# Big Push in Distorted Economies

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# Motivation

Krugman (1995), "The Fall and Rise of Development Economics"

- Rosenstein-Rodan (1943), Hirschman (1958)
- Murphy, Shleifer and Vishny (1989), "Industrialization and the Big Push"
  - Multiple equilibria and coordination failure

Our paper

- Quantitative approach
- Multiple equilibria? An extreme form of *amplification*
- Big Push without multiple equilibria

# Road Map

1. Model of firm entry, technology adoption, input-output linkage, idiosyncratic distortions
   - Standard model of firm entry and technology adoption
   - Elements of Murphy et al. (1989), Matsuyama (1995), Ciccone (2002), Jones (2011)
2. Quantitative exploration
   - Guided by aggregate and microdata from the US and India
3. Questions
   - Is development a story of coordination failures? NO (even though multiple equilibria are possible)
   - Can there be large effects of distortions and policies? YES, in Big Push region, even without multiple equilibria

# Model Economy: Summary

- Ex-ante heterogeneous potential entrants, $z \sim F(z)$
- Monopolistically competitive, differentiated goods
- Idiosyncratic correlated distortions , $\tau(z) = 1 - \tau z^{-\xi}$
- Labor cost of entry, labor and goods cost of adoption
- Produce using labor and intermediate inputs

# Intermediate Aggregate/Final Good Producers

- CRS technology using differentiated intermediates $j \in [0,1]$

$$X = \left[ \int y(j)^{1-\frac{1}{\eta}} dj \right]^{\frac{\eta}{\eta-1}}$$

- Used for final consumption, intermediate inputs, and for adoption investment

$$C + \int x(j) dj + \# \text{ of adopters} \times \kappa_a = X$$

# Intermediate Good Producers

CRS technologies $i \in \{t, m\}$

$$
\begin{aligned}
y =& f_i(z, x, l) \\
=& z \underbrace{\frac{A_i}{\nu_i^{\nu_i}(1-\nu_i)^{1-\nu_i}}}_{\bar{A}_i} x^{\nu_i} l^{1-\nu_i}, \ \bar{A}_t < \bar{A}_m, \ \nu_t \leq \nu_m
\end{aligned}
$$

,

- $z$: heterogeneous productivity
- $x$ : intermediate input
- $l$ : labor input
- Modern, $A_m$, labor entry costs $\kappa_e$, and goods costs of adoption $\kappa_a$
- Traditional, $A_t$, only labor entry cost $\kappa_e$

# Intermediate Good Producers' Problem

Monopolistically competitive

$$\pi_i^o(z) = \max_{p,x,l} \tau z^{-\xi} p \underbrace{\left(\frac{P}{p}\right)^{\eta} X}_{q} - Px - wl$$

s.t.

$$f_i(z,x,l) \geq q.$$

# Equilibrium: $P$, $w$, $z_e$ and $z_a$ such that

The marginal entrant $z_e$

$$\pi_t^o(z_e) = w\kappa_e;$$

The marginal adopter $z_a$

$$\pi_m^o(z_a) - \pi_t^o(z_a) = P\kappa_a;$$

Labor market clearing

$$\int_{z_e}^{z_a} l_t(z)dF(z) + \int_{z_a}^{\infty} l_m(z)dF(z) = L - (1 - F(z_e))\kappa_e$$

The price of the intermediate aggregate

$$P = \left[\int_{z_e}^{z_a} p_t(z)^{1-\eta}dF(z) + \int_{z_a}^{\infty} p_m(z)^{1-\eta}dF(z)\right]^{\frac{1}{1-\eta}}$$

# Complementarity

When more firms adopt the productive technology, for the marginal firm:

1. Its output price falls
2. Demand for its output increases
3. Adoption cost falls

If 2+3 stronger than 1, gains from adoption increases in the number of adopters: *complementarity* in adoption decisions.

Complementarity stronger when

1. Differentiated goods less substitutable
2. Smaller heterogeneity in firm productivity (correlated idiosyncratic distortions)
3. Higher intermediate input intensity of the productive technology

# Amplification & Multiplicity

- $\Delta\pi(z,a,s) \equiv \pi_m^o(z,a) - \pi_t^o(z,a) - (1-s)P(a)\kappa_a$
  (gain from adoption for $z$ when fraction $a$ adopted, given subsidy $s$)

- Equilibrium "best response" mapping

$$T(a) = \{a' | a' = (1 - F(z)) \text{ and } \Delta\pi(z,a,s) = 0\}$$

- Multiplier:

$$\frac{\overbrace{dz/ds}^{\text{total effect}}}{\underbrace{dz^d/ds}_{\text{direct effect}}} = \frac{1}{\underbrace{1 - \frac{\Delta\pi_a(z,a,s)f(z)}{\Delta\pi_z(z,a,s)}}_{=T'(a)}}$$

- Amplification if $T'(a) > 0$

# Amplification & Multiplicity

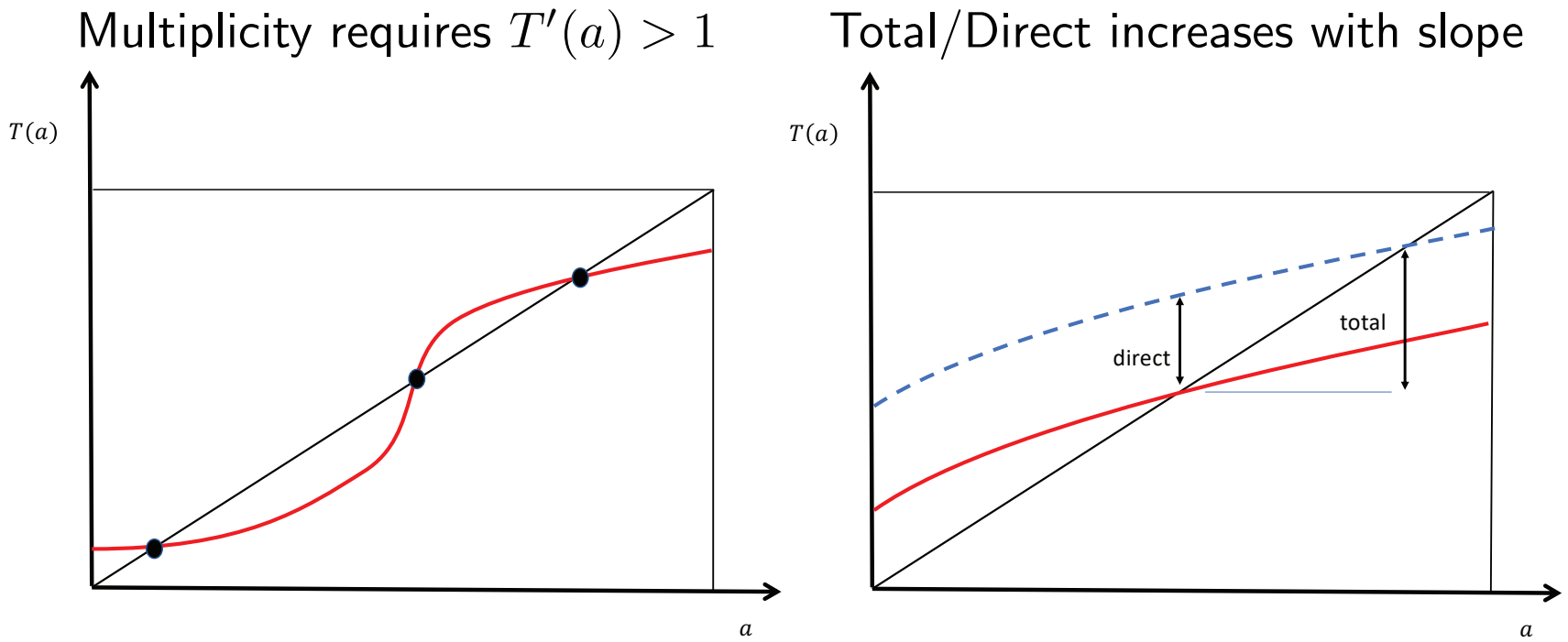



Figure: Equilibrium Mapping and Amplification

# Amplification & Multiplicity

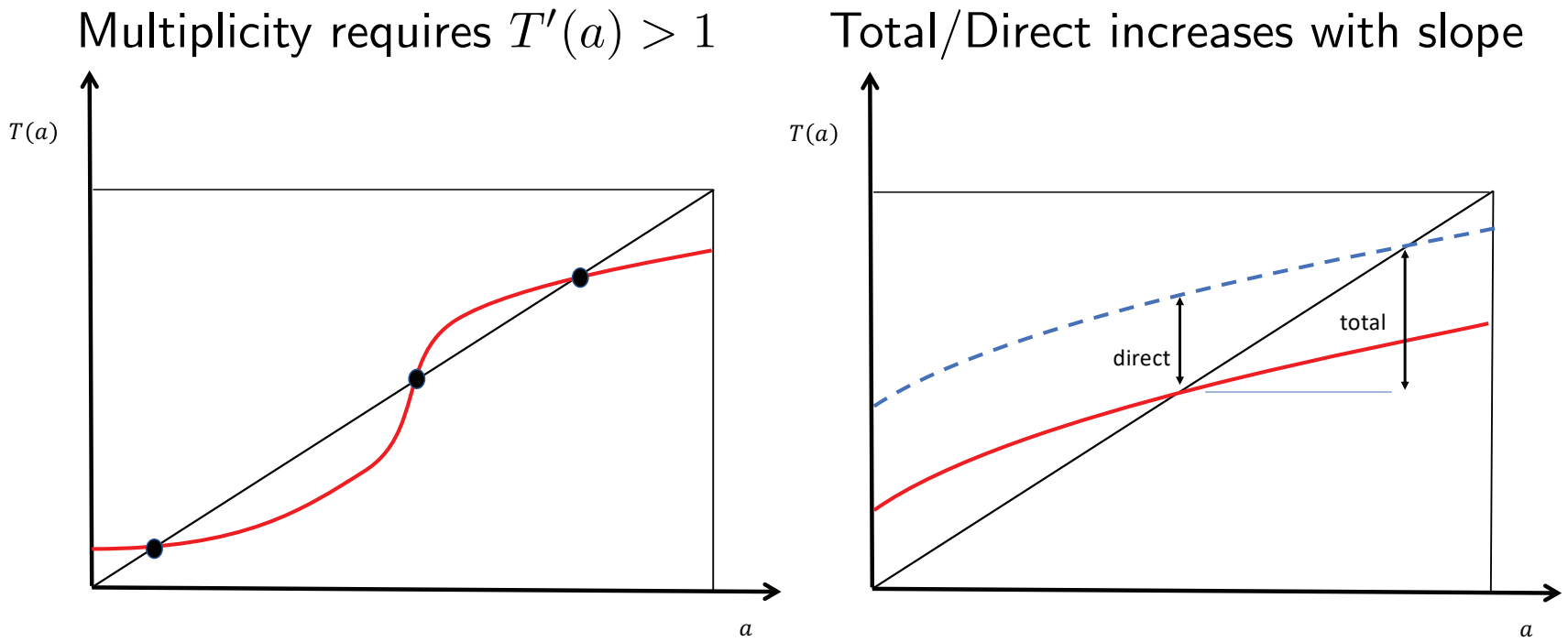



Figure: Equilibrium Mapping and Amplification

- Even with no multiplicity amplification could be very strong

# Quantitative Exploration

1. Calibrate the model with US plant/firm level data
2. Given $\zeta$, choose distortions ... to match data from India
3. Explore set of equilibria, in the calibrations and more broadly
4. Quantify the role of coordination failures on GDP
5. Explore how complementarities amplify effect of distortions and policies

# Calibration

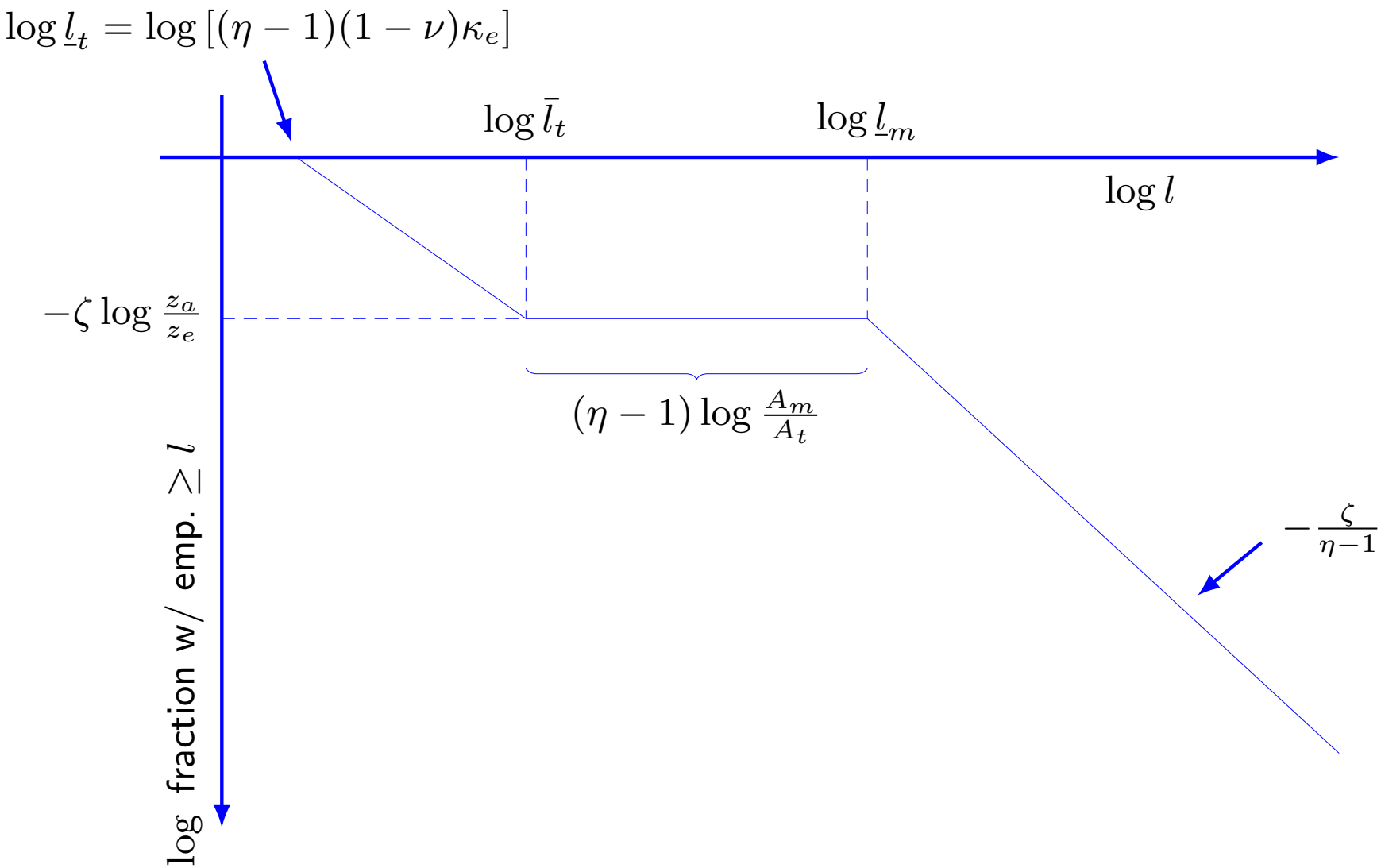
$$(\underbrace{A_m, \eta, \nu_t, \nu_m, \zeta}_{\text{common}}, \underbrace{A_t, \kappa_e, \kappa_a, \xi}_{\text{country specific}})$$

- $A_m$ normalized to $1$
- $\eta = 3$, on the lower side in the literature
- $(\nu_t, \nu_m)$ jointly determine aggregate share of intermediate goods.
  - $\nu_t = 0$ chosen to maximize gap in US benchmark (multiple equilibria)
- $(\zeta, \kappa_e, \kappa_a, \xi)$ chosen to match size distribution ($\xi = 0$ for US)
- Point identification with data on the size distribution of firms identification
- Key identification assumption: both technologies are observed in equilibrium

calibration details

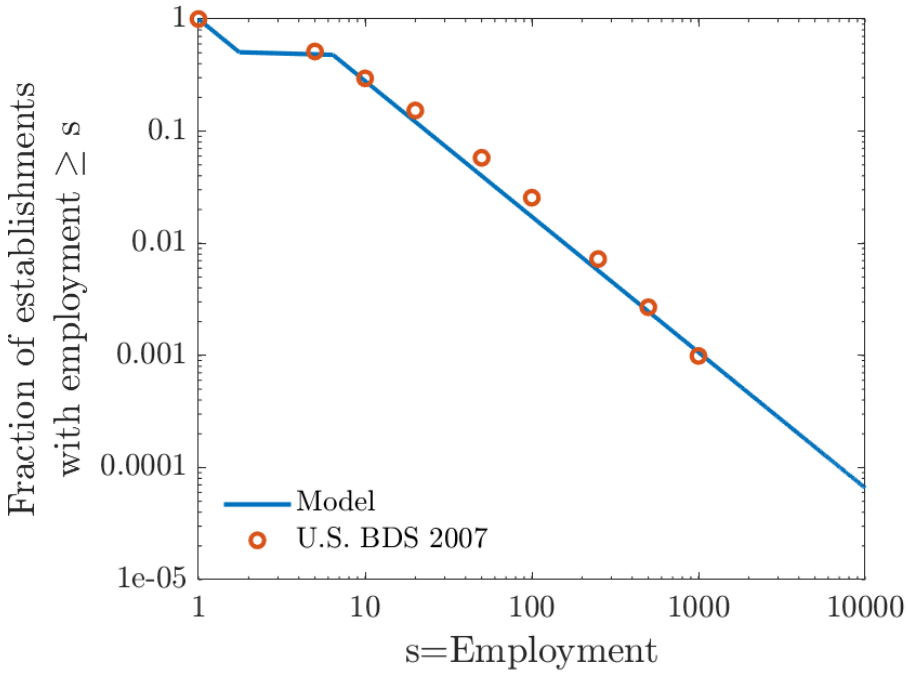
# Identification: given $\eta$, $\nu_t = \nu_m$, and $\xi = 0$

Figure: Identification from the establishment size distribution

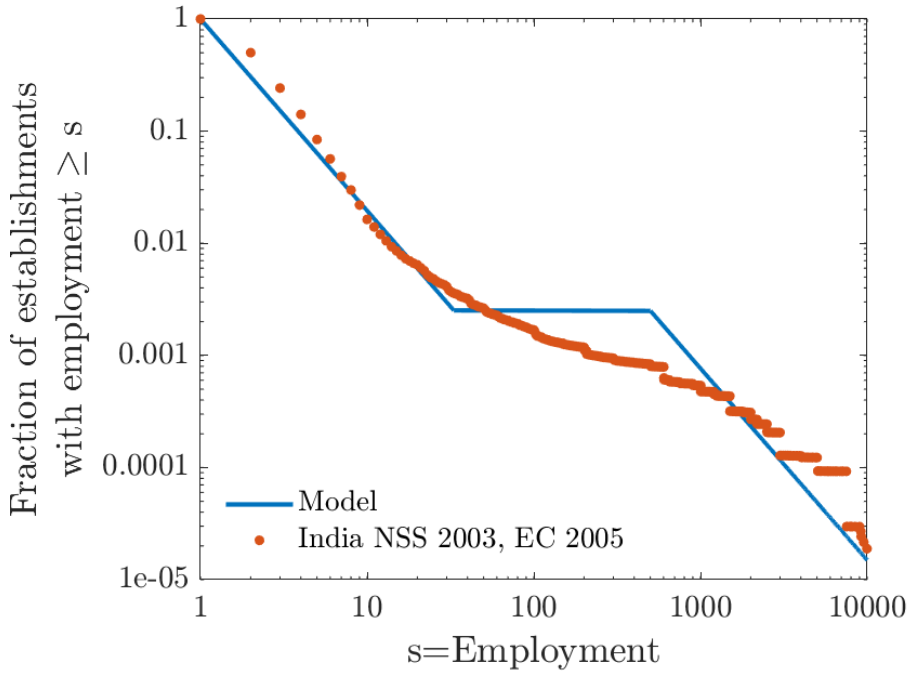


# Establishment Size Distribution: Model and Data

US




India




India: data from Buera/Fattal-Jaef/Laski/Trachter

# Aggregate Moments

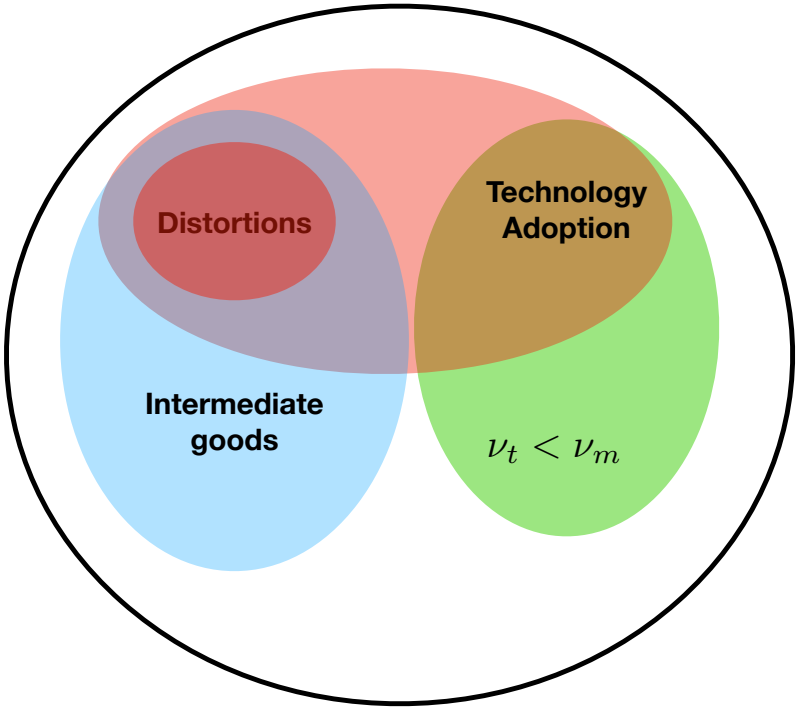
| | US | India |
|---|---|---|
| Fraction of active firms (out of 1) | 0.05 | 0.17 |
| Fraction of active firms that adopt $A_m$ | 0.5 | 0.003 |
| Average establishment size | 19.0 | 5.7 |
| Aggregate Consumption | 3.92 | 0.54 |

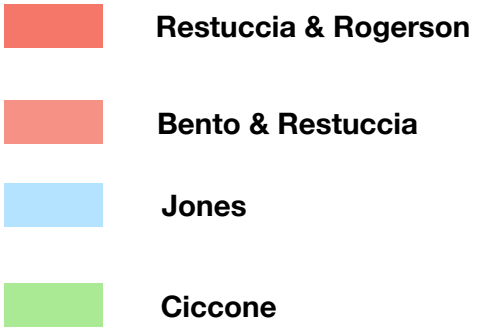
- Income gap:
  - India's GDP per worker in 2005 is 6% of US (Penn World Tables)
  - Model implies India's GDP to be 15% of US (not targeted)

# Explaining Consumption Differences

| | US w/ Indian Parameters | India w/ US Parameters |
|---|---|---|
| Benchmark | 1.0 | 0.14 |
| Adoption cost, $\kappa_a$ | 0.37 | 0.71 |
| Degree of distortions, $\xi$ | 0.41 | 0.34 |
| Traditional technology, $A_t$ | 1.03 | 0.19 |

# Unpacking the Amplification

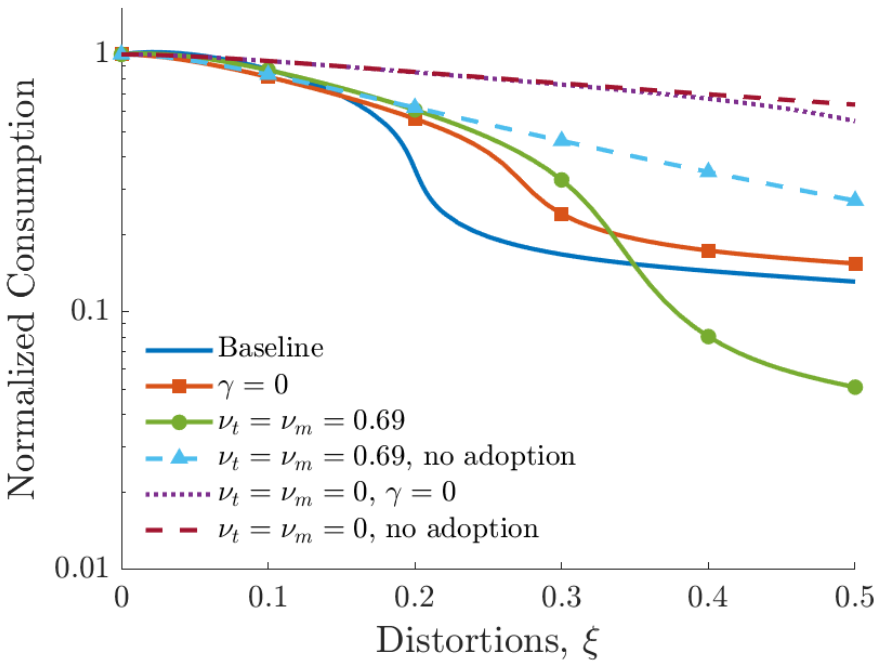


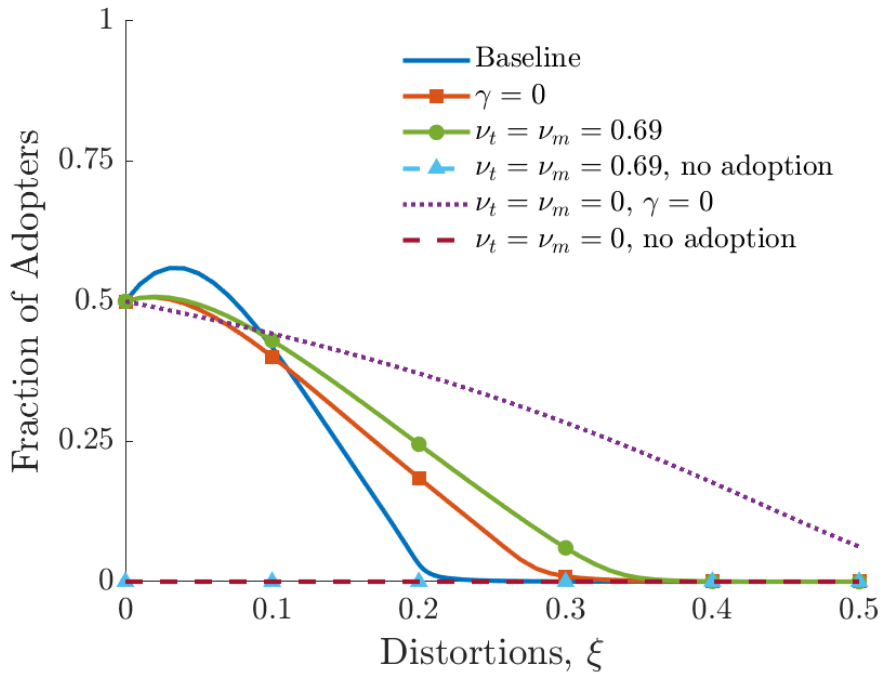
# Unpacking the Amplification

## United States

### Consumption




### Adoption




**Different cases in Figures**

From Bottom:

US baseline, solid

Labor cost of adoption, solid square

Removing Ciccone (2002), solid circle

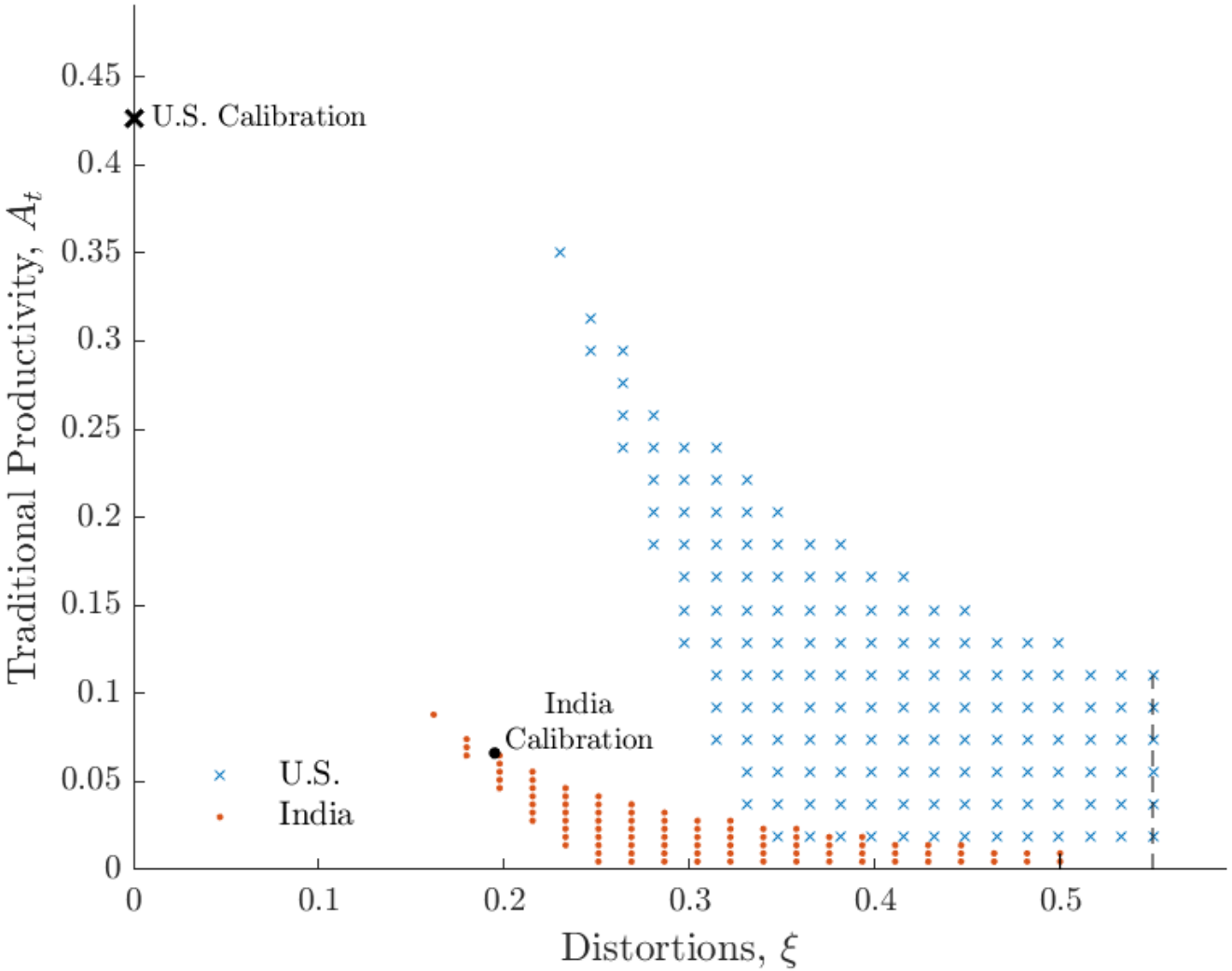
From Top:

Restuccia-Rogerson (2008), dashed

Bento-Restuccia (2017), dotted

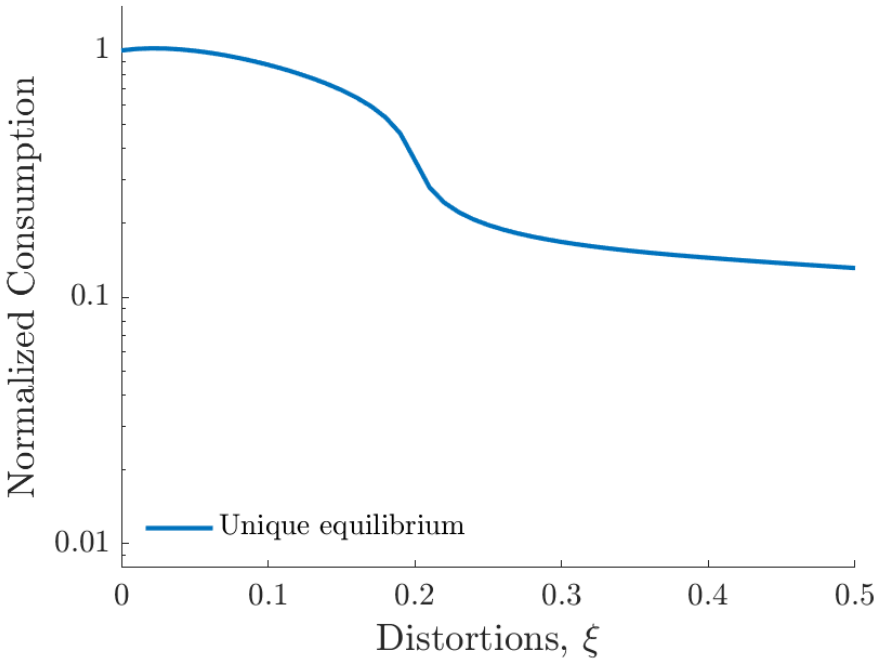
Jones (2011), dashed triangle

# Region of Multiple Equilibria

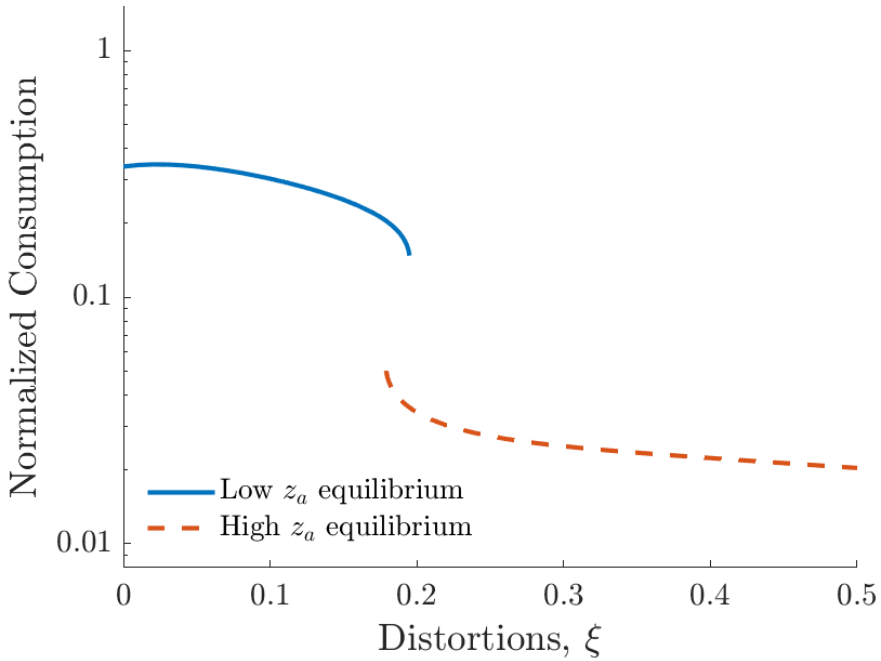


# Distortions, Multiple Equilibria, and Income

US




India

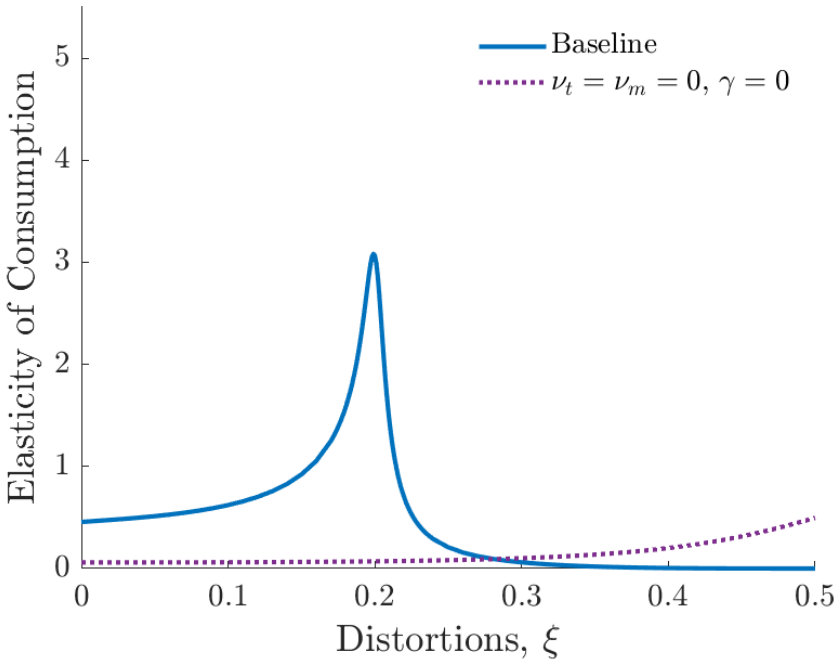



Note: We normalize the GDP to 1 for the US equilibrium with no distortions.

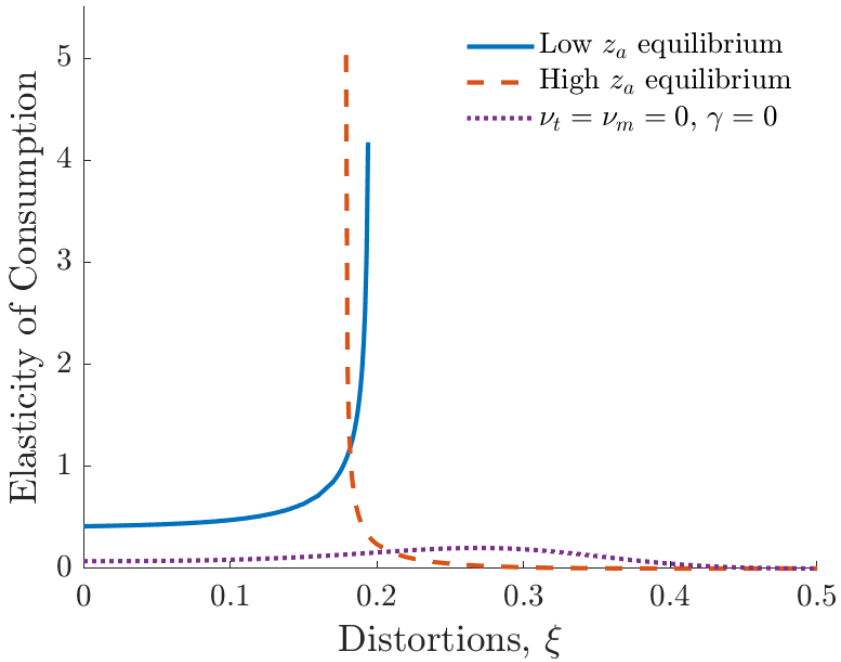
# Industrial Policy, Distortions, and the Big Push

- Subsidize the price of the adoption good: $P\kappa_a \implies (1-s)P\kappa_a$

US




India



# Taking Stock

- Do coordination failures explain the US-India income gap?
  NO (even though multiple equilibria are possible) but amplification in our model explains a big part of it.

- Can there be large effects of distortions and policies?
  YES, in the Big Push region

  - Complementarities $\Longrightarrow$ Feedbacks, amplifying the effect of distortions/policies, with or without multiplicity