Land Market Frictions in Developing Countries: Evidence from Manufacturing Firms in India

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Introduction

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- Literature Reasons: mismanagement (Bloom et al., 2013),
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- New Reason: land market frictions
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    - Inheritance system: land bequeathed from father to all sons
  - Unclear land titles
  - Land aggregation difficult:
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  - Land aggregation difficult:
    - Hundreds of negotiations, high chances of legal challenges
- Issue in India, Bangladesh, Nepal, Vietnam, Ghana, Ethiopia

Motivating Example: Land Aggregation US vs. India

- **US**:
  - Median non-residential land parcel size is 234 acres
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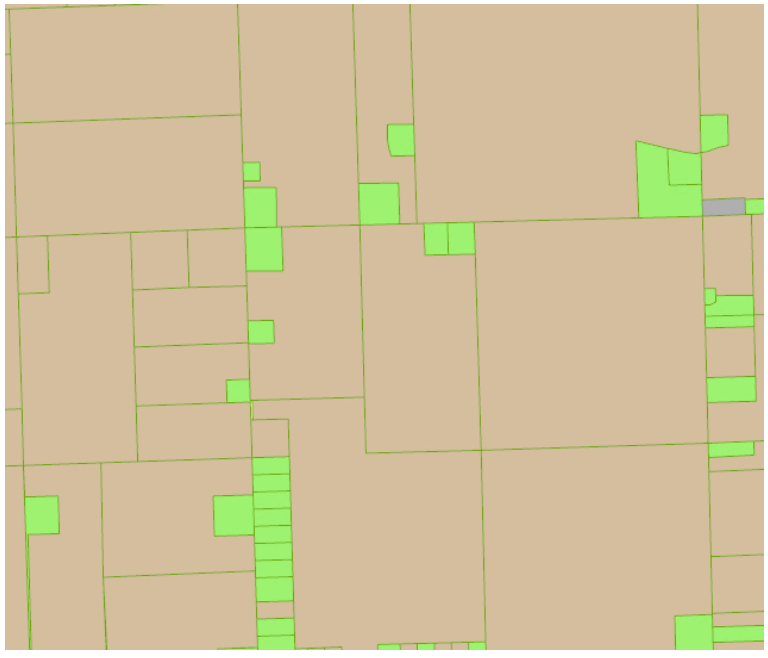
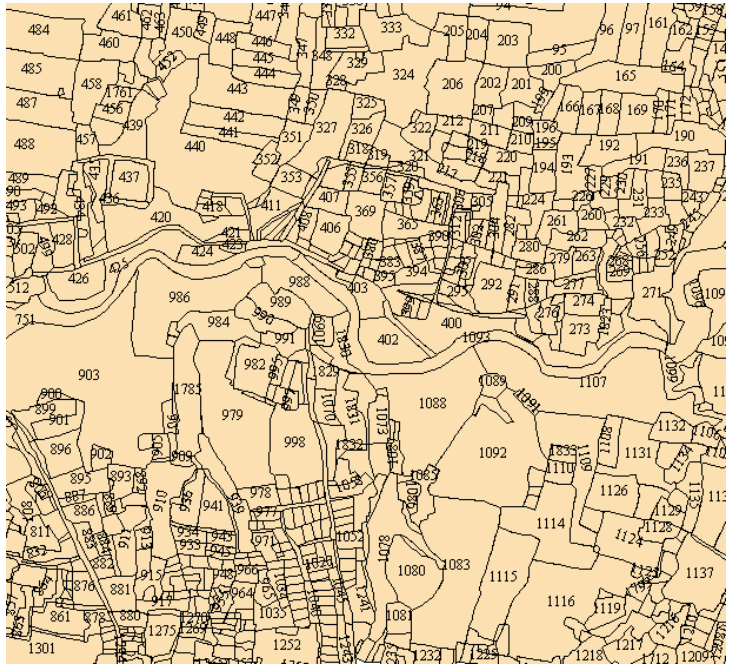
- **India**:
  - Average parcel 5.7 acres (1971) $\rightarrow$ 2.8 acres (2011)
  - Tata Nano car plant: aggregated 997 acres from 13,970 parcels (12,000 owners) (Ghatak et al., 2013)

Land Parcels: One Square Mile in U.S. vs India



Fort Wayne (GM)



Singur (Tata Nano)

▸ Average Parcel Size across States over Time

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- **Research design:**
  - Novel establishment panel data with land investment info
  - Dynamic structural establishment land acquisition model
    - Infer land aggregation costs from establishment land adjustment behavior (*bite size* and *frequency*) using **revealed preference**
  - Estimate land input elasticity: production function estimation: (Ackerberg et al, 2015)
  - Policy experiments:
    - Eminent domain restrictions in 2015
    - Policy discussion now: land pooling policies

Related Literature

- **Hindrance to growth in Indian manufacturing:** mismanagement (Bloom et al., 2013), labor frictions (Besley & Burgess, 2004), misallocation (Banerjee & Duflo, 2005; Hsieh & Klenow, 2009), land misallocation (Duranton, Ghani, Goswami and Kerr, 2015)
- **Land frictions in India:** agriculture (see Bolhuis et al., 2021; Manjunatha et al., 2013), urban development (Harari ,2020; Gandhi et al., 2021, Gechter & Tsivanidis, 2022), case studies on land aggregation (Ghatak and Mookherjee, 2014; Ghatak et al, 2013)
- **Land fragmentation and property rights across the globe:** development (De Janvry et al., 2015; Feder & Feeny, 1991; Deininger & Feder, 2001), land regulation (Herkenhoff et al, 2018; Glaeser & Ward, 2009, Hsieh & Moretti, 2019)
- **Methodology:** adjustment costs literature (Caballero, 1999; Ryan, 2012), production function estimation (Ackerberg et al, 2015)

Outline

Data (1/2)

Combine establishment panel with land adjustments + land parcel distribution

- Establishment balance-sheet for manufacturers from Annual Survey of Industries (ASI)
  - Census for employment > 100, 1/3-1/2 sample for emp. > 10
  - Panel of 48,516 establishments [1999-2015]

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  - Census for employment > 100, 1/3-1/2 sample for emp. > 10
  - Panel of 48,516 establishments [1999-2015]
- Features:
  - Sales, labor, material inputs, entry date, other characteristics
  - Location anonymized at state level
  - Ownership structure: private or government affiliated
- Key feature: Capital stock *disaggregated* into land, buildings, plants and machinery, and other fixed assets.

▸ Determination of Baseline Sample

Data (2/2)

- Data on land:
  - Land separate from building
  - Opening and closing book value of land
  - Additions, sales separate from revaluations

	Opening Value	Addition	Revaluation	Closing Value
Est. A	100	50	0	150
Est. B	100	0	50	150

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  - Can capture friction effects on land prices, not directly estimate it
- Agricultural census data (1995, 2000, 2005, 2010, 2015):
  - Size distribution of land parcels across regions

▸ Manufacturing Summary Stats ▸ Land Adjustment over Time

Small Bite Strategy

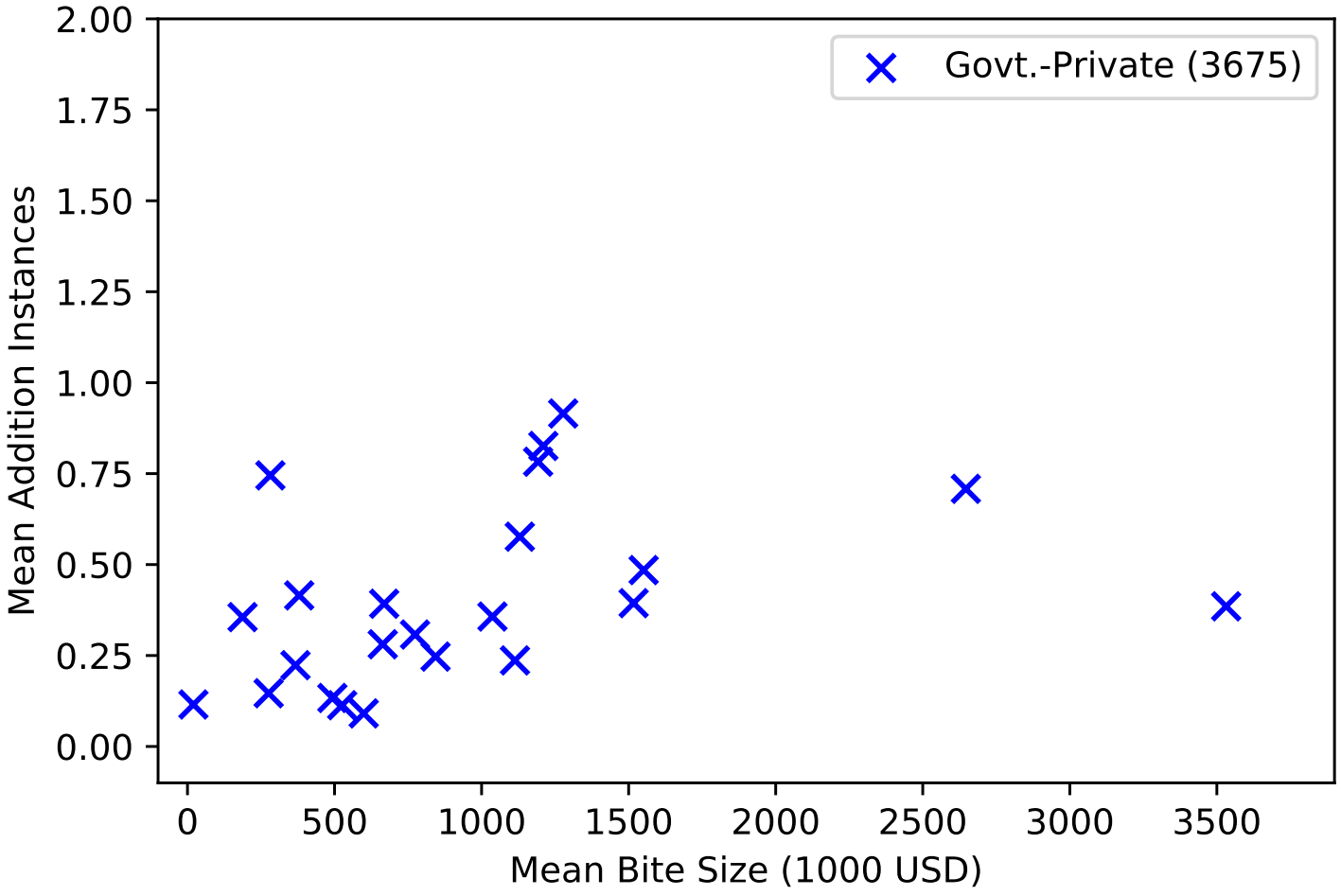
- Land friction environment differs across:
  1. Ownerships: Govt. affiliated establishments (8%) eminent domain (BCG, 2014)
  2. States: Heterogeneity in land policies, parcel size, land records
- Hypothesis: land agg. behavior differs across ownerships, regions
- Response of establishments:
  - Hard to get land in one go, aggregate in small bites over time
  - *Small bite strategy*
    - Private establishments
    - Establishments in regions with smaller parcels
- Ownership, regional variation to identify land aggregation costs
- Govt. affiliated establishments as benchmark: outcome with lower frictions

Evidence for Small Bite Strategy and Effect of Frictions

- **Small bite strategy:** smaller bite size, higher bite frequency
  - Bite size: mean land add value
- Land bite strategy different across:
  - Ownership: private establishments follow small bite strategy
  - Smaller parcels in state: small bite strategy
- Aggregation is gradual, can take years:
  - 25% establishments sit on land for 5 years or longer ▸ Time to aggregate

▸ Land Bites to Meal

Government vs Private Discrepancy in Land Bite Strategy



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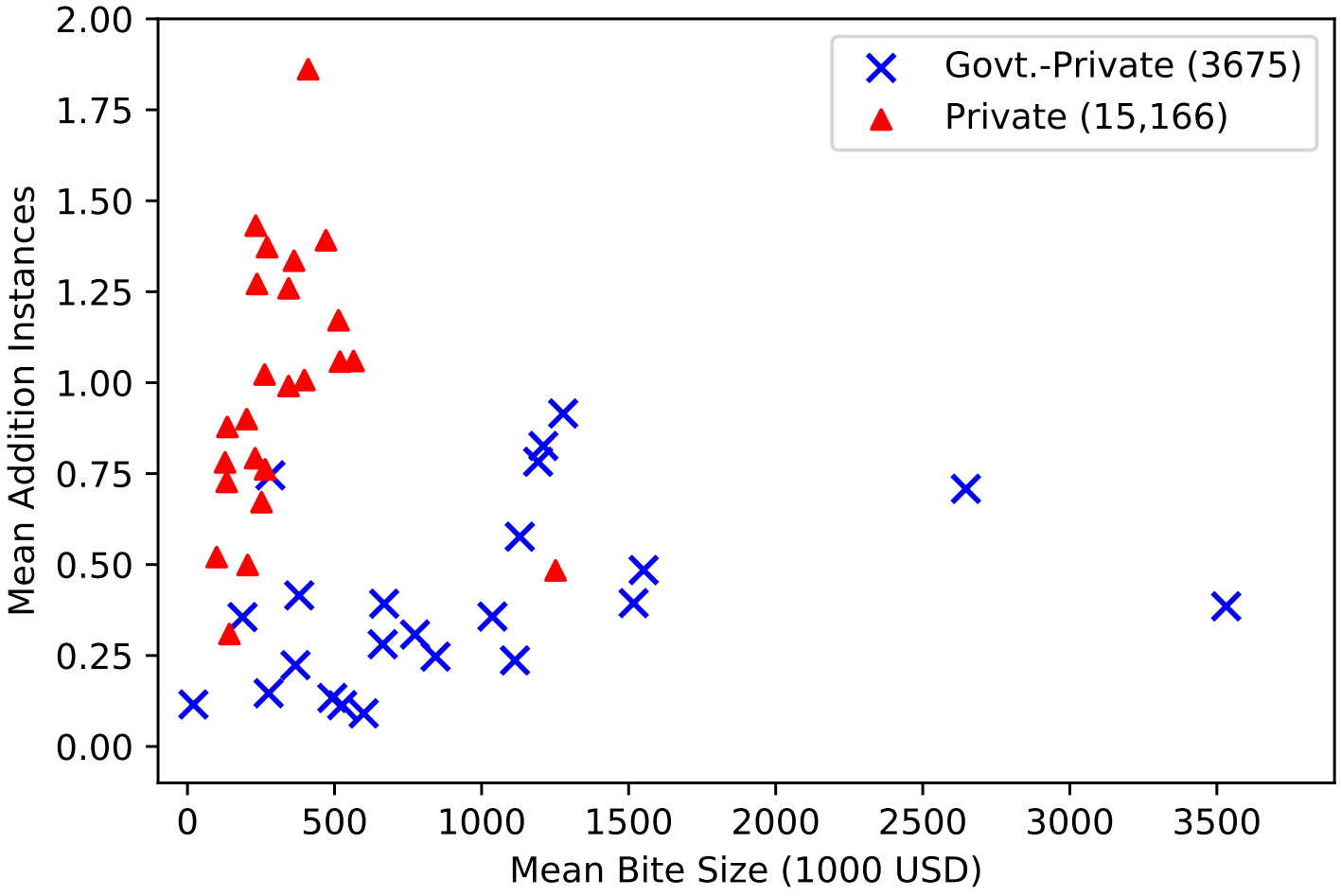

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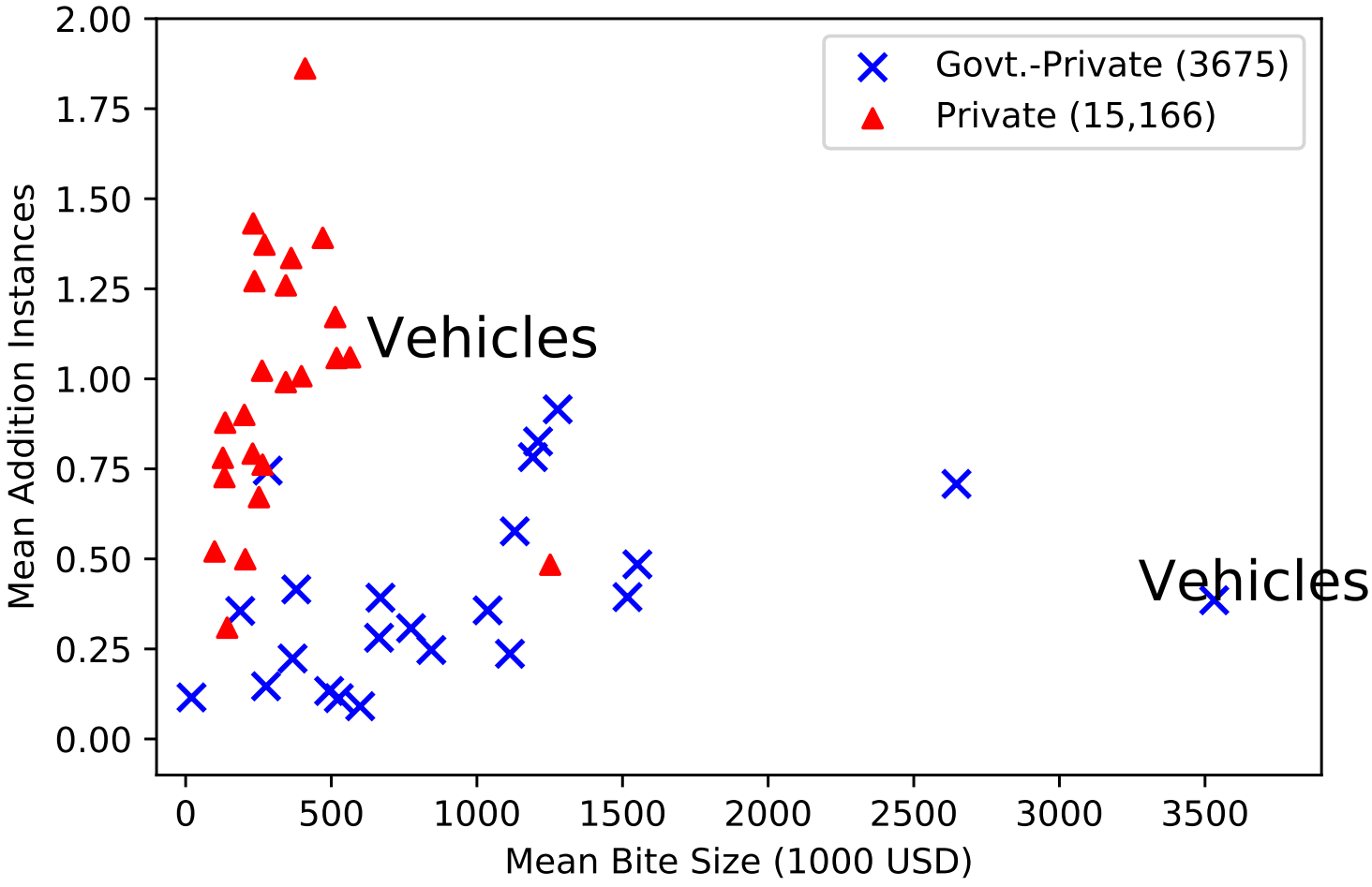

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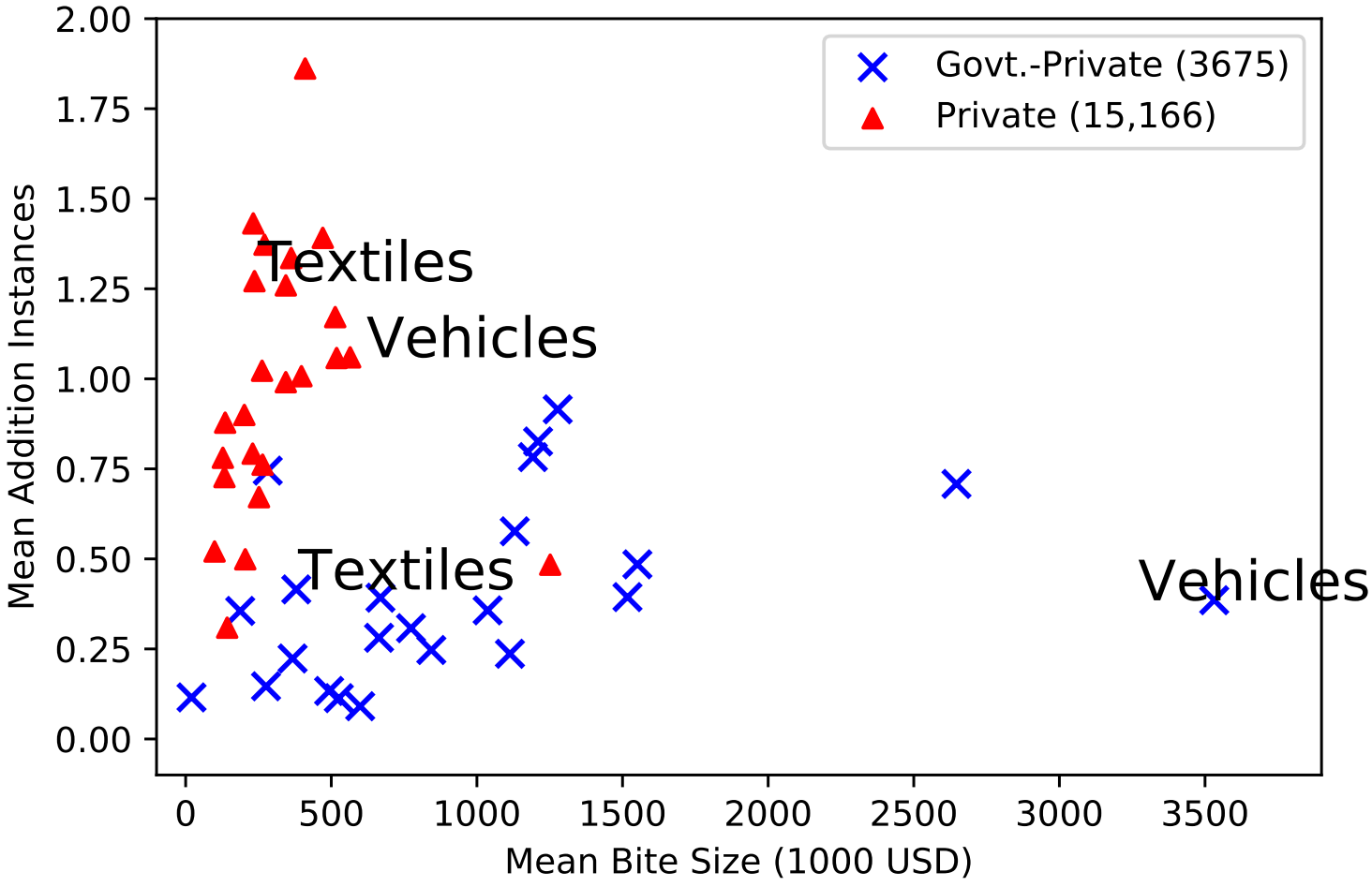

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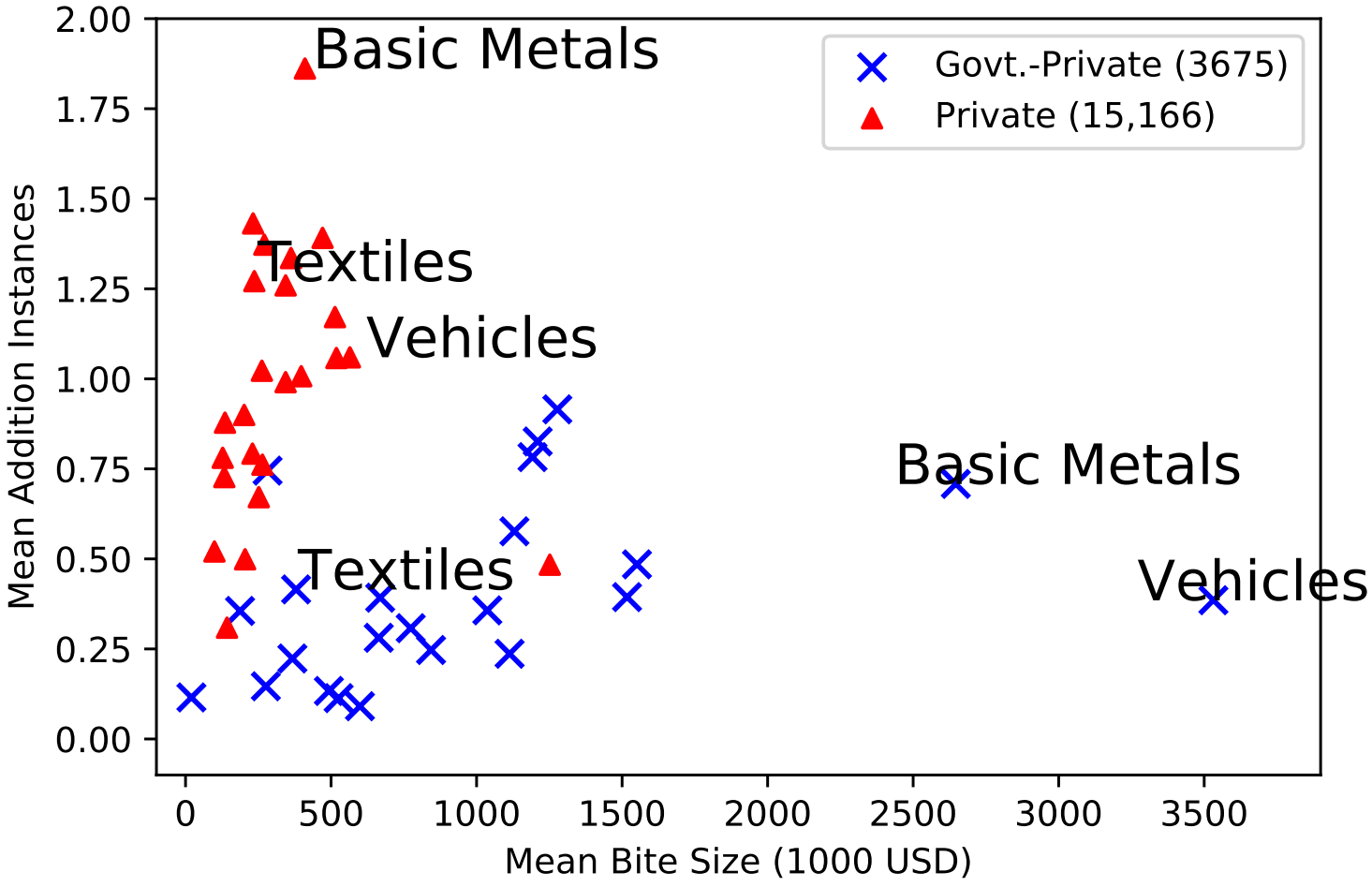

Land Bite Strategy: Across States

State	Mean Parcel Size (acres)
Bihar	0.43
West bengal	0.79
Uttar Pradesh	0.80
Tamil Nadu	0.83
Assam	1.11
Andhra Pradesh	1.20
Maharashtra	1.46
Chhattisgarh	1.51
Karnataka	1.63
Madhya Pradesh	2.02
Gujarat	2.20
Haryana	2.24
Rajasthan	3.39
Punjab	3.95

Land Bite Strategy: Across States

State	Mean Parcel Size (acres)	Mean Bite Size ($1000)
Bihar	0.43	256
West bengal	0.79	516
Uttar Pradesh	0.80	958
Tamil Nadu	0.83	757
Assam	1.11	140
Andhra Pradesh	1.20	660
Maharashtra	1.46	1722
Chhattisgarh	1.51	1538
Karnataka	1.63	1648
Madhya Pradesh	2.02	1057
Gujarat	2.20	1646
Haryana	2.24	1570
Rajasthan	3.39	1305
Punjab	3.95	1047

Land Bite Strategy: Across States

State	Mean Parcel Size (acres)	Mean Bite Size ($1000)	% Build Events preceded with >3 Bites
Bihar	0.43	256	57.4
West bengal	0.79	516	37.5
Uttar Pradesh	0.80	958	24.1
Tamil Nadu	0.83	757	30.8
Assam	1.11	140	66.6
Andhra Pradesh	1.20	660	27.1
Maharashtra	1.46	1722	17.1
Chhattisgarh	1.51	1538	24.7
Karnataka	1.63	1648	18.8
Madhya Pradesh	2.02	1057	23.5
Gujarat	2.20	1646	18.7
Haryana	2.24	1570	24.8
Rajasthan	3.39	1305	21.6
Punjab	3.95	1047	23.4

- Land bite strategy varies across:
  - Ownership ▸ Ownership and Land Bite Strategy
  - States (land fragmentation) ▸ Fragmentation and Land Bite Strategy
  - Smaller parcels across states also correlated with:
    - Building additions
    - Establishment size (labor and revenue) ▸ Establishment Growth

- Observe small bite strategy after controlling:
  - Establishment revenue, rural/urban dummy, industry FE, state FE
  - State level controls: fixed capital, workers, output, railway and highway length, electricity deficit, 2001 and 2011 census
  - Credit constraints (Rajan & Zingales, 1998; Duflo & Banerjee, 2014):
    - Establishment loan-to-value and cash-in-hand

- Moving forward:
  - Quantify costs of land market frictions
    - Estimate time and effort costs across ownerships and states
  - Policy Experiments: eminent domain restrictions; land pooling

Model Overview

- Study land markets with multiple agents: buyers and sellers
- Focus on demand for land by manufacturing establishments
  - Single agent dynamic discrete choice model
  - Establishments take land market friction environment as given

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- Study land markets with multiple agents: buyers and sellers
- Focus on demand for land by manufacturing establishments
  - Single agent dynamic discrete choice model
  - Establishments take land market friction environment as given
- Land add decisions: both **intensive** and **extensive** margin
  - *Whether* to buy and *how much* to buy
- Recover land aggregation cost structure using:
  - **Revealed preferences**: infer from establishment's land bite strategy
  - *Frequency* of land bites: fixed costs
  - *Size* of land bites: convex costs
  - Estimate fixed and convex costs across ownerships and locations

State Variables and Timing

- Time is discrete, each decision period is one year
- State variables are land ℓ and plant productivity z

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- State variables are land ℓ and plant productivity z
- Timing:
  1. State variable land is carried from last period, productivity is realized
  2. Land purchase or sale decision shocks are realized
  3. Incumbents make land adjustment decisions
  4. Land adjusts deterministically if land purchase or sale was made
  5. Per period profits are realized

Profit Function

- Production function for establishment i in industry s:

$$f_{is}(\ell, z; \alpha) = z_i \ell_i^{\alpha_{1s}} n_i^{\alpha_{2s}} k_i^{\alpha_{3s}} e_i^{\alpha_{4s}}$$

- z: productivity, ℓ: land, n: labor, k: capital, e: materials, energy, fuel

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- z: productivity, ℓ: land, n: labor, k: capital, e: materials, energy, fuel
- Capital k is a free variable
- Establishment pay labor w, capital r, materials p_e
- Payment for land input is done when land is acquired
- Per period profit function:

$$\bar{\pi}_{is}(\ell, z; \alpha) = p_s f_{is}(\ell, z; \alpha) - w_i n_i - r k_i - p_e e_i$$

Land Adjustment Cost Function (1/3)

- m_{it} is *total* land adjustment in period t by establishment i
- Land adjustment cost function at location j is

$$C\left(m_{it};\gamma_j\right) = \mathbb{1}_{m_{it}>0}\left(\gamma_{0j} + m_{it}^{1+\gamma_{2j}}\right)$$

- Land cost function captures keys aspects of land frictions:
  - Fixed costs (γ_0): generate lumpiness, induces decision to adjust; adjustments not made every period
  - Convex parameter (γ_2): reduces the amount of land investment; difficult to put together land in one go
  - γ_0, γ_2 also differ by ownership, but notation suppressed

Land Adjustment Function (2/3)

$$C\left(m_{it};\gamma_j\right) = \mathbb{1}_{m_{it}>0}\left(\gamma_{0j} + m_{it}^{1+\gamma_{2j}}\right)$$

- m_{it} is value of land
- Effect of frictions on prices is already captured in m_{it}
- γ_0, γ_2 estimate non-price costs of frictions: time, effort costs
- If there were no land market frictions:
  - γ_0, $\gamma_2 = 0$
  - $C\left(m_{it};\gamma_j\right) = m_{it}$

Land Adjustment Function (3/3)

$$C\left(m_{it};\gamma_j\right) = \mathbb{1}_{m_{it}>0}\left(\gamma_{0j} + m_{it}^{1+\gamma_{2j}}\right)$$

- Establishments land adjustment decisions induced by:
  - Productivity z: follows a Markov process
  - Extreme value i.i.d logit shock ϵ_{im_t}
    - Captures cases like land parcel is available for sale next to a establishment, not observed by econometrician

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- Logit shock of land adjustment is associated with both:
  - Intensive margin
  - Extensive margin
- Shock ϵ_{i0} is associated with no land investment $m_{it} = 0$

Value Function for Incumbent

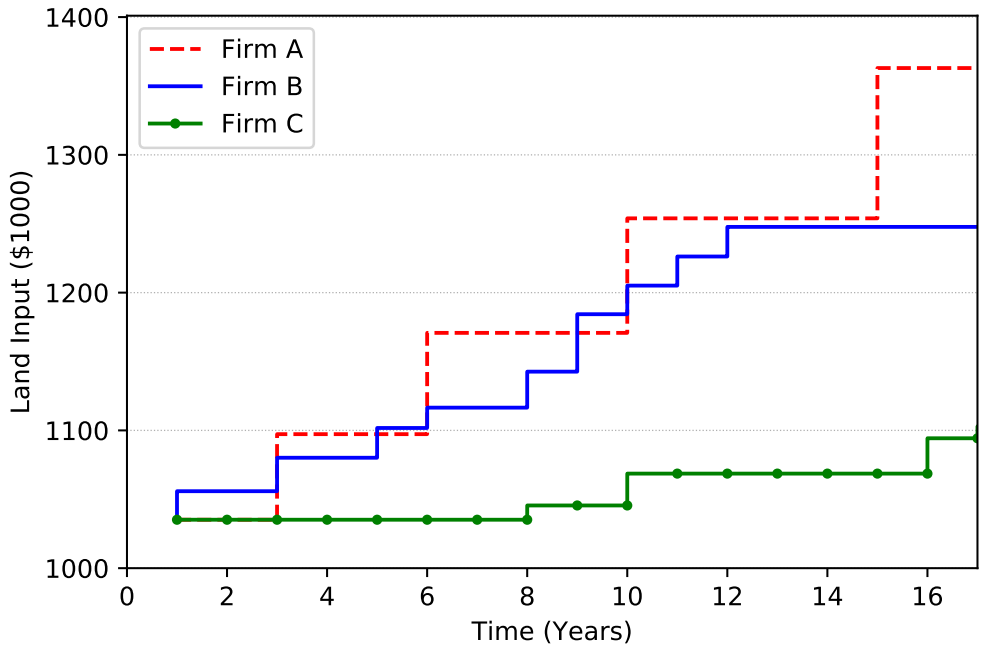
$$V_i(z,\ell) = \max\left\{ \underbrace{\left[\epsilon_{(m_i=0)} + \bar{\pi}_{ij}(\ell, z; \alpha) + \beta \mathbb{E}_{\epsilon,z} V_i(z', \ell) \right]}_{\text{no land adjustment}}, \right.$$

$$\max_{m_i>0} \left[\left(-\gamma_{0sj} - m_{ist}^{1+\gamma_{2sj}} + \epsilon_{(m_i>0)} \right) \right.$$

$$\left. \left. \underbrace{+\bar{\pi}_{ij}(\ell + m_i, z; \alpha) + \beta \mathbb{E}_{\epsilon,z} V_i(z', \ell + m_i)}_{\text{positive land adjustment}} \right] \right\}$$

▸ Model Explanation

Identification of Land Aggregation Cost Parameters



- Identification: variation in adjustment across ownerships, locations
- 3 establishments in auto industry across locations, same productivity
- Lumpy land adjustments: high fixed costs (Est. A)
- Smaller parcels, add land in small bites: high convexity (Est. B)
- Land adjusted less frequently: high fixed & convex costs (Est. C)

Outline

Empirical Strategy

- Step 1: Estimate production function parameters, productivity using control function approach (Ackerberg et al, 2015)
  - Methodology accounts for endogeneity in land and capital
  - Estimated land coefficient $\hat{\alpha}_1$, other input coefficients $\vec{\alpha}$
  - Estimated establishment-specific residual $\hat{z}_t$ over time

Empirical Strategy

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  - Estimated land coefficient $\hat{\alpha}_1$, other input coefficients $\vec{\alpha}$
  - Estimated establishment-specific residual $\hat{z}_t$ over time
- Step 2: Estimation of land aggregation cost structure
  - Discretize state space $\ell, \hat{z}$
  - Nested Fixed Point MLE
- Estimate parameters for 10 largest industries, 8 largest manufacturing states, and 2 ownerships

Step 2: Specification for Estimation of Land Costs (1/2)

- Each period is one year
- Establishments discount the future at rate $\beta = 0.95$
- Markov process for productivity z_t differs across ownerships
- Continuous decision of how much to invest is discretized
  - Index b ($b = 0, ...B$) corresponds to discrete adjustment levels
  - Establishment draws logit land adjustment draw ϵ_{ib}
  - ϵ_{i0} is the shock associated with no land investment $m_{ib} = 0$

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  - Establishment draws logit land adjustment draw ϵ_{ib}
  - ϵ_{i0} is the shock associated with no land investment $m_{ib} = 0$
- Nested logit:
  - Allow for correlation λ across positive land adjustment levels
  - $\lambda = 0$ is simple logit

▸ Details

Step 2: Specification for Estimation of Land Costs (2/2)

- Baseline Specification:
  - Estimate fixed cost γ_0, curvature parameter γ_2
  - γ_0, γ_2 estimated flexibly without restrictions
  - Adjustment discretized to 5 levels of investment (6 total choices)
  - Nested logit

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  - Adjustment discretized to 5 levels of investment (6 total choices)
  - Nested logit
- Alternative Specifications:
  - Adjustment levels also discretized to 7, 9, 11 levels of investment
  - Simple logit ($\lambda = 0$)

Step 1: Production Function Results

Industry (NIC Code)	Land	Capital	Labor	Obs.
All Industries	0.011	0.141	0.281	119,277
	(0.004)	(0.009)	(0.014)	
Food Products (10)	0.019	0.005	0.259	23,677
	(0.013)	(0.017)	(0.027)	
Wearing Apparel (14)	0.036	0.109	0.306	3,444
	(0.017)	(0.042)	(0.118)	
Leather (15)	0.038	0.096	0.493	2,466
	(0.021)	(0.034)	(0.029)	
Printing (18)	0.026	0.043	0.255	1,466
	(0.017)	(0.027)	(0.035)	
Chemical Products (20)	0.024	0.083	0.261	6,342
	(0.014)	(0.032)	(0.073)	
Non-Metallic Minerals (23)	0.035	0.190	0.292	5,372
	(0.016)	(0.061)	(0.078)	
Other Manufacturing (32)	0.084	0.034	0.483	1,629
	(0.026)	(0.058)	(0.078)	

Production Function Results

- Land is significant input: elasticity 0.011 - 0.084
- The capital coefficient *excluding* land is estimated to be 0.14 and labor 0.28
  - All capital: 0.09, labor: 0.27 (Collard-Wexler & De Loecker, 2020)
- Provide a land input production function coefficient for India and other countries at establishment level
  - Estimates at sectoral level (US) is 0.04 - 0.1 (Herrendorf & Valentinyi, 2008; Nordhaus, 1992)

Land Aggregation Cost Parameters: Across Ownership

Table: Nested Logit Specification

Ownership	Fixed Costs (γ_0)	Curvature (γ_2)	# Obs.
Govt. Affiliated	19.535 (1.009)	0.0124 (0.0021)	5,986
Private	42.371 (0.148)	0.0389 (0.0015)	56,092
$\lambda = 0.58$ (0.027)			

Note: This tables presents estimates of the dynamic parameters across ownership codes pooled over 10 industry codes. Standard errors are in parenthesis. Results evaluated at 1,000 US Dollars in 2005 constant prices.

▸ Alternative Specifications

Land Aggregation Cost Estimates: Across Ownerships

- Fixed costs (γ_0): \$19,535 for govt. affiliated, \$42,371 for private
  - Govt. Affiliated: fixed costs 1.7% of mean land add value
  - Private: fixed costs 14% of mean land add value

Land Aggregation Cost Estimates: Across Ownerships

- Fixed costs (γ_0): \$19,535 for govt. affiliated, \$42,371 for private
  - Govt. Affiliated: fixed costs 1.7% of mean land add value
  - Private: fixed costs 14% of mean land add value
- Convex costs (γ_2): 0.0124 for govt. affiliated, 0.0389 for private
  - Govt. Affiliated: convexity adds 19% extra costs for 90th percentile land add
  - Private: adds 68% extra costs for 90th percentile land add

▸ Fitted Values: Land Aggregation Costs across Ownerships

Land Costs Across State

States	Fixed Costs (γ_0)	Convex Costs (γ_2)	# Obs.
Gujarat	17.045 (2.358)	0.0409 (0.0016)	6274
Maharashtra	39.713 (1.029)	0.0599 (0.0023)	9625
Karnataka	62.396 (2.108)	0.0121 (0.0028)	2879
Tamil Nadu	58.364 (1.383)	0.0293 (0.0015)	8566
Punjab	28.628 (2.381)	0.0321 (0.0006)	2768
Uttar Pradesh	92.763 (2.049)	0.0219 (0.0029)	4069
Assam	39.562 (3.739)	0.0517 (0.0024)	2437
$\lambda = 0.46$ (0.089)			

▸ Alternative Specification

Land Aggregation Cost Estimates: Across State

- Fixed costs (γ_0): \$17,045 - \$152,058
  - Gujarat: fixed costs are 2.3% of mean land add value
  - Uttar Pradesh: fixed costs are 18% of mean land add value
  - Rajasthan: fixed costs are 27% of mean land add value

Land Aggregation Cost Estimates: Across State

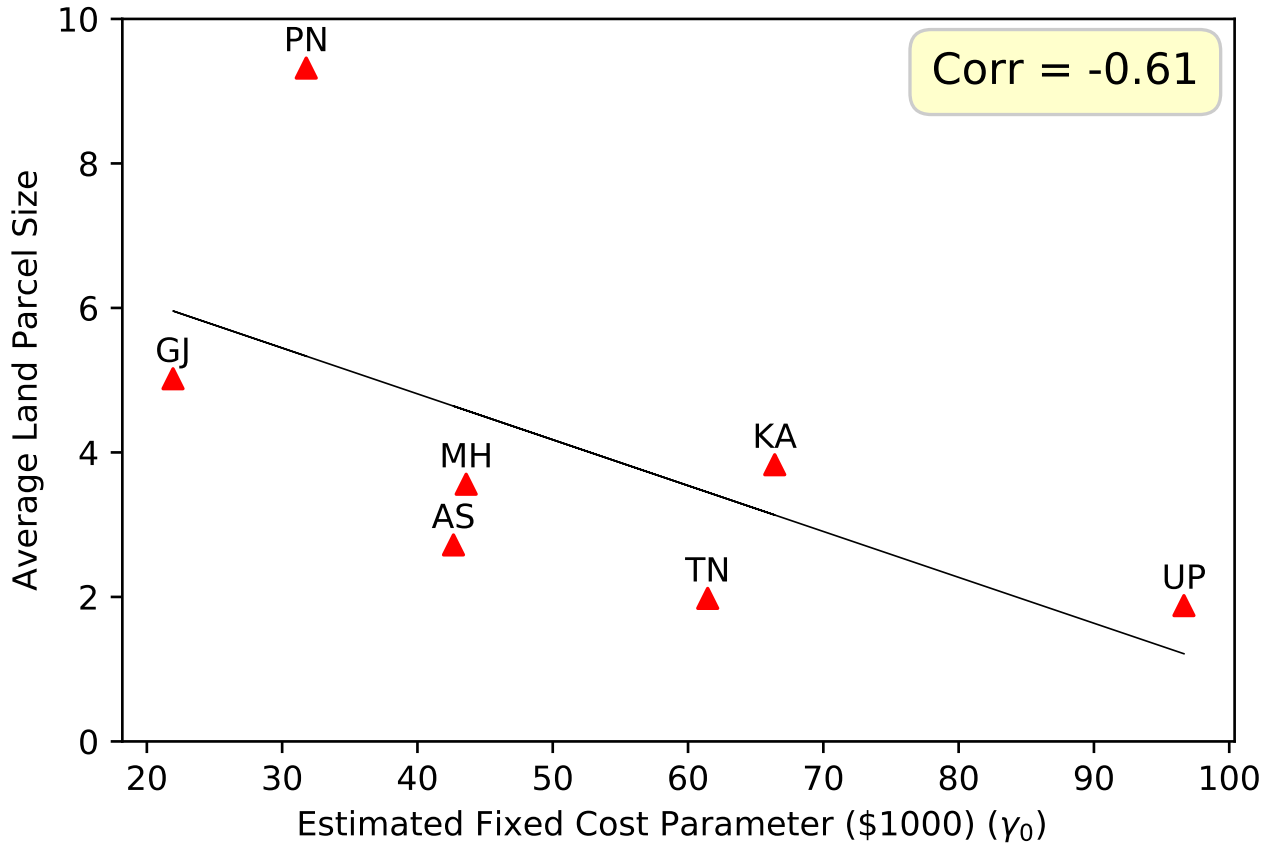
- Fixed costs (γ_0): \$17,045 - \$152,058
  - Gujarat: fixed costs are 2.3% of mean land add value
  - Uttar Pradesh: fixed costs are 18% of mean land add value
  - Rajasthan: fixed costs are 27% of mean land add value
- Curvature parameter (γ_2): 0.012 - 0.060; convexity adds:
  - Karnataka: 19% extra costs for 90th percentile land add
  - Assam: 82% extra costs for 90th percentile land add
  - Maharashtra: 119% extra costs for 90th percentile land add

▸ Fitted Values: Land Aggregation Costs across States

Corroborating Evidence for Estimated Parameters

- No data on hundreds of sources of land frictions
- Can corroborate estimated land aggregation costs with:
  - Average land parcel size in state
  - Share of land related court cases in a state
  - State government's land leasing policy measure

Estimated Costs and Average Land Parcel Size

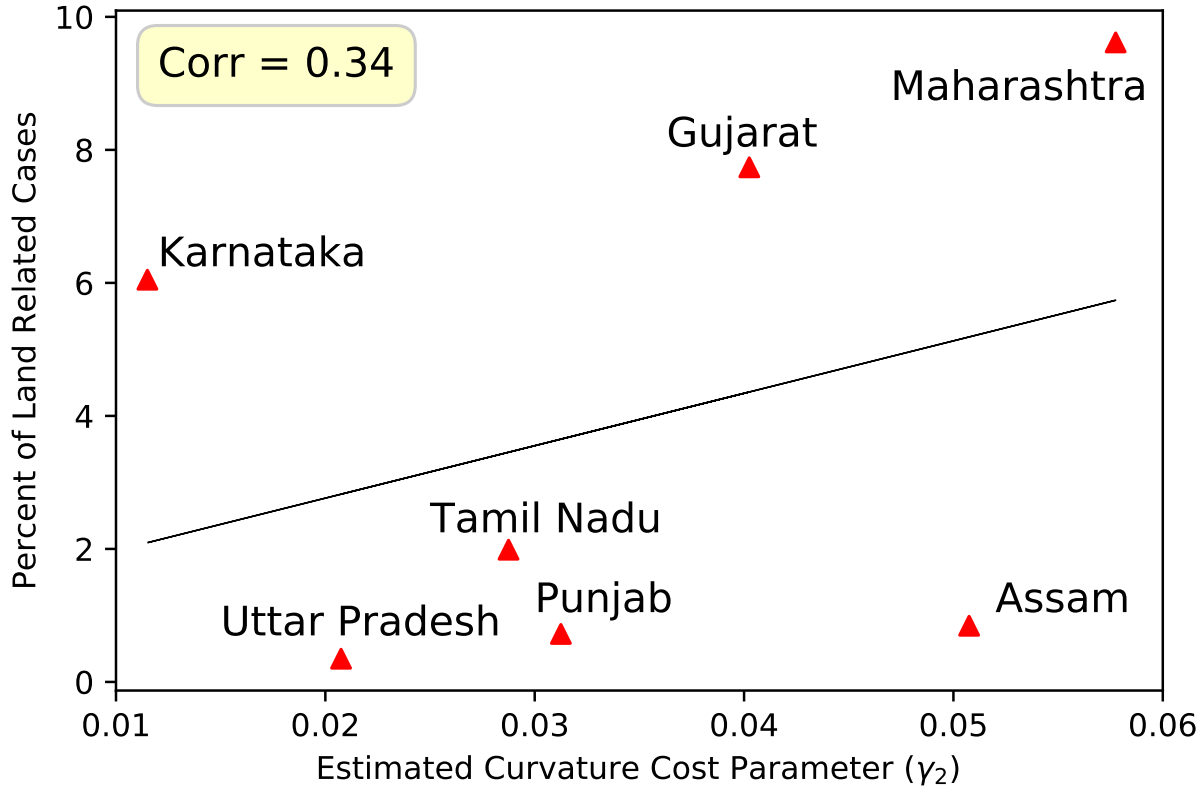


Note: This figure plots the estimated fixed costs in $1,000 constant prices against the average land parcel size in a state. The data on land parcel size if from Agricultural Census.

▸ Estimated Convex Costs and Land Court Cases ▸ Estimated Fixed Costs and Land Lease Policy

Estimated Curvature Costs and Land Court Cases

- % of land related court cases of civil cases (Boehm & Oberfield, 2018)



Note: This figure plots the estimated curvature costs against the percent of land related civil court cases in 2015. The data on land court cases is self-collected from National Judicial Data Grid.

▸ Estimated Fixed Costs and Land Lease Policy ▸ Land Misallocation across Ownerships 1

▸ Land Misallocation across Ownerships 2

Outline

Counterfactual Policy Experiments

- Study effects of two policies:
  1. Eminent domain restrictions (2015)
     - Reduces the scope of eminent domain for manufacturing
  2. Proposed land pooling policies
     - Govt. acting as intermediary to aggregate land for establishments
- Study effect of small, targeted changes for establishments:
  - Land pooling proposals are of modest size
  - Large effect on land aggregation costs for establishments
  - GE effects on land and output prices relatively small
- Effect on:
  - Establishment profits and growth
  - Land misallocation

Effect of Eminent Domain Law Restrictions

- Quantify effect on govt. affiliated establishments post 2015 restrictions (data ends in 2015)
- For govt. affiliated establishments, set land costs:
  - Same as private establishments land aggregation costs
  - $\gamma_0 = 42.371$
  - $\gamma_2 = 0.0389$
- Production function parameters left unchanged
- Compare establishments with same initial productivity level across govt. affiliated and private land aggregation parameters
  - Productivity Markov process across ownerships remains unchanged

Effect of Eminent Domain Law Restrictions

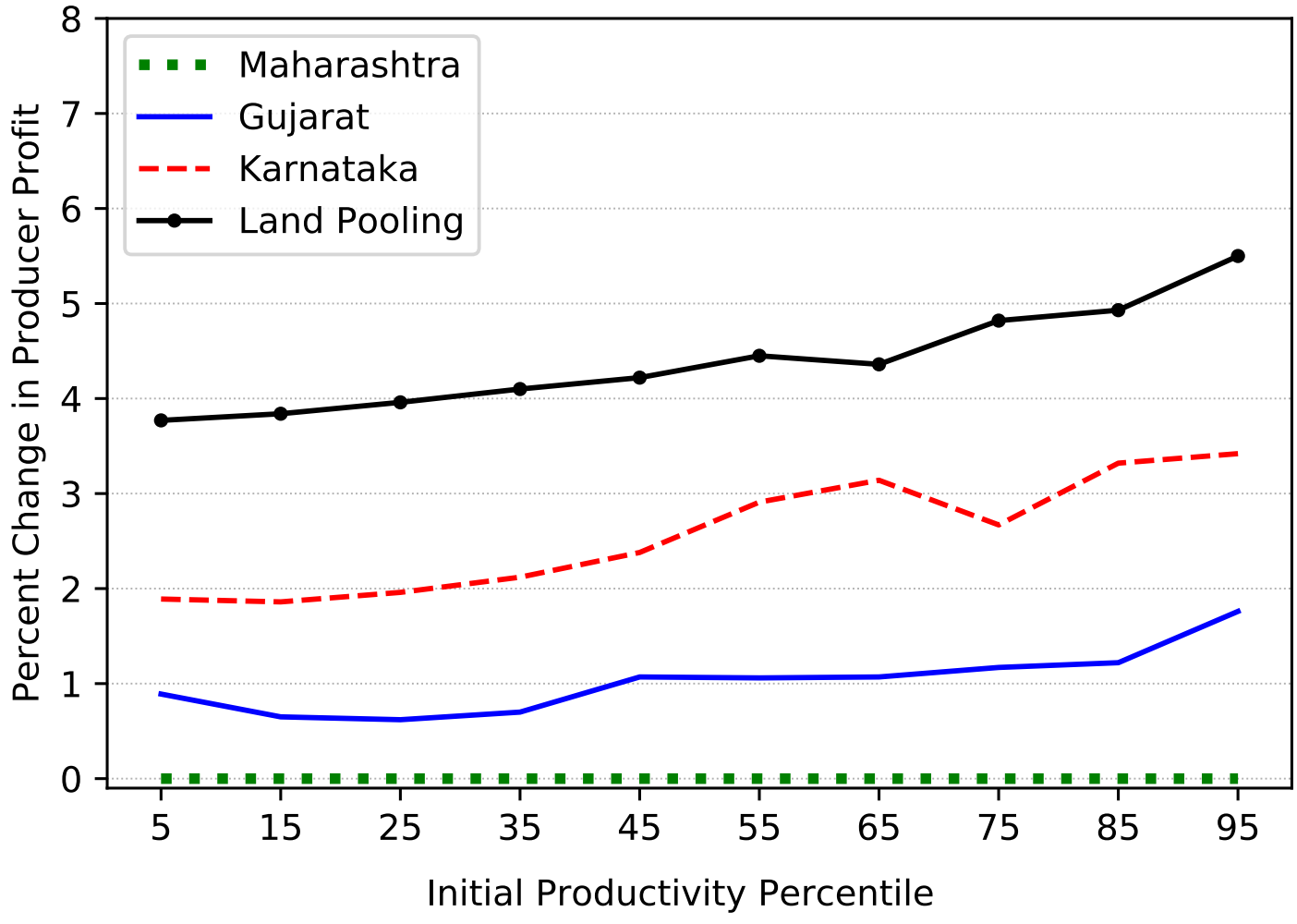
Start Productivity Percentile	Profit Δ	Profit Δ %	Growth (10 year) %
10th	-1012	-1.07%	-1.81%
25th	-1733	-1.70%	-2.57%
50th	-2591	-2.15%	-3.72%
75th	-3155	-2.41%	-4.23%
95th	-5083	-3.71%	-5.89%
99th	-6814	-4.80%	-6.74%

Note: Producer profits are means over different land input values. Results evaluated at 1,000 US Dollars in 2005 constant prices. NPV: net present value.

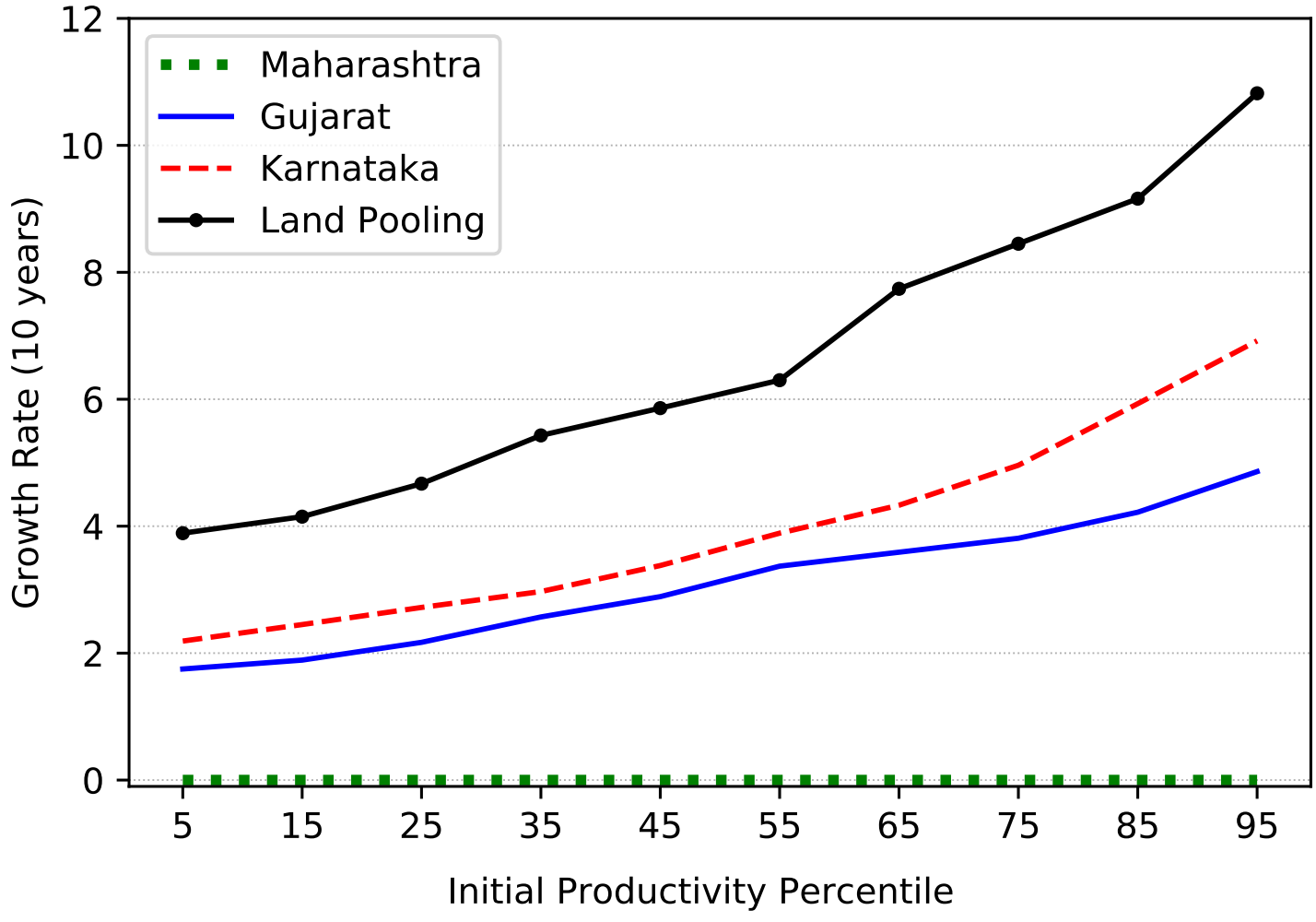
Effect of Land Pooling Policy

- Quantify effects of land pooling policy on establishment profits, growth rates
- Forward simulate establishment paths under the cost parameters (γ_0, γ_2) of:
  - Best practices of Gujarat: lowest fixed costs
  - Best practices of Karnataka: lowest convex costs
  - Zero frictions: $\gamma_0 = 0, \gamma_2 = 0$
- Production function parameters left unchanged
- Compare establishments with same initial productivity level for establishments located in Maharashtra
  - Productivity Markov process across states remains unchanged

Land Pooling Policies for Establishments in Maharashtra (Profits)



Land Pooling for Maharashtra Establishments (Growth Rates)



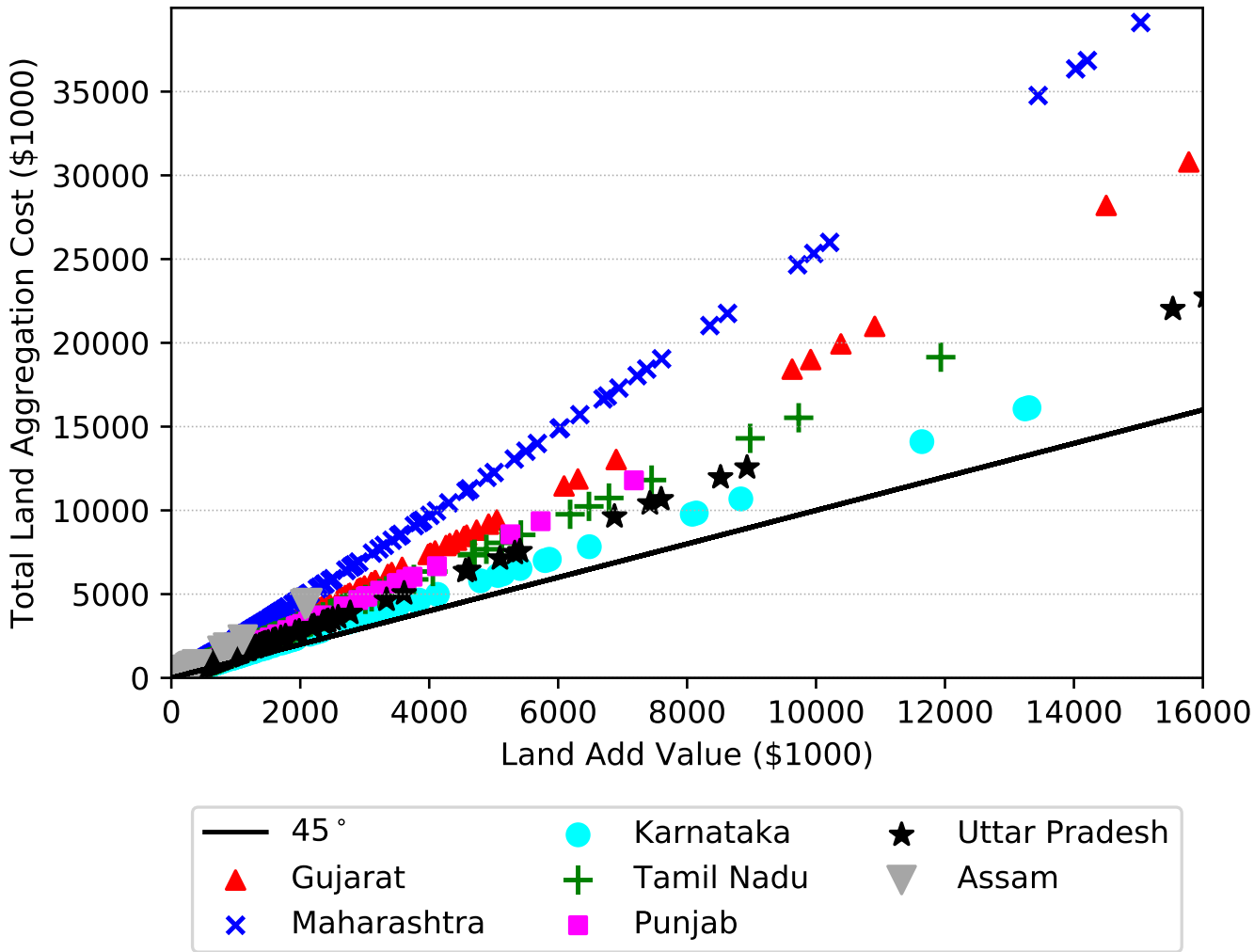
Outline

Conclusion

- Study the effects of land frictions on Indian manufacturing
  - Use novel data + dynamic structural model
  - Find large costs of land frictions on growth and profits
- Findings:
  - Small bite strategy
  - Estimated land costs differ significantly across states
  - Land costs are *three* times higher for private establishments
  - Land is significant input into manufacturing
- Policy Evaluation:
  - Eminent domain restrictions $\downarrow$ lifetime profits, growth, misallocation
  - Land pooling policies $\uparrow$ lifetime profits, growth

Appendix

Estimated Land Aggregation Costs across State



Note: This figure plots fitted values of total land aggregation costs against dollar value paid for a land transaction across different states.

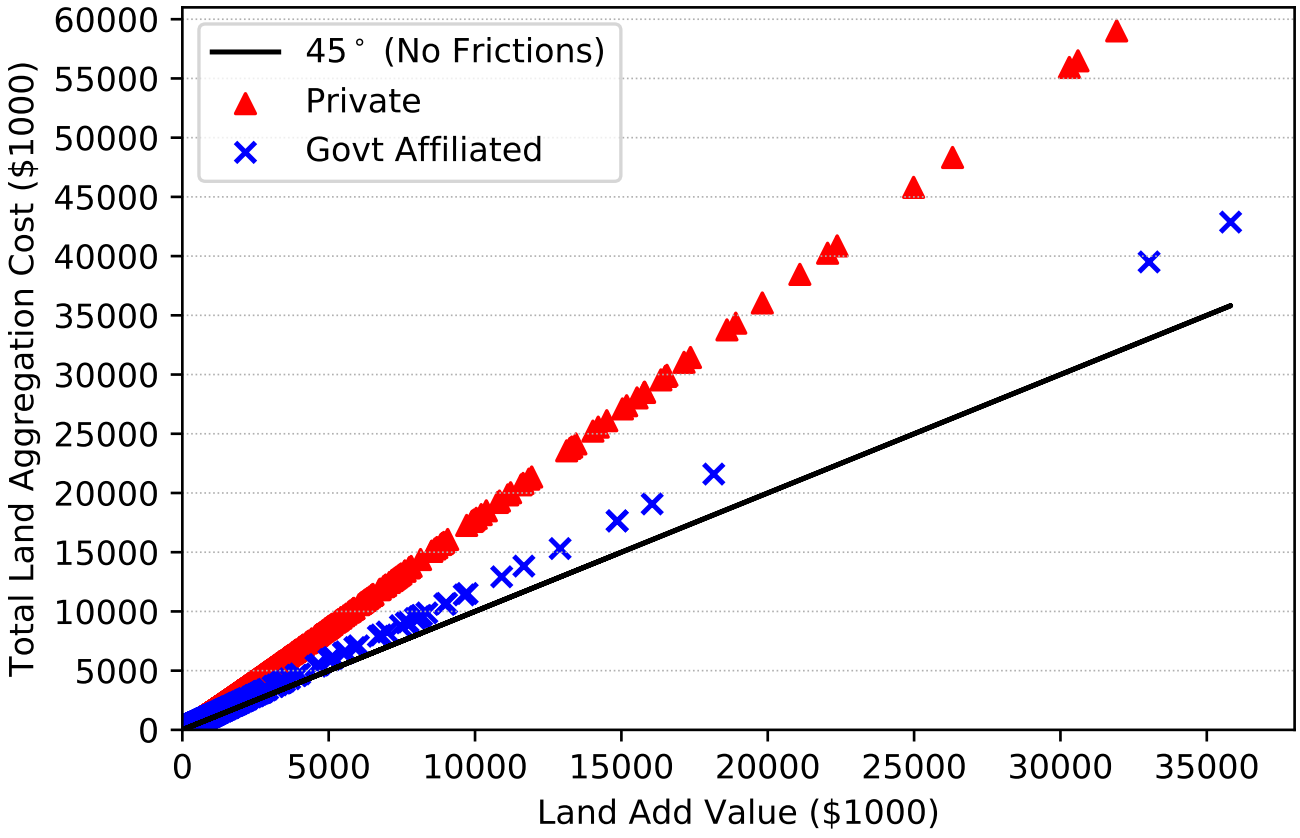
▸ Back to

Determination of Base Sample

	Establishment (Est.) - Year		Unique Est.
	Dropped Observations	Resulting Sample Size	Resulting Sample Size
Original ASI data		892,068	287,050
Non-manufacturing NIC codes	1,740	890,328	286,917
Closed, Deleted, Non-response	97,763	792,565	254,460
Missing state codes	50	792,515	254,410
More than one plant in state	36,602	755,913	250,883
Missing revenues	149,653	606,260	199,573
Missing land input	209,971	396,289	125,959
Establishments with one year only	48,029	348,260	77,930
Baseline sample		218,296	48,516
Restricted sample		140,903	28,336

▸ Back to

Estimated Land Aggregation Costs across Ownerships



Note: This figure plots fitted values of total land aggregation costs against the dollar value paid for a land transaction across ownerships.

▸ Back to

Land Bite Strategy and Firm Ownership

	(1) Bites	(2) Bites	(3) Bite Prob.	(4) Bite Prob.
Private	-7,899***	-11,500***	0.185***	0.167***
	(684)	(485)	(0.002)	(0.003)
N	18,749	28,328	120,017	206,864
R^2	0.018	0.022	0.028	0.028
dy/dx			.024***	.020***
			(0.0002)	(0.0003)
Firm Controls	Y	Y	Y	Y
State Controls	Y	Y	Y	Y
Loan to Value	Y	N	Y	N
Cash in Hand	Y	Y	Y	Y
State FE	Y	Y	Y	Y
Time Trend	Y	Y	Y	Y

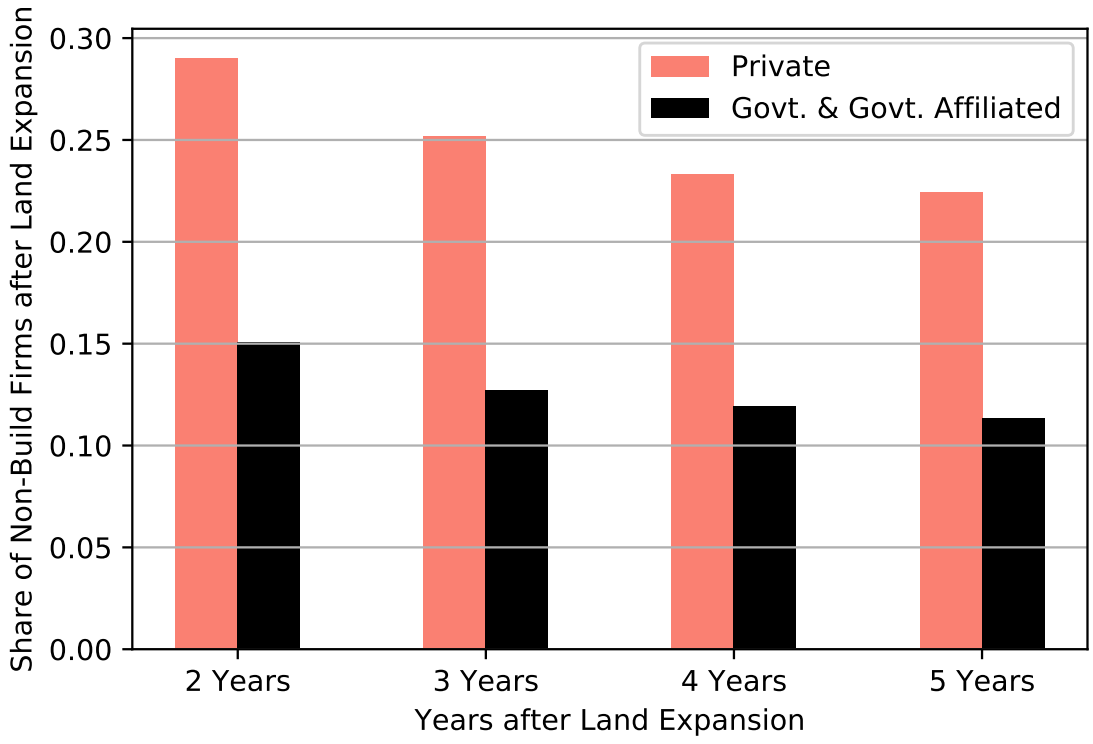
▸ Back to

Land Bite Strategy and Fragmentation

	(1) Bites	(2) Bites	(3) Bite Prob.	(4) Bite Prob.
Fragmentation	4,506***	4,915***	0.101***	0.165***
	(1,060)	(1,034)	(.026)	(.024)
N	18,749	28,328	120,017	206,864
R^2	0.015	0.02	0.026	0.024
dy/dx			0.014***	0.021***
			(.004)	(.005)
Firm Controls	Y	Y	Y	Y
State Controls	Y	Y	Y	Y
Loan to Value	Y	N	Y	N
Cash in Hand	Y	Y	Y	Y
State FE	Y	Y	Y	Y
Time Trend	Y	Y	Y	Y

▸ Back to

Share of Firms Not Building after Land Expansion



Note: This figure presents share of firms not building after land expansion varied across ownership status [1999-2015]. Establishments are either fully private owned, fully government owned or jointly owned by government and private parties. The data is from ASI.

▸ Back to

Firm Growth and Parcel Size Distribution

- Land fragmentation $\rightarrow$ building expansion, firm size
- Empirical model:

$$Y_{ijt} = \beta_0 + \beta_1 \text{avg}_{jt} + \Gamma_1 X_{1it} + \Gamma_2 X_{2jt} + \eta_2 t + \epsilon_{ijt}$$

- Y_{ijt}:
  1. Dummy for positive building adjustment by firm i in state j
  2. Firm size (log labor or log revenue)
- avg_{jt}: average land parcel size in state in $t = 1995, 2000, 2005, 2010, 2015$
- X_{1it}: firm controls, X_{2it}: location controls
- If $\beta_1 > 0$, lower land frag positively correlated with firm growth

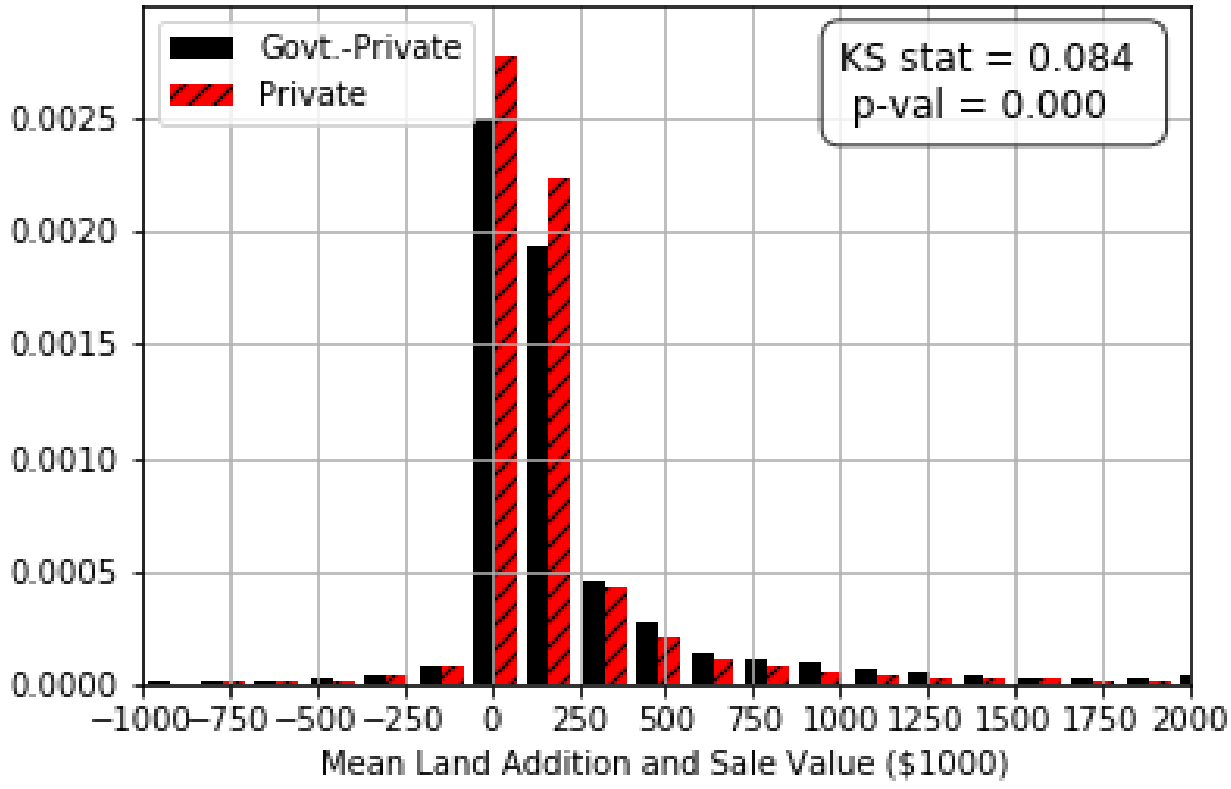
▸ Back to

Fragmentation and Firm Size and Growth

	(1) Log Revenue	(2) Log Revenue	(3) Log Labour	(4) Log Labour	(5) Building Added	(6) Building Added
Fragmentation	0.146**	0.288**	0.097**	0.147**	2,844***	3,234***
	(0.042)	(0.064)	(0.04)	(0.045)	(612)	(713)
N	118,994	204,827	119,952	206,300	57,864	90,645
R^2	0.228	0.210	0.386	0.396	0.028	0.037
Firm Controls	Y	Y	Y	Y	Y	Y
State Controls	Y	Y	Y	Y	Y	Y
Loan to Value	Y	N	Y	N	Y	N
Cash in Hand	Y	Y	Y	Y	Y	Y
State FE	Y	Y	Y	Y	Y	Y
Time Trend	Y	Y	Y	Y	Y	Y

▸ Back to

Density of Land Adjustment across Ownership Status



Note: This figure presents the land adjustment density of firms varied across ownership status [1999-2015]. Establishments are either fully private owned or jointly owned by government and private parties. Values are in 2005 constant thousand USD. The figure is truncated on both sides for clarity. The data is from ASI.

▸ Back to

Intensive and Extensive Margin Decision of Land Adjustment

- Establishments make land adjustment decisions on the intensive and extensive margins induced by:
  - Productivity z follows a Markov process
  - i.i.d logit structural error
- Curvature: reduces the amount of land investment
- Increase in γ_{1j} or γ_{2j} results in lower value of land investment
- Fixed costs: generate lumpiness, induces decision to adjust
- Increase in γ_{0j} results in fewer land expansions
- Increase in the logit shock $\left(\epsilon_{(m_i=0)} - \epsilon_{(m_i>0)}\right)$ results in fewer land expansions

▸ Value Function Incumbent

Value Function for Entrant

$$V_i^e(z,\ell) = \max\left\{0, -\kappa_{ij} + \max_{m_i>0}\left[\left(-\gamma_{0sj} - (1+\gamma_{1sj}) m_{ist}^{1+\gamma_{2sj}} + \epsilon_{(m_i>0)}\right) + \bar{\pi}_{ij}(m_i, z; \alpha) + \beta \mathbb{E}_{\epsilon,z} V_i(z', m_i)\right]\right\}$$

κ_{ij} is entry cost ▸ Value Function Incumbent

Empirical Specification (2/2)

The empirical specification is given by:

$$V(z,\ell) = \max_b \left\{ u(z,\ell,b) + \beta \mathbb{E}_{\epsilon_b, z} V_i(z', \ell', \epsilon') \right\}$$

where

$$u(z,\ell,b) = \left\{ \begin{array}{ll} \hat{z} D (\ell + m_b)^{\hat{\alpha}_1} - \gamma_{0sj} - m_b^{1+\gamma_{2sj}} + \epsilon_{(m_{ib}>0)} & \text{if } b > 0 \\ \hat{z} D (\ell)^{\hat{\alpha}_1} + \epsilon_{(m_{ib}=0)} & \text{if } b = 0 \end{array} \right\}$$

where D is other non-land inputs into production function ▸ Back to

Levinsohn-Petrin Estimated Productivity

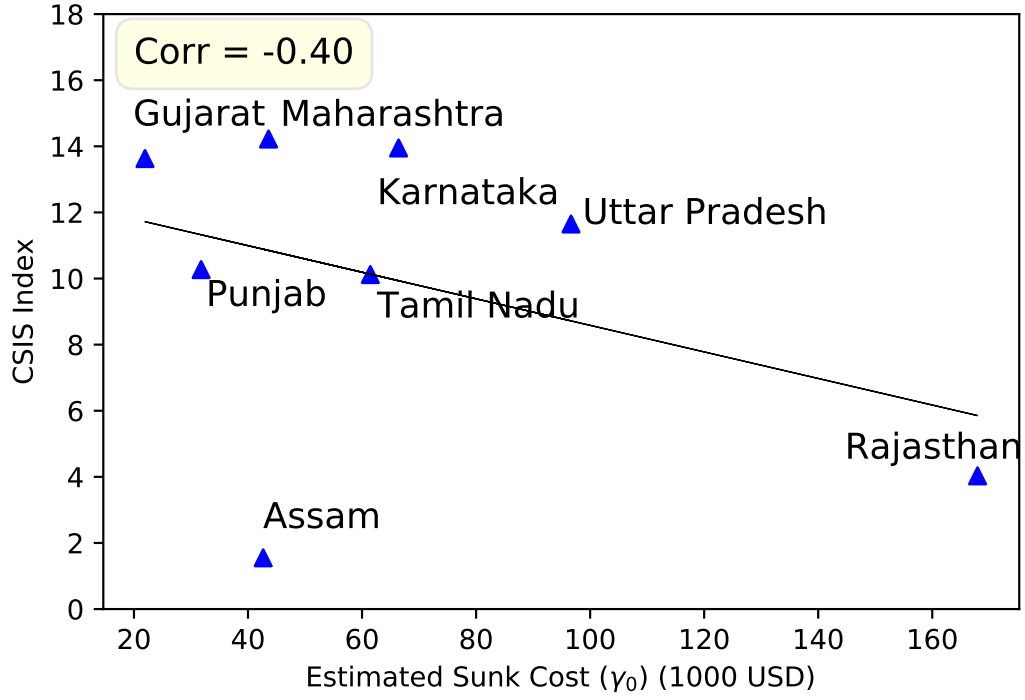
Industry (NIC Code)	Count	Mean	St. Dev.
Food Products (10)	19026	12.725	1.497
Textiles (13)	14983	12.036	1.139
Non-Metallic Mineral (23)	13752	10.551	1.463
Chemical Products (20)	10114	12.457	1.617
Basic Metals (24)	8165	12.207	1.383
Machinery & Equipment (28)	8061	12.936	1.536
Wearing Apparel (14)	6114	10.634	1.123
Fabricated metals (25)	6628	12.023	1.372
Vehicles (29)	6631	11.741	1.253
Electrical Equipment (27)	6265	13.454	1.610

Note: This tables presents the residual productivity estimates from Levinsohn and Petrin (2003) estimation on Indian manufacturing establishment data (1999-2015) using both land and capital as state variables.

▸ Production Function Estimates

Estimated Fixed Costs and Industrial Land Policy

- CSIS index ranks states on government lease terms for industrial purpose and openness to selling state land to private sector buyers (2015)



Note: This figure plots the estimated curvature costs against CSIS state land industrial policy index in 2015.

▸ Back to

Motivating Fact 3: Land Fragmentation and Growth

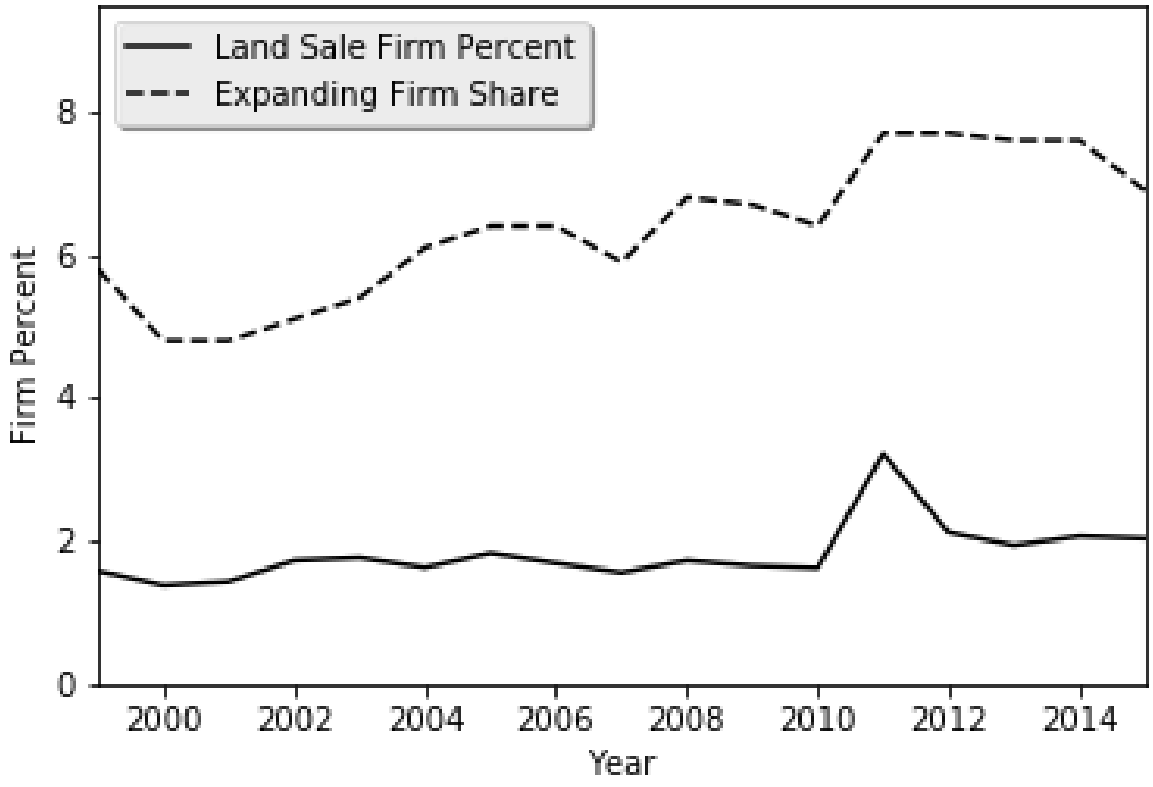
- Correlation between land fragmentation and firm growth
- Regress the amount of building addition by establishment on average parcel size in a state
- The empirical model is given by the equation below:

$$k_{ijt} = \alpha_0 + \alpha_1 f_{jt} + X_{it}\beta_1 + X_{jt}\beta_2 + \alpha_2 \eta_i + \epsilon_{ijt}$$

- k_{ijt} is building addition by firm i in state j at time t
- f_{jt} is average land parcel size in state j at time t
- X_{it} and X_{jt} are firm and state characteristics, respectively.
- Average parcel size of a state for years 1995, 2000, 2005, 2010
- η_i captures firm fixed effects.

▸ Back to

Land Input Adjustment in Cross-Section



Note: This figure presents the share of establishment adjusting land in a given cross section year [1999-2015]. The data is from ASI.

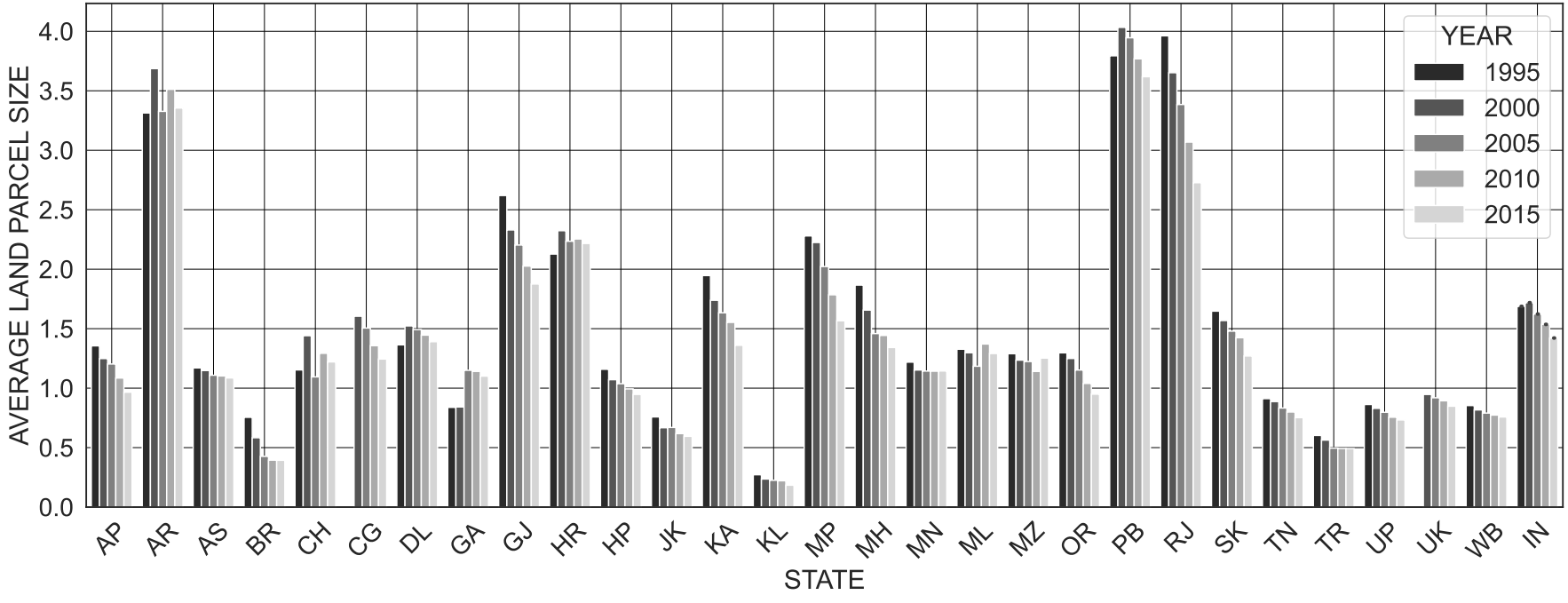
▸ Back to

Summary Statistics for Manufacturing Establishments

	Less Restrictive Sample			More Restrictive Sample		
Variable	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.
Revenue	215,985	329,710	470,021	139,299	362,793	489,515
Wage Bill	217,611	66,435	155,719	140,431	76,951	166,156
Other Capital	201,726	214,952	370,007	128,411	245,755	393,719
Land	213,234	32,576	125,516	137,143	37,865	136,901
Land Purchase	29,662	23,073	92,094	20,857	24,388	95113
Land Sales	8,558	14,416	64,116	6,047	14,465	64,946
Percent Govt. Aff.	218,003	7.65		140,693	8.43	
Percent Urban	218,237	49.15		140,832	47.65	

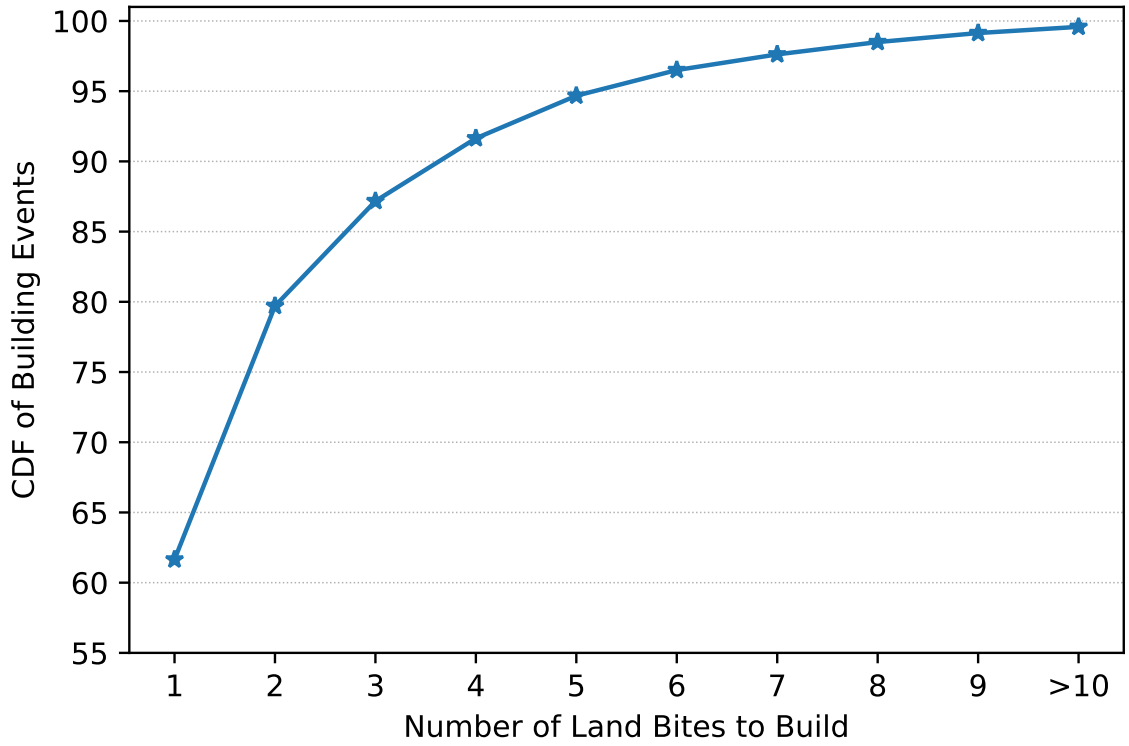
▸ Back to

Average Parcel Size over Time



▸ Back to

Land Bites to Meal



Note: This figure presents the percent of building events (cumulative density function) preceded by land aggregation over one land bite (or transaction) or more. Building events considered are building events are large building events requiring land.

▸ Back to

Production Function Estimation Details

- Take logs of production function:

$$\log y_{it} = \alpha_{0s} + \alpha_{1s} \log \ell_{it} + \alpha_{2s} \log n_{it} + \alpha_{3s} \log k_{it} + \alpha_{4s} \log e_{1it} + \alpha_{5s} \log e_{2it} + \alpha_{6s} \log e_{3it} + \omega_{it} + \epsilon_{it}$$

- $\omega_{it} = \log z_i$, firm's optimal choice of materials e_{1i}:

$$\log e_{1i} = g_t(\log \ell_{it}, \log k_{it}, \omega_{it})$$

$$g_t(\log \ell_{it}, \log b_{it}, \omega_{it}) = \alpha_{0s} + \alpha_{1s} \log \ell_{it} + \alpha_{3s} \log k_{it} + \alpha_{4s} \log e_{1it} + \omega_{it}(\log \ell_{it}, \log b_{it}, e_{1it}) + \epsilon_{it}$$

$$\log y_{it} = \alpha_{2s} \log n_{it} + g_t(\log \ell_{it}, \log k_{it}, \omega_{it}) + \alpha_{5s} \log e_{2it} + \alpha_{6s} \log e_{3it} + \epsilon_{it}$$

- The standard errors are estimated using bootstrap method Back to

Land Aggregation Cost Parameters: Across Ownership

Table: Baseline Specification 1

Ownership	Fixed Costs (γ_0)	Curvature (γ_2)	# Obs.
Govt. Affiliated	30.655 (1.121)	0.0103 (0.0017)	5,986
Private	66.660 (0.343)	0.0355 (0.0008) †	56,092

Note: This tables presents estimates of the dynamic parameters across ownership codes pooled over 10 industry codes. Standard errors are in parenthesis. Results evaluated at 1,000 US Dollars in 2005 constant prices.

▸ Nested Logit Estimates

Land Aggregation Cost Estimates: Across State

Table: Alternative Specification

States	Fixed Costs (γ_0)	Convex Costs (γ_2)	# Obs.
Gujarat	21.934 (1.964)	0.0403 (0.0007)	6274
Maharashtra	43.602 (0.935)	0.0578 † (0.0008)	9625
Karnataka	66.408 (1.497)	0.0115 (0.0044)	2879
Tamil Nadu	61.453 (0.756)	0.0288 (0.0007)	8566
Punjab	31.781 (1.692)	0.0313 (0.0019)	2768
Uttar Pradesh	96.652 (1.212)	0.0208 (0.0010)	4069
Assam	42.663 (2.026)	0.0508 (0.0017)	2437

Note: This tables presents estimates of dynamic parameters across states pooled over 10 industries. Standard errors are in parenthesis. Results evaluated at 1,000 US Dollars in 2005 constant prices.

▸ Nested Logit Estimates

Land Misallocation across Ownerships

- Misallocation measure: Olley-Pakes (OP) decomposition

$$TFP_s = \sum_{i=1}^{n} s_i z_i$$

- s_i is land input share of establishment i in industry s

$$\begin{aligned} TFP_s &= \sum_{i=1}^{n} (\overline{s}_t + \Delta s_{it})(\overline{z}_t + \Delta z_{it}) \\ &= \overline{z}_t + \sum_{i=1}^{n} (s_{it} - \overline{s}_t)(z_{it} - \overline{z}_t) \\ &= \overline{z}_t + n\mathrm{Cov}(s_{it}, z_{it}) \end{aligned}$$

- $\overline{z}_t, \overline{s_t}$: unweighted mean productivity, land share
- Lower the covariance OP term, higher land misallocation

▸ Back to

Land Misallocation across Ownerships

Industry	All Establishments	Govt. Affiliated	Private
Food Products (10)	56.69	4.94	50.72
Textiles (13)	14.57	5.57	9.57
Non-Metallic Mineral (23)	4.50	-0.20	4.04
Chemical Products (20)	76.17	7.29	64.71
Basic Metals (24)	82.82	15.17	62.42
Machinery & Equipment (28)	61.18	22.10	37.97
Wearing Apparel (14)	45.19	4.71	37.27
Fabricated metals (25)	41.46	3.35	36.11
Vehicles (29)	69.09	5.85	59.78
Electrical Equipment (27)	61.95	11.75	46.51

▸ Back to