Misallocation and Aggregate Productivity across Time and Space

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GDP per capita across Countries and Time

	Year						
Decile	1960	1970	1980	1990	2000	2010	2014
1	3.4	3.2	3.1	2.3	1.7	1.8	2.0
2	5.5	5.1	4.5	3.2	2.7	3.0	3.3
3	7.4	6.8	6.4	4.5	3.9	4.8	5.7
4	9.6	8.9	8.0	6.8	6.2	9.2	10.9
5	12.7	11.5	11.5	10.2	10.0	14.8	18.5
6	14.9	15.8	17.4	15.4	16.1	21.9	25.6
7	22.0	22.9	24.1	22.3	22.1	29.9	35.0
8	30.5	33.4	39.1	38.0	45.3	53.0	56.7
9	49.9	56.0	62.2	65.1	72.6	77.0	79.5
10	80.1	81.3	82.6	79.3	83.5	98.3	105.0
R 10/1	23.4	25.4	27.1	34.0	49.5	53.6	51.3

GDP per capita across Countries and Time

Country	1960	1980	2000	2014
Botswana	2.3	7.5	21.5	29.1
Ethiopia	2.5	2.5	1.2	2.6
Malawi	4.7	4.3	2.1	1.9
Indonesia	5.3	7.1	9.0	19.8
China	5.6	5.7	9.5	24.6
India	5.9	4.0	4.4	10.5
Korea	6.2	18.3	50.5	68.2
Zimbabwe	11.3	10.0	6.1	3.1
Singapore	14.3	41.7	83.3	149.7
Japan	30.8	63.2	73.9	68.2
Mexico	32.0	38.1	25.4	31.1
Austria	53.4	62.9	77.8	92.7
France	59.4	75.4	68.3	76.5
United Kingdom	68.0	64.7	74.9	75.3
New Zealand	81.2	60.2	59.4	66.0

Overview

(1) Differences in income per capita across countries mostly accounted for by total factor productivity (TFP)

- What accounts for these productivity differences?

(2) Simple framework to discuss/assess potential channels:

- technology
- selection
- misallocation

(3) Evidence of misallocation, causes, and aggregate effects

(4) Broader consequences of misallocation via effects on selection and technology

(1) TFP and Income Differences

- Cross-country income differences mostly accounted for by TFP (e.g. Klenow and Rodriguez-Clare 1997; Jones 2016)
- Similar conclusion when accounting for human capital quality differences (e.g. Erosa, Koreshkova, and Restuccia 2010; Manuelli and Seshadri 2014)

Basic Development Accounting 2010

	Y/E	$(K/Y)^{\frac{\alpha}{(1-\alpha)}}$	h	TFP	Contrib. (%)
United States	1.00	1.00	1.00	1.00	—
Hong Kong	0.85	1.09	0.83	0.94	48.8
Germany	0.74	1.08	0.92	0.75	57.0
Japan	0.68	1.22	0.90	0.62	63.9
South Korea	0.60	1.15	0.93	0.56	65.3
Argentina	0.38	1.11	0.78	0.44	66.5
Mexico	0.34	0.93	0.76	0.48	59.7
China	0.14	1.14	0.71	0.17	82.9
India	0.10	0.82	0.53	0.22	67.0
Malawi	0.02	1.11	0.51	0.04	93.6
Average	0.21	0.98	0.71	0.31	63.8

Source: Jones (2016)

(2) Simple Framework of TFP Differences

- What accounts for productivity differences across countries?
- One explanation is that poor countries are slow in adopting advanced technologies and best practices
- Another distinct but complementary explanation is that resources are not allocated to best uses among heterogeneous producers in poor countries causing misallocation
- Draws from Restuccia and Rogerson (2017)

(2) Simple Framework of TFP Differences

- In each period, a single good produced by M potential heterogeneous production units indexed by i
- Output y_i is produced according to

$$y_i = A_i \cdot h_i^{\gamma}, \qquad \gamma \in (0,1)$$

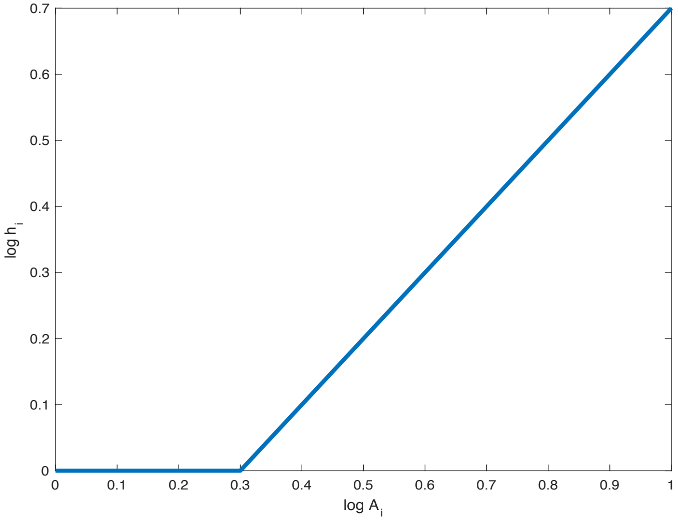
  where A_i reflects productivity differences across producers, h_i is labor input, and γ measures the extent of decreasing returns to scale at the establishment level
- Fixed cost of operation c in units of output

(2) Simple Framework of TFP Differences

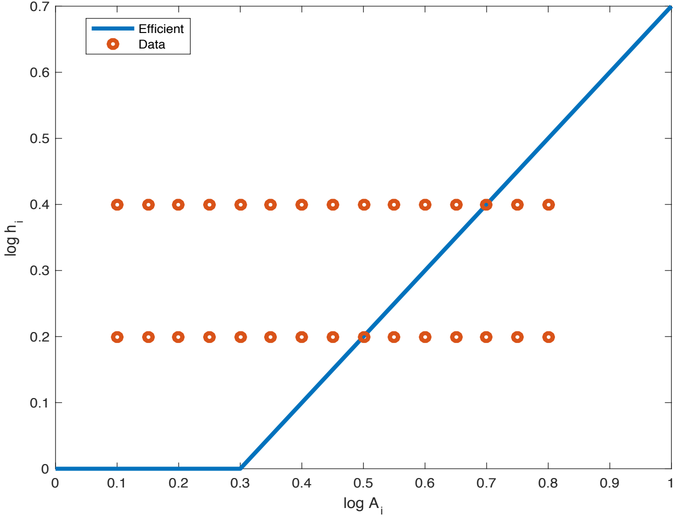
Efficient allocation:

- Consider the efficient allocation of labor across producers that maximizes aggregate output net of operation costs
- Given aggregate labor H, there is unique threshold $\bar{A}$ such that producers with $A_i \geq \bar{A}$ operate, producers with $A_i < \bar{A}$ do not operate
- Among operating producers, those with higher A_i are allocated greater amount of labor, producers with the same productivity operate at the same scale

Stylized Efficient Allocation



Stylized Misallocation



(2) Simple Framework of TFP Differences

- Holding the amount of aggregate resources constant, three channels can account for aggregate TFP differences across countries:
  - Distribution of A_i's differs across countries (technology)
  - Countries choose different set of producers to operate (selection)
  - Countries allocate inputs differently across producers (misallocation)
- All channels seem relevant
- Remark: specific policies/institutions generating misallocation can have larger effects on TFP by affecting technology/selection channels

Restuccia and Rogerson (2008)

- Study misallocation by extending the neoclassical growth model with production heterogeneity
- Focus on misallocation (no selection, fixed cost set to zero)
- Consider *idiosyncratic* policy distortions in the form of effective output taxes/subsidies τ_i

$$(1-\tau_i) = \frac{1}{A_i^{\theta}}\epsilon_i$$

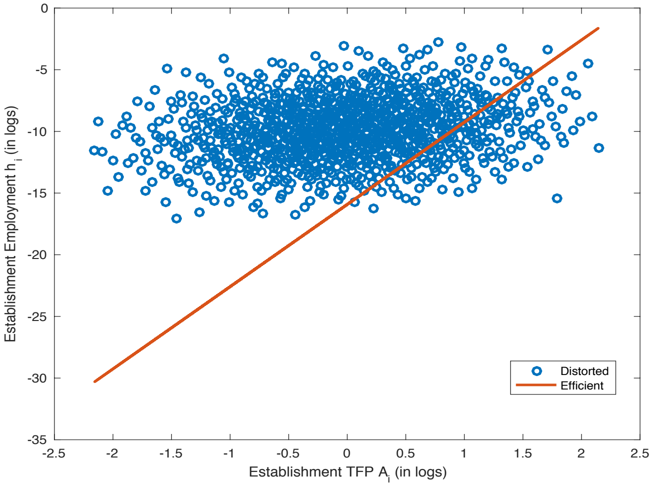
  where θ controls the elasticity of distortions with respect to productivity (correlated distortions) and ϵ_i reflects random idiosyncratic distortions (uncorrelated distortions)
- Assume ϵ_i log normally distributed with mean zero and standard deviation σ_ϵ

Restuccia and Rogerson (2008)

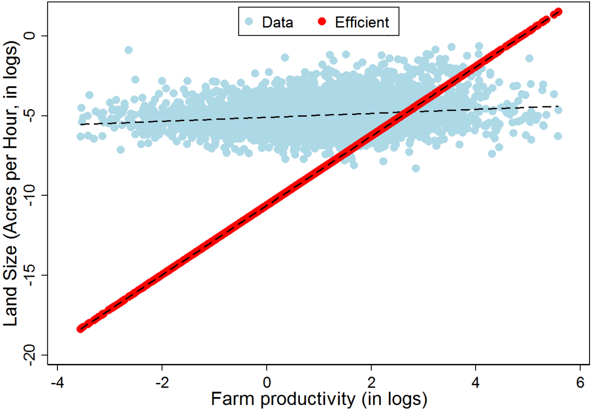
- Calibrate benchmark economy with no distortions ($\theta = 0, \sigma_\epsilon = 0$) to US data: key are moments of productivity distribution A_i (employment-size distribution or estimates of TFP)
- Study the impact of correlated and/or uncorrelated distortions on aggregate output and TFP
- For each economy (θ, σ_ϵ), report the ratio of TFP in the efficient allocation (benchmark economy) to the distorted economy

	θ		
σ_ϵ	0	0.5	0.9
0	1.00	1.10	2.02
0.1	1.03	1.12	2.07
0.4	1.23	1.43	2.72

Distorted Allocation ($\theta = 0.9, \sigma_\epsilon = 0.4$)



Land Misallocation in Malawi



- Restuccia and Santaeulalia-Llopis (2017): Efficient factor reallocation increases aggregate agricultural productivity by 3.4-fold

(3) Evidence of Misallocation

- An important insight of basic framework is that to maximize output, the marginal (or average) product of factors should equalize across producers of the same good

$$\underbrace{(1-\tau_i)\gamma\frac{y_i}{h_i}}_{\text{Value of marginal output}} = w$$

- In this context we can define Revenue Productivity as

$$\text{TFPR}_i \equiv \frac{y_i}{h_i} \propto \frac{1}{(1-\tau_i)}$$

- TFPR_i equalizes across producers in the efficient allocation (more productive establishments are larger) whereas in the distorted economy TFPR_i is higher for producers with higher distortions

(3) Evidence of Misallocation

$$\text{TFPR}_i \equiv \frac{y_i}{h_i} \propto \frac{1}{(1-\tau_i)}$$

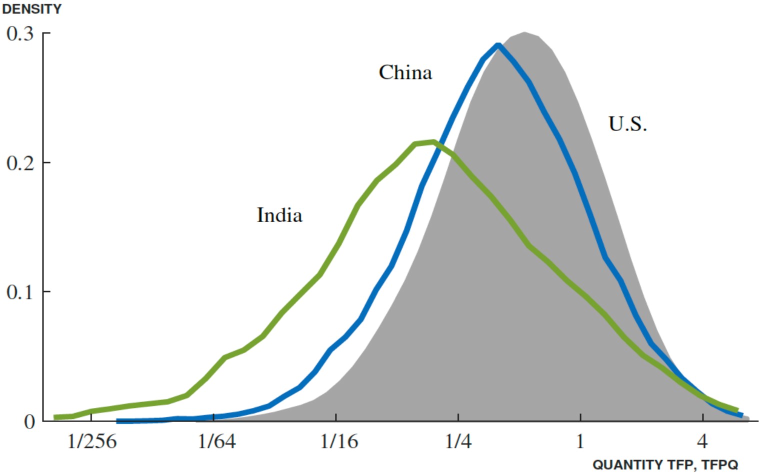
- Suggests two broad approaches to assess the empirical relevance of misallocation: indirect and direct
- Indirect: measure deviations in TFPR_i across producers using data on output and inputs
- Direct: Measure specific policies and institutions that generate $(1-\tau_i)$ differences
- Remark: The aggregate productivity cost of misallocation depends not only on dispersion in TFPR_i but also on dispersion of A_i (generally joint distribution)

Indirect Approach

- Assess extent of misallocation without identifying underlying cause: Hsieh and Klenow (2009)
- Evidence points to substantial misallocation and large TFP loses from misallocation

	SD (log TFPR_i)	TFP gains
China (1998)	0.74	115%
India (1991)	0.67	102%
India (1994)	0.67	128%
United States (1997)	0.49	43%

Figure 35: The Distribution of TFPQ in 4-digit Manufacturing Industries



Note: This is the average distribution of TFPQ within 4-digit manufacturing industries for the U.S. in 1997, China in 2005, and India in 1994, computed as described in the text. The means across countries are not meaningful. Source: Hsieh and Klenow (2009); data provided by Chang Hsieh.

Indirect Approach

- Evidence of misallocation from many other contexts/countries
- Recent World Bank study using census data for manufacturing in poor African countries (Cirera, Fattal-Jaef, and Maemir 2017)

	SD (log $TFPR_i$)	θ	TFP gains
Cote d'Ivoire	0.65	0.42	31%
Kenya	1.52	0.52	67%
Ghana	0.95	0.44	76%
Ethiopia	0.78	0.53	163%

Indirect Approach

- Approach useful in identifying relevant patterns (within industry, across industry, across time and space, across occupations, etc.)
- But is silent about the specific sources of misallocation
- Identifying causes of misallocation key for policy analysis
- There are also important limitations related to measurement and specification
    - Demand structure to separate price and output from revenue data (not an issue with plant-specific price deflators or when quantity data is available)
    - Specification of production structure
    - Inputs-outputs may be measured with error (Bils, Klenow, and Ruane 2017)
    - Adjustment costs vs. distortions (David and Venkateswaran 2017)

Direct Approach

- Quantifies role of specific policies/institutions creating misallocation either through quasi-natural experiments or via a structural model
- Some examples:
  - Regulation and discretionary provisions
  - Selective industrial policy
  - Financial frictions
  - Trade restrictions

Regulations

- Firing costs (Hopenhayn and Rogerson 1993)
  - Adjustment costs created by policy generating misallocation
  - Firing cost equivalent to 1 year's wages (prevalent in some OECD and developing countries) implies a TFP loss of 2%
  - Firing cost equivalent to 5 year's wages implies dispersion in TFPR of 0.19, correlation log TFPR and TFPQ of 0.76, and TFP loss of 8% (Hopenhayn 2014)
- Size-dependent policies (Guner, Ventura, and Xu 2008)
  - Distortions related to the size of the establishment (e.g. number of employees)
  - Large effects on number of establishments and average size
  - Relatively small effects on TFP

Financial Frictions

- Large literature, survey in Buera, Kaboski, and Shin (2015)
  - Credit constraints generate dispersion in the marginal product of capital across producers
  - Country-level institution, idiosyncratic effects: credit constraints disproportionally affect productive producers that should operate al larger scale
  - TFP loss from this type of misallocation can be large

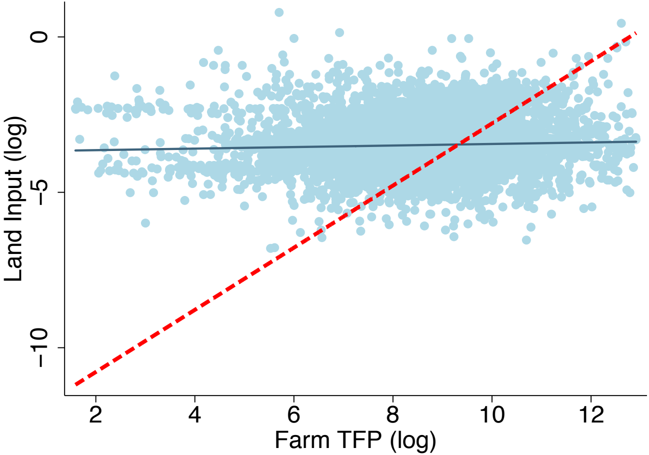
Causes of Misallocation

- Challenges of direct approach:
  - Many specific policies/institutions not easily amenable to direct measurement
  - Not a single source generating the bulk of misallocation and productivity differences across countries
  - Role of misallocation from specific policies quantitatively limited
  - Many different policies/institutions needed to account for the data
- Some notable exceptions:
  - Land market institutions in agriculture (Adamopoulos and Restuccia 2014)
  - Changes in policy over time in specific contexts

Land Market Institutions

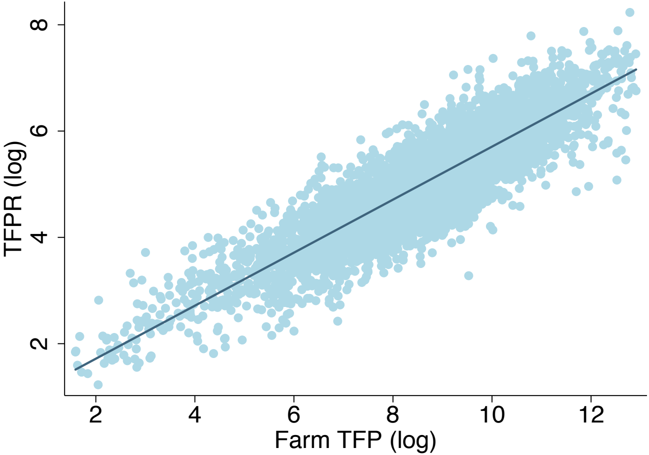
- Land institutions in poor countries characterized by:
  - Lack of well-defined property rights over land
  - Land use-rights are distributed in a fairly egalitarian basis...
  - ...coupled with difficulty of adjusting operational scales
- As a result, land not allocated to best uses, leading to small operational scales, preventing the adoption of best practices and investment in farm operations
- Evidence points to substantial land (and factor) misallocation in agriculture in poor and developing countries

Land Misallocation in China



- Adamopoulos, Brandt, Leight, and Restuccia (2017): Factor misallocation in agriculture has not decreased in China (1993-2002)

Implicit Agricultural Distortions in China



- Large implied correlated distortions in the agricultural sector $\sigma(\log(\text{TFPR}))$=0.97, $\rho(\log(\text{TFPR}),\log(\text{TFP}))$=0.88

Aggregate Implications

- Productivity impact of distortions:
  - Eliminate distortions in agricultural sector in China
  - Result: TFP gain 1.8-fold (Adamopoulos et al 2017)
  - Take US manufacturing distribution of A_i's from Hsieh-Klenow
  - Apply China distortions in agriculture from Adamopoulos et al (2017)
  - Result: TFP gain 4-fold
  - Instead apply China distortions in manufacturing
  - Result: TFP gain 1.6-fold
- Remarks
  - Much larger distortions (misallocation) in agriculture
  - Differences in productivity distribution important
  - Heavier distortions to more productive units prevalent in poor countries, key for broader implications of misallocation

Changes in Policy in Specific Contexts

(1) Land reform in Philippines (Adamopoulos and Restuccia 2015)

- Cap in farm size + gov. intervention in the land market (direct excess land to landless/smallholders, restrict reallocation)
- Reform reduces farm size (34%) and aggregate productivity (17%), gov intervention key as market reallocation of excess land generates only 1/3 of the negative effects

(2) Trade reform in Chile (Pavnick 2002)

- Liberalized trade reform on productivity using plant-level data, exploiting differential exposure to external competitive pressure
- Plants in import competing sectors grew 3-10% more than plants in the non-traded sector
- Reallocation of resources from less to more efficient plants and through plant exit contributed substantially to aggregate productivity growth during the period

(4) Broader Consequences of Misallocation

- Early misallocation analysis: given a fixed productivity distribution common across countries, assess quantitative impact of factor misallocation (e.g. Restuccia and Rogerson, 2008)
- Recent work considers dynamic implications of misallocation
- Policies/institutions causing misallocation can generate larger effects on aggregate productivity by altering the productivity distribution via technology and selection channels

(4) Broader Consequences of Misallocation

- Distribution of A_i's differs across countries (technology, selection, sample selection?)
- Consider accounting from simple parametric framework discussed earlier and moments from micro/aggregate data in Hsieh and Klenow (2009)
- TFP gain of eliminating distortions China/India relative to US distortions is 60% (half of actual TFP differences)
- Only half (30%) when China/India relative distortions applied to US productivity distribution
- A rough TFP decomposition in manufacturing: misallocation (1/4) + selection (1/4) + technology (1/2)
- Substantial shifts in the productivity distribution via technology/selection required

(4) Broader Consequences of Misallocation

Some illustrative examples (misallocation + selection):

- Financial frictions (Buera, Kaboski, and Shin 2011; Midrigan and Xu 2014)
  - Distorts entrepreneur-worker choices in addition to misallocation
  - Generates large negative effects on productivity
  - Can account for 40% of non-agricultural productivity differences across countries

(4) Broader Consequences of Misallocation

Some illustrative examples (misallocation + selection):

- Trade liberalizations
  - Selection effects important in all the empirical studies of trade liberalizations (also important productivity effects of incumbents)
    - Pavcnik (2002) for Chile
    - Trefler (2004) for the Canada-US Free Trade Agreement
    - Eslava, Haltiwanger, Kugler, and Kugler (2013) for Colombia
  - Khandelwal, Schott, and Wei (2013): elimination of export quotas on Chinese textile and clothing by US, EU, and Canada in 2005, particularly government allocation of quotas to less productive state-owned enterprises; large TFP gain, 70% due to quota misallocation (selection)

(4) Broader Consequences of Misallocation

Some illustrative examples (misallocation + selection):

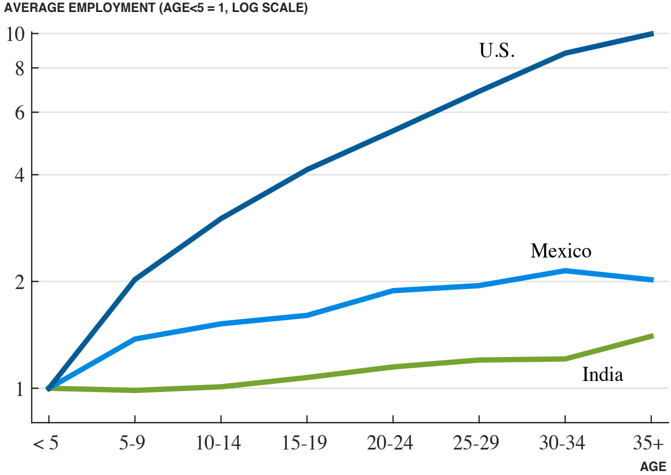
- Imperfect land markets (Adamopoulos, Brandt, Leight, and Restuccia 2017)
  - Pattern of implicit distortions affect sector choice of highly productive farmers in addition to misallocation
  - In China a 1.8-fold TFP gain in agriculture from eliminating misallocation translates into a 15-fold gain when accounting for selection

(4) Broader Consequences of Misallocation

Some illustrative examples (misallocation + technology):

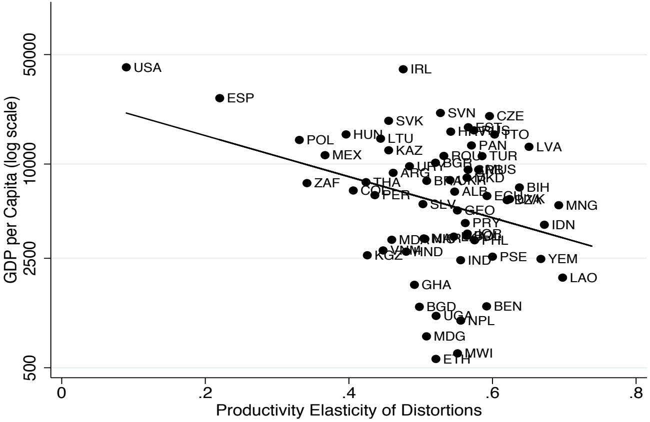
- Trade liberalization and technology upgrading (Bustos 2011)
- Technology adoption and difussion (Ayerst 2016)
- Productivity investment and firm dynamics

Plant Life-Cycle Employment Growth



- Source: Hsieh and Klenow (2014)

Productivity Elasticity of Distortions



- Source: Bento and Restuccia (2017)

Productivity Investment and Firm Dynamics

- Bento and Restuccia (2017) Standard monopolistic competition framework extended to include: endogenous entry and entry-level and life-cycle productivity investment

Prod. elasticity of distortions:	0.09 (US)	0.50 (India)
Average Establishment Size	22	3
Entrant Productivity	1.00	0.42
Life-cycle growth (%)	5.0	2.1
Prod. investment share (%)	13.5	5.4
Decomposition of agg. output:		
(a) Static misallocation	1.00	0.63
(c) Endogenous life-cycle growth	1.00	0.70
(d) Entrant investment	1.00	0.47

Conclusion

- Productivity at the core of cross-country differences in aggregate economic outcomes
- Misallocation quantitatively important in accounting for productivity differences but...
- ...there is not a single source of misallocation that can account for the bulk of differences
- Current work shows important link between misallocation and technology/selection channels in accounting for productivity differences
- More work is needed in quantifying the dynamic implications of misallocation