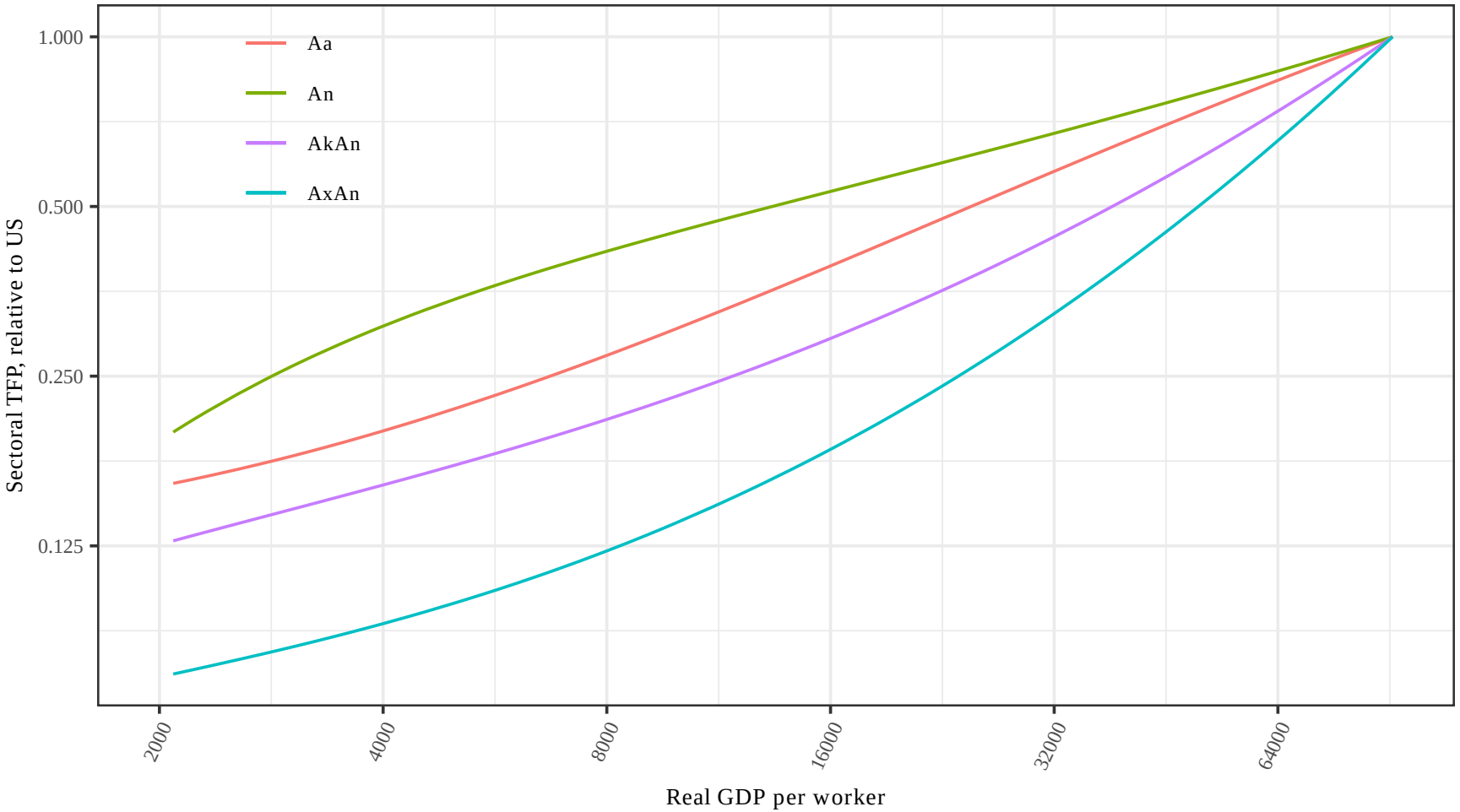


Figure 8: TFPs by sector

Source: Boppart, Kiernan, Krusell, Malmberg (2023).

Agriculture: Labor Productivity vs. TFP

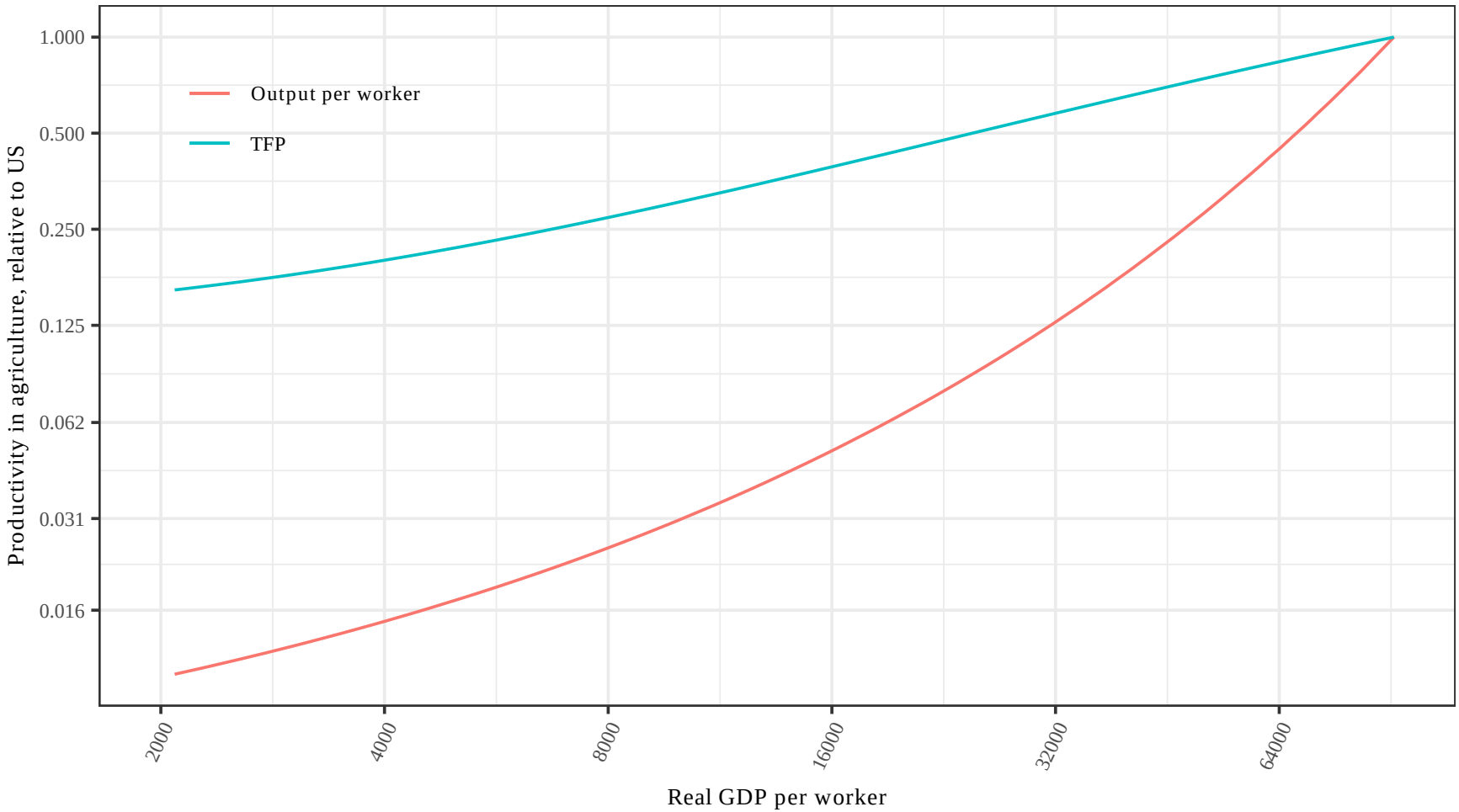


Figure 9: Labor productivity vs. TFP in agriculture

Source: Boppart, Kiernan, Krusell, Malmberg (2023).

Boppart, Kiernan, Krusell, Malmberg (2023)

- Go on to estimate production functions
- Estimate high elasticities of substitution in agriculture
  more so that in non-agriculture
- Low price of labor in poor countries leads to very labor intensive
  agriculture and thus low labor productivity in agriculture
- Development leads to “intensification” of agriculture
  (more capital and intermediates)
- Need to assume low human capital in agriculture
  and some frictions to fit the data.

Rural-Urban Income Gap

- Rural incomes are lower than urban incomes in poor countries
- Why don't people move to cities?
- Two classes of explanations:
  - Selection: People in rural areas are less productive
  - Frictions: Something prevents them from moving
- Quite a few quasi-experimental studies support substantial frictions

Quasi-Experimental Evidence on Mobility

- Bryan, Chowdhury, Mobarak (2014): Randomly giving workers in rural Bangladesh a bus ticket ($8.50) led to large increase in consumption
- Sarvimäki, Uusitalo, Jäntti (2022): Forced migration in Finland after WWII led to large increases in income for people that started off in agriculture
- Chetty, Hendren, Katz (2016): Giving families in high poverty areas vouchers to move to lower-poverty areas raises long-term outcomes of young children
- Nakamura, Sigurdsson, Steinsson (2021): People induced to move from high income village due to volcanic eruption saw large increase in income (how could this work?)

Comparative Advantage

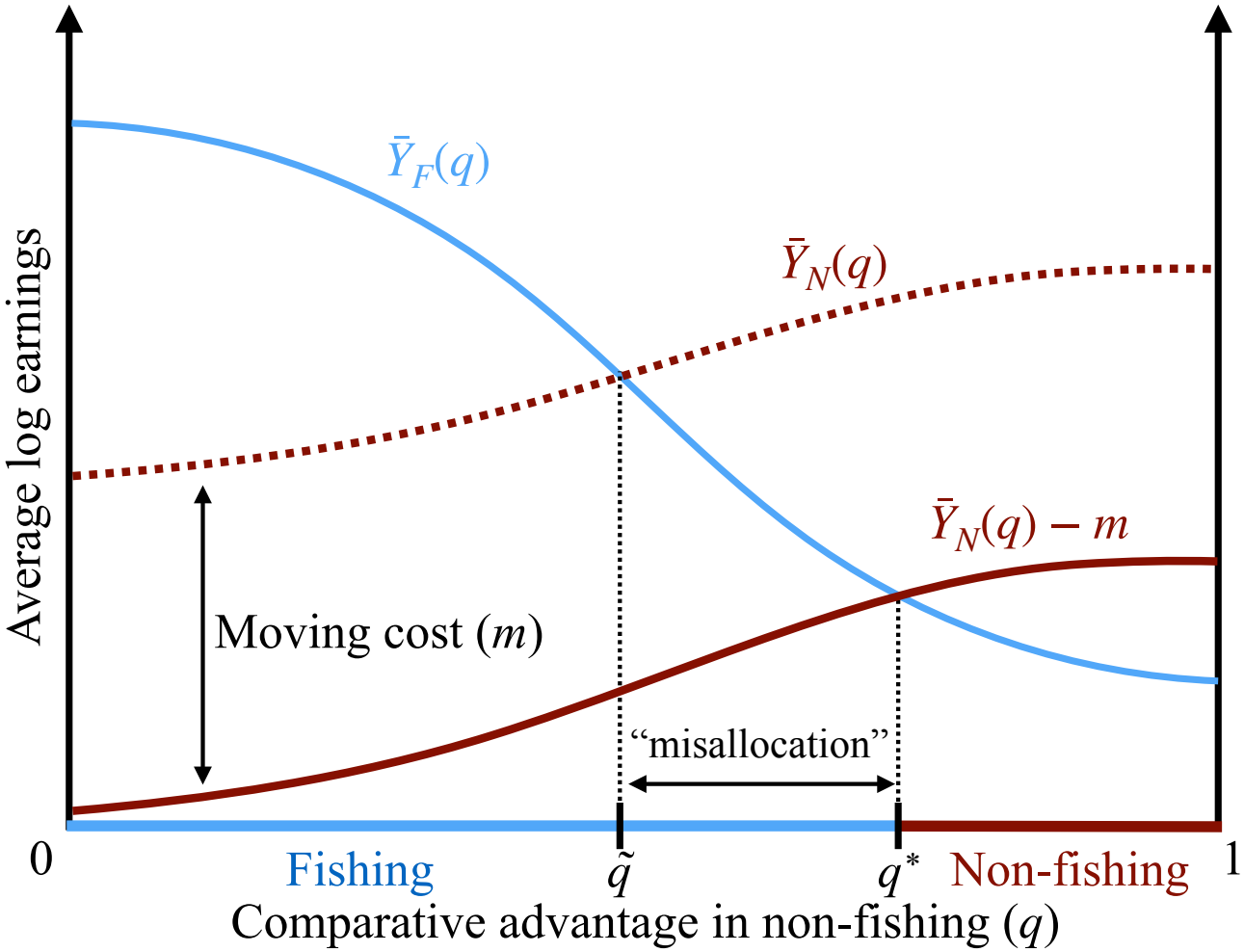


Figure 8: Sorting by Comparative Advantage

Source: Nakamura, Sigurdsson, Steinsson (2021)

Absolute vs. Comparative Advantage

- Absolute advantage: Someone is better at everything
- Fixed effects regressions control for absolute advantage
  - Abowd, Kramarz, Margolis (1999)
- Comparative advantage:
  - Some people are good at fishing
  - Others are good at rabbit hunting
- "Roy model" means model with comparative advantage (Roy, 1951)

  (as does Ricardian model)