Accounting for cross-country income differences: New evidence from multinational firms

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Why are some countries so much richer than others?

- Development accounting: contribution of factors vs TFP
  - TFP measured as a residual
- What drives TFP?
  - Country-embedded factors
    - Institutions, geography, quality of workers
    - Immobile across countries, common across firms
  - Firm know-how
    - Innovation, know-how, intangible capital, management practices
    - Internationally mobile within firm boundaries
  - Burstein & Monge-Naranjo ('09)

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This paper: new development accounting framework

- Provides a *direct* measure of aggregate firm know-how
- Uses firm-level data on MNEs that operate simultaneously in multiple countries
- **Idea:** MNEs use same know-how but different country-embedded factors
  - Differences in MNE performance driven only by country-embedded factors
  - Differences in TFP driven both by firm know-how & country factors
  - Hendricks & Schoellman ('18)
- Aggregate firm know-how contributes to 30% of cross-country TFP differences

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Stylized framework

- Tradable final good: $Y_n^{\frac{\rho-1}{\rho}} = \sum_i \int_{\omega \in \Omega_{in}} \left[Q(\omega) Y_{in}(\omega) \right]^{\frac{\rho-1}{\rho}} d\omega$
  - Firms from different source countries indexed by i
  - $Q(\omega)$: quality idiosyncratic to good ω
- Non-tradable intermediate goods: $Y_{in}(\omega) = Z_n X(\omega) L_{in}(\omega)$
  - $X(\omega)$: productivity idiosyncratic to producer ω
- Z_n: "Country-embedded productivity"
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Aggregates

- Aggregate production function

$$Y_n = Z_n \Phi_n L_n$$

- Aggregate firm know-how

$$\Phi_n \equiv \left[\sum_i \int_{\omega \in \Omega_{in}} A(\omega)^{\rho - 1} d\omega \right]^{\frac{1}{\rho - 1}}$$

- TFP and output per worker (lowercase denotes logs)

$$y_n = z_n + \phi_n$$

- Contribution of firm know-how to cross-country TFP variance

$$\frac{cov(tfp_n, \phi_n)}{var(tfp_n)} + \frac{cov(tfp_n, z_n)}{var(tfp_n)} = 1$$

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Measurement with revenue data

- Revenue share of firm ω in country n:

$$S_{in}(\omega) \equiv \frac{P_{in}(\omega)\, Y_{in}(\omega)}{\sum_i \int_{\omega \in \Omega_{in}} P_{in}(\omega)\, Y_{in}(\omega)\, d\omega} = \left[\frac{A(\omega)}{\Phi_n}\right]^{\rho-1}$$

- In logs:

$$s_{in}(\omega) = [\rho - 1]\,[a(\omega) - \phi_n]$$

$\Longrightarrow$ *Within-firm* differences in revenue shares pin-down differences in ϕ_n

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Imperfect transfer of firm know-how across countries

- Assumption:

$$A_{in}(\omega) = A(\omega) \times exp(-\kappa_{in}(\omega)) \quad \text{with} \quad \kappa_{ii}(\omega) = 0$$

- Aggregate firm know how:

$$\Phi_n \equiv \left[\sum_i \int_{\omega \in \Omega_{in}} A_{in}(\omega)^{\rho-1} \, d\omega \right]^{\frac{1}{\rho-1}}$$

- Modified revenue share equation:

$$s_{in}(\omega) = [\rho - 1] [a(\omega) - \phi_n - \kappa_{in}(\omega)]$$

Quantitative framework: multiple sectors and factors

- Many sectors: $j = 1, \ldots, J$
  - Final output: $Y_n = \prod_j \left[Y_n^j\right]^{\theta_n^j}$
  - Aggregate firm know-how: $\Phi_n \equiv \prod_j \left[\Phi_n^j\right]^{\theta_n^j}$
  - Sectoral firm-level revenues: $s_{in}^j(\omega) = [\rho - 1]\left[a^j(\omega) - \phi_n^j - \kappa_{in}^j(\omega)\right]$
- Factors: labor, human capital, and physical capital
  - TFP different from output per-worker

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Data

- Firm-level revenue shares: $s^j_{in}(\omega) = r^j_{in}(\omega) - r^j_n$
  - $r^j_{in}(\omega)$: (log) revenues of an MNE in a country-sector, ORBIS (2016)
  - r^j_n: (log) sectoral revenues from EU-KLEMS
  - 336 sectors (NAICS 4); 26 countries
  - Compare *same* MNE-sector across locations
- Aggregate data: TFP from Penn World Table (9.1)

Estimation

$$s_{in}^{j}(\omega) = [\rho - 1]\left[a^{j}(\omega) - \phi_{n}^{j} - \kappa_{in}^{j}(\omega)\right]$$

- Assumptions:
  1. Gravity: $\kappa_{in}^{j}(\omega) = O_{i}^{j} + D_{n}^{j} + b_{1}^{j}\text{dist}_{in} + b_{2}^{j}\text{lang}_{in} + \varepsilon_{in}^{j}(\omega)$
  2. Selection on country-sector or firm-sector characteristics, not on $\varepsilon_{in}^{j}(\omega)$
- Estimating equation:

$$s_{in}^{j}(\omega) = \delta^{j}(\omega) + \mathbb{A}_{n}^{j} + \mathbb{P}_{n}^{j} + \beta_{d}^{j}\text{dist}_{in} + \beta_{c}^{j}\text{lang}_{in} + u_{in}^{j}(\omega)$$

  - $\mathbb{A}_{n}^{j} = 1$ if firm operates in n and $n \neq i$
  - $\mathbb{P}_{n}^{j} = 1$ if firm operates in n and $n = i$

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- Differences with respect to France: $\Delta x_n^j \equiv x_n^j - x_{FR}^j$

$$\Delta \mathbb{A}_n^j = [1-\rho]\left[\Delta\phi_n^j + \Delta D_n^j\right] \quad \text{and} \quad \Delta \mathbb{P}_n^j = [1-\rho]\left[\Delta\phi_n^j - \Delta O_n^j\right]$$

- Aggregation across sectors: $\Delta x_n \equiv \sum \theta_n^j \Delta x_n^j$

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Recovering aggregate firm know-how

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$$\frac{\Delta \mathbb{A}_n}{1-\rho} = \Delta\phi_n$$

2. Eaton-Kortum ('02): $\Delta O_n = 0$

$$\frac{\Delta \mathbb{P}_n}{1-\rho} = \Delta\phi_n$$

If costs are larger in low-TFP countries:

$$cov\left(\Delta tfp_n, \frac{\Delta \mathbb{A}_n}{1-\rho}\right) \leqslant cov\left(\Delta tfp_n, \Delta\phi_n\right) \leqslant cov\left(\Delta tfp_n, \frac{\Delta \mathbb{P}_n}{1-\rho}\right)$$

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Estimating the elasticity of substitution

$$\Delta tfp_n = \Delta \phi_n + \Delta z_n$$

- Estimating equation:

$$\Delta tfp_n = b_0 + b_1 \Delta \mathbb{A}_n + b_2 C_n + u_n$$

  - $b_1 = \frac{1}{\rho - 1}$
  - OLS is biased if $cov(\phi_n, z_n) \neq 0 \implies$ Add controls (C_n) for omitted variables

- $\rho = 10$:
  - In paper, estimates using sectoral data and output per worker

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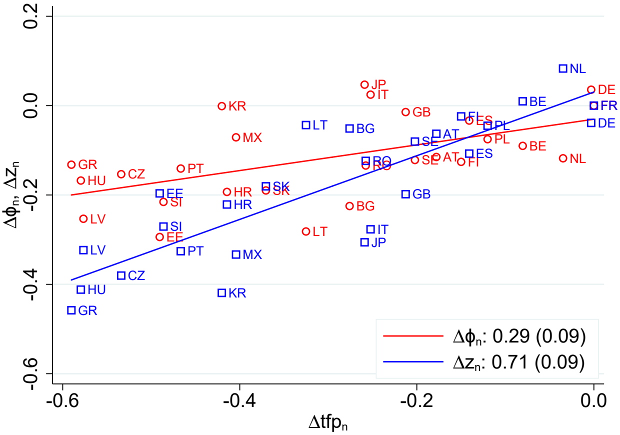
Development accounting: TFP



- Average country (relative to France): $\Delta\phi_n = -0.12$ vs $\Delta tfp_n = -0.30$
- Fraction of TFP variance accounted by $\Delta\phi_n$: 0.29 (upper bound is 0.31)

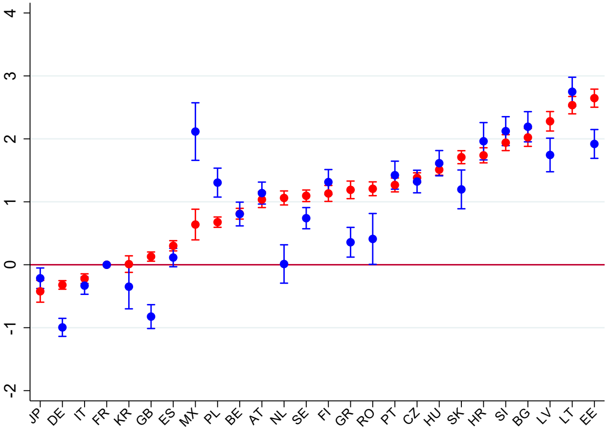
More results and robustness in paper

- Contribution of aggregate firm know-how to differences in output per-worker
- Results by 2-digit sectors (Manufacturing and Services)
- Results using employment and value-added data
- Robustness to address selection and other measurement issues
- Contribution of foreign vs domestic firms
- Extensions to include intermediate inputs and inefficiencies

Final remarks

- **New development accounting framework**
  - Based on data on MNEs producing in different countries
  - Estimate (a component of) TFP directly, not as residual
- **Main finding: Large differences in aggregate firm know-how**
  - Account for about 30% of cross-country differences in TFP
  - Driven mainly by differences in domestic firms (in paper)

OLS estimates



Red is $\mathbb{A}_n$. Blue is $\mathbb{P}_n$.

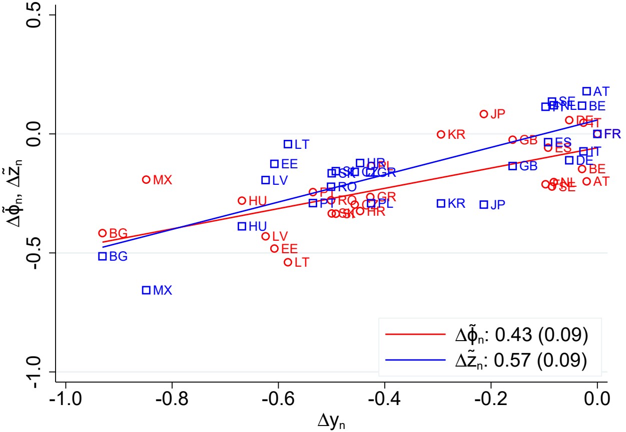
Estimates of elasticity of substitution

	All sectors			Manufacturing sectors			Service sectors		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta \mathbb{A}_n^j / [1-\alpha^j]$	-0.120***	-0.118***	-0.107***	-0.119***	-0.121***	-0.103***	-0.118***	-0.116***	-0.107***
	[0.0170]	[0.0165]	[0.0181]	[0.0236]	[0.0250]	[0.0234]	[0.0252]	[0.0241]	[0.0240]
k_n / y_n		0.365***	0.226		0.483**	0.206		0.174	0.103
		[0.123]	[0.157]		[0.186]	[0.175]		[0.128]	[0.136]
h_n		0.0935	-0.339		0.544	-0.261		-0.203	-0.437
		[0.385]	[0.473]		[0.496]	[0.649]		[0.249]	[0.368]
Rule of law			0.234*			0.415**			0.124
			[0.134]			[0.154]			[0.104]
Observations	430	430	430	151	151	151	154	154	154
R-squared	0.315	0.361	0.398	0.361	0.451	0.568	0.382	0.405	0.423
Implied ρ	9.33	9.47	10.36	9.44	9.29	10.68	9.48	9.65	10.38
s.e ρ	1.18	1.18	1.59	1.68	1.72	2.19	1.81	1.80	2.11

Estimates of elasticity of substitution, by sector

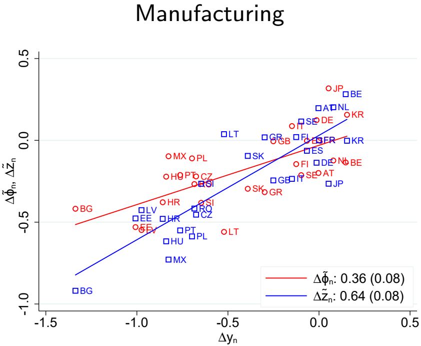
	Implied ρ	S.E
Other goods		
Agriculture and Mining	19.19	9.25
Construction	10.28	1.81
Electricity	25.5	9.25
Manufacturing		
Food and Beverage	9.31	1.66
Textiles, Apparel and Wood	5.68	0.77
Chemicals, Petroleum and Plastic	7.25	1.06
Basic Metals	12.07	2.24
Electrical Equipment and Machinery	9.49	1.31
Transport Equipment and Other Manufacturing	7.45	0.79
Services		
Wholesale Trade and Retail Trade	8.03	1.69
Transportation and Storage	45.17	53.47
Information	6.27	0.88
Financial and Insurance Services	68.98	90.01
Support Services	12.36	2.00
Accommodation and Recreation	9.36	2.02

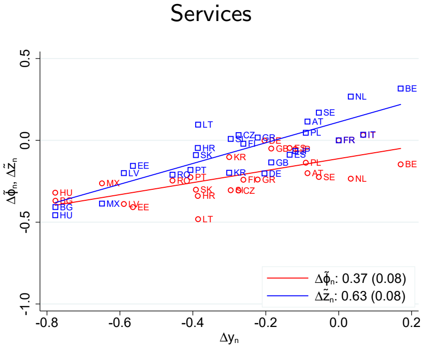
Development accounting: output per-worker



- $\tilde{\phi}_n = \frac{1}{1-\alpha_n}\phi_n$ where $\alpha_n = \sum_j \theta_n^j \alpha^j$
- Average country (relative to France): $\Delta\tilde{\phi}_n = -0.21$ vs $\Delta y_n = -0.31$
- Fraction of y_n variance accounted by $\Delta\tilde{\phi}_n$: 0.43 (upper bound is 0.59)

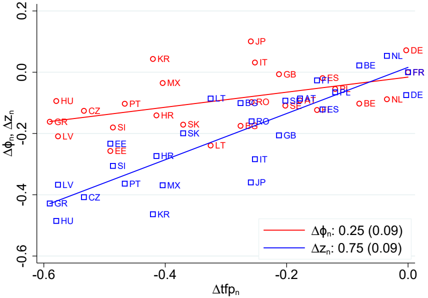
Development accounting: Manufacturing vs Services



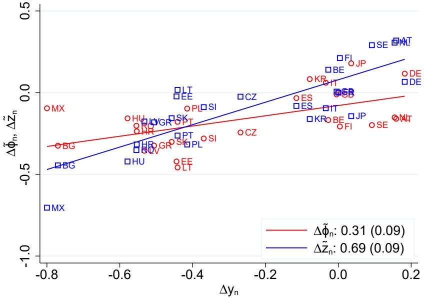


Development accounting: employment data

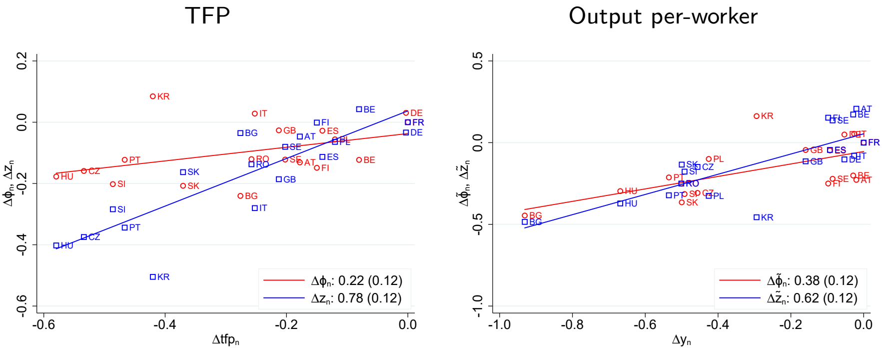
TFP



Output per-worker

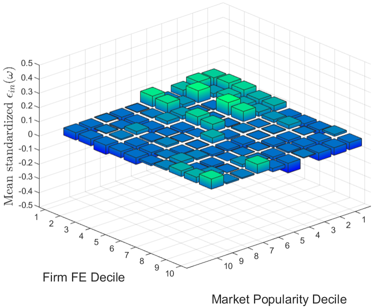


Development accounting: value-added data

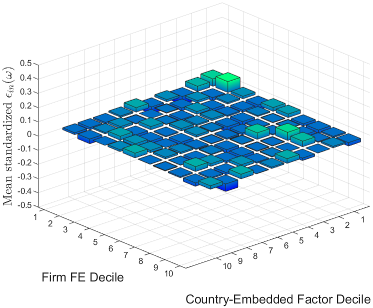


Selection issues: OLS residuals

By firm-sector and market popularity



By firm-sector and country-embedded factor



Robustness

	$\frac{cov(\Delta tfp_n, \Delta\phi_n)}{var(\Delta tfp_n)}$	$\frac{cov(\Delta y_n, \Delta\tilde{\phi}_n)}{var(\Delta y_n)}$
Baseline	0.29 (0.09)	0.43 (0.09)
2nd to 9th Decile	0.27 (0.08)	0.40 (0.09)
3rd to 8th Decile	0.28 (0.09)	0.38 (0.10)
4th to 7th Decile	0.28 (0.09)	0.37 (0.10)
5th to 6th Decile	0.32 (0.12)	0.49 (0.14)

Robustness

	$\frac{cov(\Delta tfp_n, \Delta\phi_n)}{var(\Delta tfp_n)}$	$\frac{cov(\Delta y_n, \Delta\tilde{\phi}_n)}{var(\Delta y_n)}$
Baseline	0.29 (0.09)	0.43 (0.09)
I. Dropping firms:		
below 50th pc size	0.23 (0.08)	0.31 (0.08)
above 50th pc size	0.33 (0.10)	0.46 (0.11)
above 20th pc size	0.35 (0.12)	0.53 (0.14)
below 80th pc size	0.17 (0.07)	0.28 (0.08)
II. Keeping firms operating in at least		
3 countries	0.26 (0.08)	0.37 (0.09)
5 countries	0.22 (0.07)	0.32 (0.08)
10 countries	0.16 (0.07)	0.34 (0.08)
III. Narrow industries:		
4-digit SIC	0.32 (0.10)	0.48 (0.10)

Development accounting: foreign vs domestic firms