The Micro and Macro Productivity of Nations

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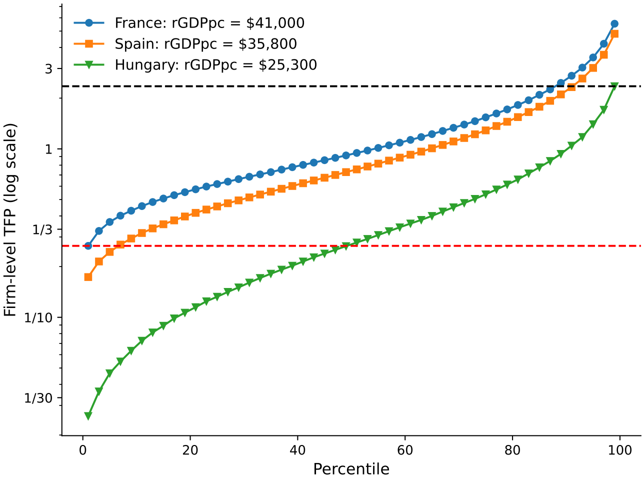
Firm-level productivity distribution



- About 50% of firms in Hungary with TFP below p1 in France, whereas ≈ 10% of firms in France with higher TFP than p99 in Hungary.

Motivation

- Evidence of higher dispersion in firm-level productivity in less developed countries motivates two questions:
  - What accounts for differences in firm-level productivity?
  - How important are differences in firm-level productivity in accounting for international income differences?
- Our approach follows Restuccia & Rogerson (2017) in developing model linking firm-level TFP distributions to policies and institutions that misallocate resources across firms.
- Approach motivated by empirical evidence from policy reforms that find substantial effects on selection and technology upgrading from reductions in misallocation.

What we find

- Empirically, dispersion in firm-level productivity and measured distortions higher in less developed countries.
  - Higher TFP dispersion mostly from low productivity firms operating in less developed countries.
  - Higher measured productivity-distortions elasticity in less developed countries.
- Quantitatively,
  - Differences in measured elasticity of distortions account for bulk of empirical patterns.
  - Measured distortions generate differences in aggregate labor productivity in the model that represent $\approx 2/3$ variation in cross-country data.
  - Variation in firm-level productivity accounts for 60% of aggregate output differences.

Related literature

- Production heterogeneity and misallocation: Restuccia & Rogerson (2008); Guner, Ventura & Xu (2008); Hsieh & Klenow (2009).

- Technology adoption, producer dynamics, and aggregate productivity: Parente and Prescott (1994); Bhattacharya, Guner & Ventura (2013); Hsieh & Klenow (2014); Bento & Restuccia (2017); Comin & Mestieri (2018); Ayerst (2022); Buera et al. (2023).

- Link of misallocation with selection/technology: Pavcnik (2002), Bustos (2011), Kanderwal et al. (2013), Yang (2021), Majerowitz (2023).

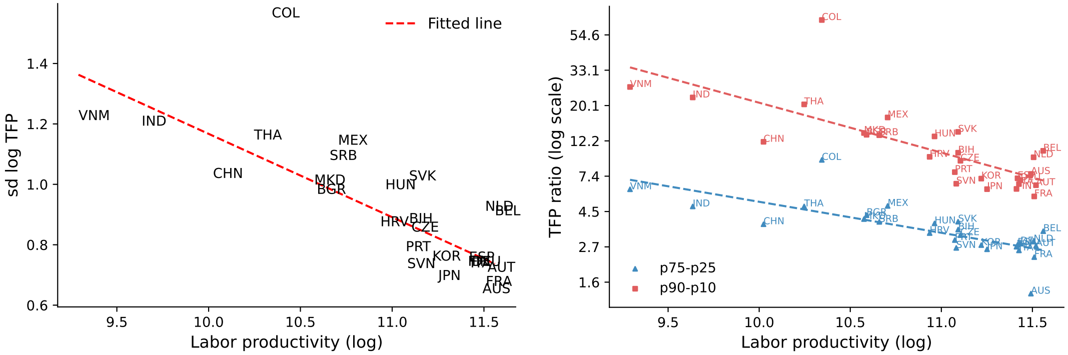
- Orbis data: Andrews, Criscuolo & Gal (2015); Poschke (2018); Alviarez, Cravino & Ramondo (2023); Kalemli-Ozcan et al. (2023); Fattal-Jaef (2022).

Facts

Using Orbis data, we document cross-country differences:

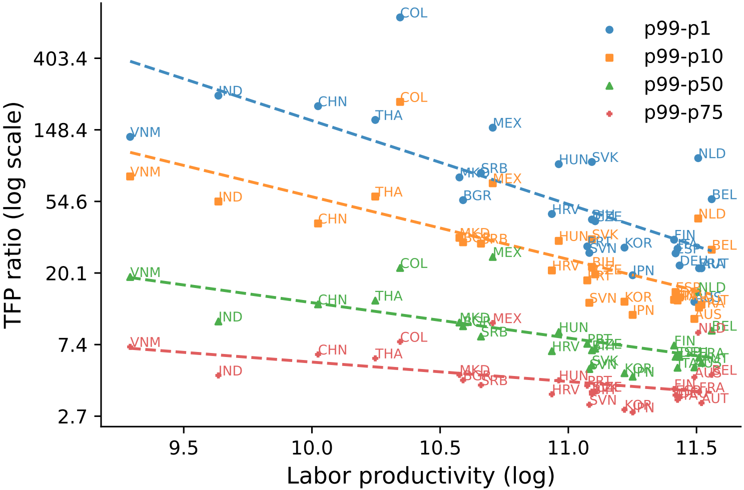
- Fact 1 - Productivity:
  - Higher dispersion in firm-level TFP in less developed countries.
  - Larger dispersion mostly due to low productivity firms in poor countries.
- Fact 2 - Distortions:
  - Higher dispersion in wedges in less developed countries.
  - Higher correlated distortions in less developed countries.

Fact 1a: Productivity dispersion across countries



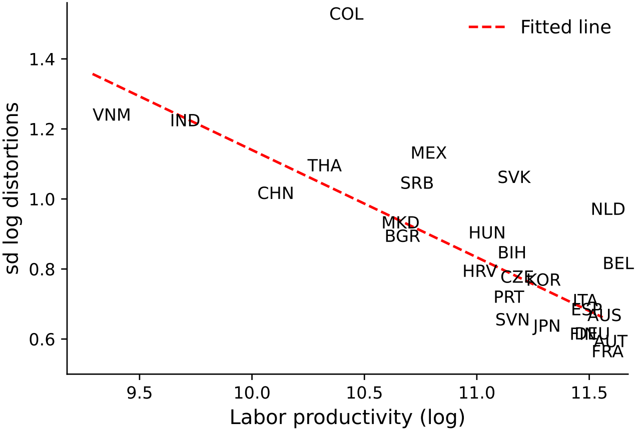
- Higher productivity dispersion in less developed countries.

Fact 1b: Productivity dispersion across countries



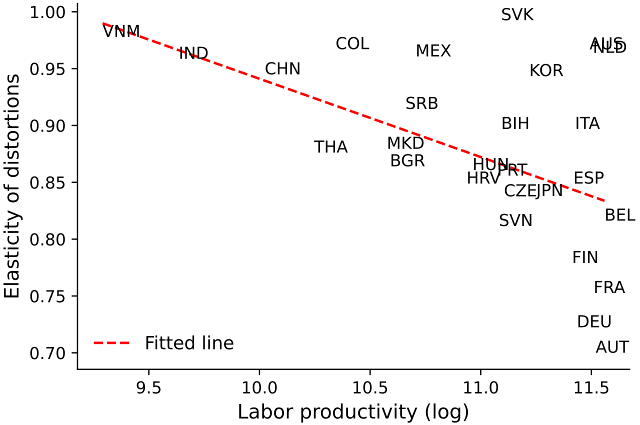
- Higher productivity dispersion mainly driven by differences at bottom of distribution.

Fact 2a: Dispersion in distortions across countries



- Higher dispersion in wedges in less developed countries.

Fact 2b: Measured productivity elasticity of distortions



- Elasticity coefficient from regressing $\log(\text{wedge})$ on $\log(\text{TFP})$.
- Higher correlated distortions in less developed countries.

Model

- Standard model of production heterogeneity with distortions building on Hopenhayn (1992) and Restuccia and Rogerson (2008).

- Framework allows for productivity enhancing investment (technology) and operation decisions by firms (selection).

- Focus on a stationary competitive equilibrium.

- Time is discrete and indexed by $t \in \{1, 2, ..., \infty\}$.

- Representative household, standard preferences on consumption $\log(C)$, one unit of productive time supplied inelastically to firms.

Technology

- At each date, a homogeneous good is produced by firms indexed by i.
- Each firm i employs labor (n_i) to produce output (y_i) following a decreasing-return-to-scale technology:

$$y_i = v_i {z_i}^{1-\gamma} {n_i}^{\gamma},$$

where $z_i^{1-\gamma}$ is a permanent component of productivity, $v_i \overset{\text{iid}}{\sim} H(v)$ is a transitory mean zero component and $\gamma \in (0, 1)$.

- To attain productivity z, a firm incurs a productivity investment cost of $\psi \frac{z^{\phi}}{\chi_i}$ in units of output where χ_i is an innovation ability drawn from iid cdf $G(\chi)$.
- Selection: Firm face an operating fixed cost c_f in units of labor every period.

Market structure and distortions

- Competitive economy where households and firms take prices as given.
- Price of output normalized to 1, wage rate denoted by w.
- Firms face idiosyncratic distortions, modeled as a proportional tax τ_i on revenues:

  $$(1-\tau_i) = \left(z_i{}^{-\rho}\epsilon_i\right)^{1-\gamma},$$

  where ρ is the elasticity of distortions with respect to firm TFP and ϵ_i is a random component of distortions drawn from iid cdf $F(\epsilon)$.
- ρ represents a general form of "correlated distortions" motivated by different policies studied in earlier literature.
- Endogenous entry and exogenous exit with rate λ every period.

Equilibrium

A stationary competitive equilibrium comprises a wage w; decision functions for firms: labor demand $n(z,\tau)$, profits $\pi(z,\tau)$, operating decision $o(z,\tau)$, value of incumbent firm $W(z,\tau)$, productivity $z(\chi,\epsilon)$, net value of firm $V(\chi,\epsilon)$, value of entry V_e, a distribution of firms $\mu(\chi,\epsilon)$, mass of firms M and entrants E; and allocation C for households such that:

(i) Given w, allocation C solves the household's problem.

(ii) Given w, $n(z,\tau)$ and $o(z,\tau)$ solve the incumbent's firm problem, determining $\pi(z,\tau)$ and $W(z,\tau)$.

(iii) Given w, entrants choose $z(\chi,\epsilon)$ to maximize net value of firm $V(\chi,\epsilon)$.

(iv) Zero profit entry condition $V_e = 0$.

(v) Invariant distribution of firms μ.

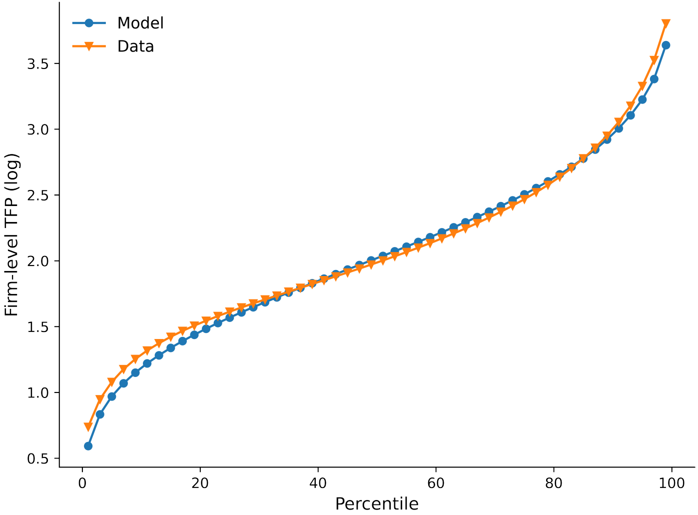
(vi) Markets clear.

Calibration to France as Benchmark Economy

Parameter	Value	Targeted moments	Model	Data
ρ	0.525	Elasticity of distortions	0.75	0.75
σ_ϵ	1.4	sd log distortions	0.55	0.55
σ_χ	11.0	sd log employment	1.31	1.31
σ_v	0.2	sd log TFP	0.68	0.66
c_f	0.14	Average firm size	14.7	14.9

- Calibrated $\rho = 0.525$ implies measured elasticity of distortions 0.75.
- Gap between model parameter and measured elasticity due to strong operation selection of firms.

Firm-level TFP distribution



Cross-country experiments

- We examine the model's fit and ability of calibrated distortions to account for cross-country data.
- We vary the set $(\rho, \sigma_\epsilon, \sigma_v)$ within the cross-country range.
- Model well replicates cross-country variation, bulk of effects from ρ.
  Distortions | Productivity | Employment | Allocative Efficiency
- Model implies the estimator of measured elasticity is biased upward, especially for richer economies due to strong selection. Estimation Bias
- Aggregate labor productivity in model $\approx 2/3$ variation cross-country data.

Static versus dynamic misallocation

	Value of ρ				
	0.00	0.525	0.65	0.80	0.90
Aggregate output	1.49	1.00	0.75	0.41	0.23
– Static misallocation	1.09	1.00	0.88	0.69	0.55
Contribution (%)	*22*	–	*44*	*42*	*41*
– Dynamic misallocation	1.37	1.00	0.89	0.59	0.42
Contribution (%)	*78*	–	*56*	*58*	*59*

- Static misallocation measures effect of distortions in same set of producers and technologies as BE.
- Dynamic misallocation accounts for around 60% of aggregate productivity loss.
- Technology and selection each account for half of changes in firm-level TFP distribution. ▸ Technology vs. Selection

Dynamic misallocation and allocative efficiency

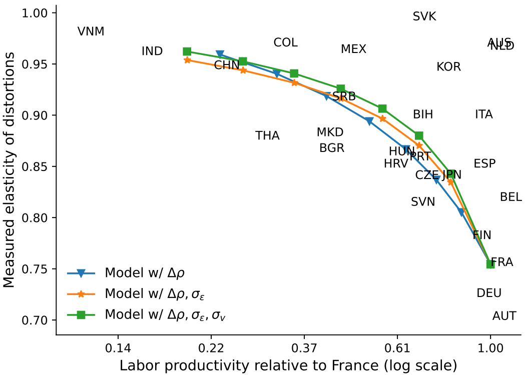
	Value of ρ				
	0.00	0.525	0.65	0.80	0.90
Dynamic misallocation					
Firm-level productivity	1.34	1.00	0.88	0.70	0.56
Contribution (%)	*73*	–	*44*	*40*	*40*
Firm productivity with distortions	1.02	1.00	0.97	0.86	0.77
Contribution (%)	*5*	–	*12*	*18*	*19*
Allocative efficiency (Y/Y_e)	0.85	0.76	0.65	0.45	0.32

- Firm-level productivity contributes bulk of dynamic misallocation, one-third to allocative efficiency.

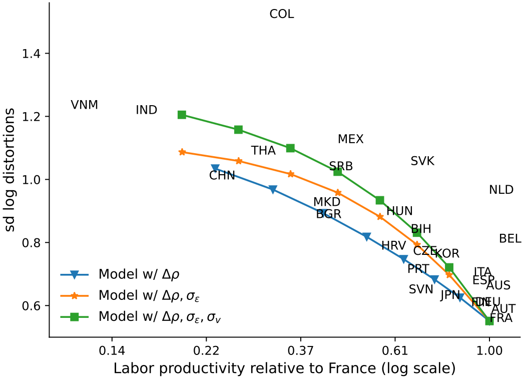
Conclusions

- The productivity costs of misallocation extend beyond static misallocation.
- Costs substantial due to changes in firm-level productivity distribution (technology and selection), account for 60% of output differences (1/3 of allocative efficiency).
- In less developed countries, correlated distortions lead to:
  - Under-investment in technology by productive producers.
  - Lack of selection explaining prevalence of unproductive producers.
- Technology and selection each account for half of changes in firm-level TFP distribution.
- Standard misallocation measures biased due to sample selection, stronger in more productive countries.

Elasticity and dispersion of distortions



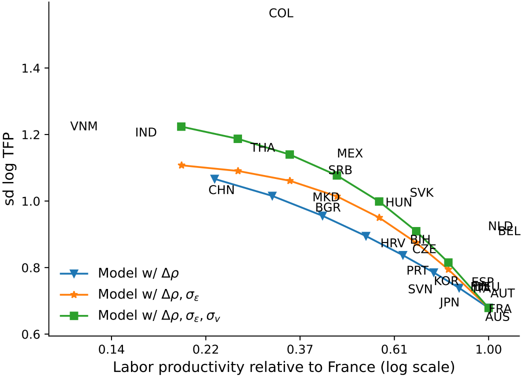
Elasticity of distortions



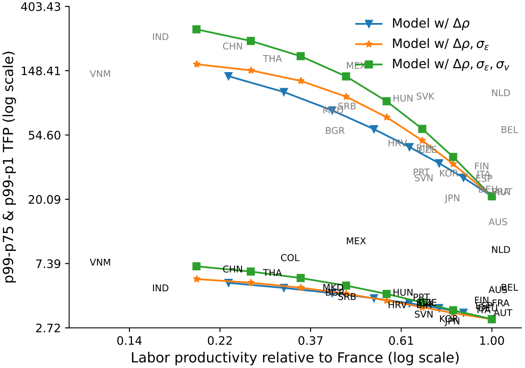
sd log distortions

- Models fit cross-country data well, bulk of effects from ρ.
- Aggregate labor productivity in model $\approx 2/3$ variation cross-country data. ▸ Back

Dispersion measures firm-level TFP



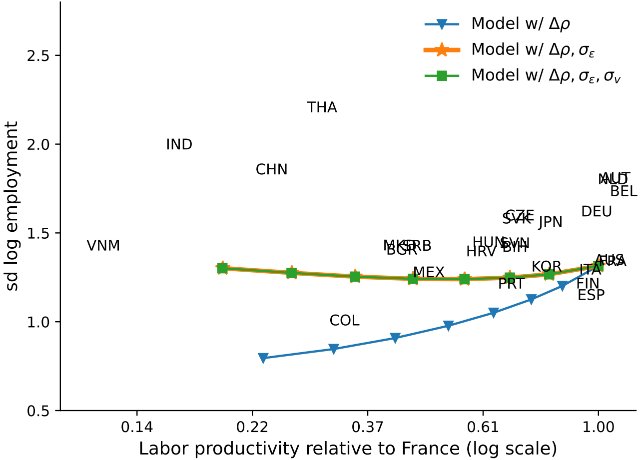
sd log TFP



p99-p75 & p99-p1 log TFP

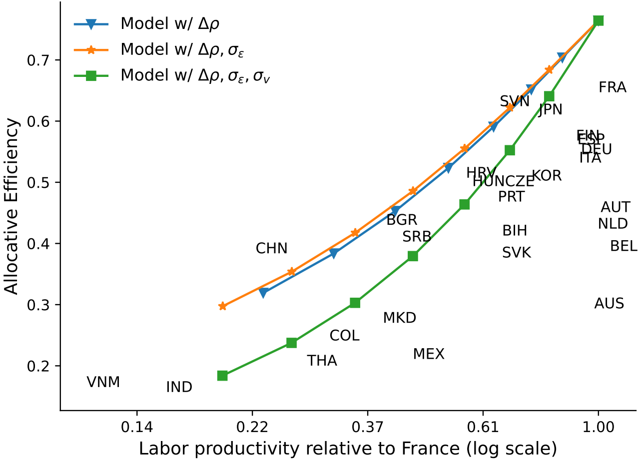
- Model fits data relatively well, bulk of effects from ρ.
- Variation in σ_ϵ, σ_v move model closer to data. Back

Dispersion in employment



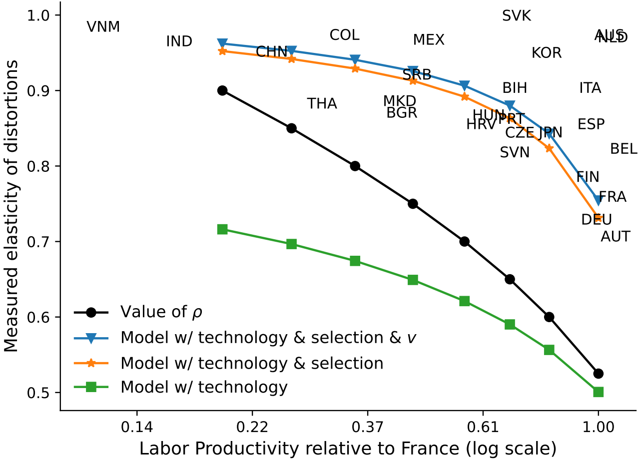
- Correlated distortions compress employment distribution across firms.
- Variation σ_ϵ captures lack of systematic relationship in data. Back

Allocative efficiency (AE)



- AE benchmark economy 0.76 (France 0.65), ρ reduces AE 44 p.p., data range 48.
- Unlike aggregate output, AE more susceptible to mismeasurement (σ_v). Back

Estimation bias in measured elasticity of distortions



- Measured bias due to ex-post v, selection, and endogeneity (technology choice).
- Substantial bias in measured elasticity, mostly selection, larger in more productive countries. Back

Technology versus selection

	Value of ρ				
	0.00	0.525	0.65	0.80	0.90
Technical efficiency	2.38	1.00	0.76	0.52	0.38
– Technology	1.38	1.00	0.88	0.72	0.58
Contribution (%)	*37*	–	*46*	*52*	*58*
– Selection	1.72	1.00	0.86	0.73	0.68
Contribution (%)	*63*	–	*54*	*48*	*42*

- Measure impact of selection and technology on technical efficiency (aggregate TFP in efficient allocation).
- Selection more important in less distorted economies, roughly equally shared in most distorted. Back