Survey

Descriptives

Model

# Achieving Scale Collectively

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#### Premise: Three Facts on Firms in Developing Countries

#### 1. Small firm size; 2. Many firms; 3. Operate side by side

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Source: Uganda Census of Business Establishments

#### Drivers of Firm-level Technology Adoption

#### ▶ Technology often embodied in large indivisible capital inputs

- firms are small (Fact 1)  $\rightarrow$  indivisibility of capital might hinder adoption

- many small firms (Facts 2 & 3)  $\rightarrow$  indivisibility may not bind for the cluster

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# Overview

#### ▶ Novel **survey** of 1,000 manufacturing firms in urban Uganda

- focus on three sectors: carpentry, metal fabrication, grain milling
- detailed information on the  $how~{\rm firms}~{\rm produce}~{\rm output}~{\rm (production~process)}$

**Describe** the organization of production in the three sectors

- economies of scale due to large capital equipment (especially in carpentry)
- active *inter-firm* rental markets (especially in carpentry)

Model of technology adoption and machine rentals, w/ frictions
 1. estimate the size of frictions in the rental market

- 2. quantify aggregate and distributional effects of the rental market
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# The Survey

#### Geographical Coverage



# Information on Production Process for Key Products



(a) Key Product

Step	Step Description
1	Design
2	Drying the timber
3	Cutting
4	Planing
5	Thicknessing
6	Edging
7	Sanding
8	Mortising
9	Finishing
10	Final Drying

(b) Production Steps

For each step we know: hours of labor, hours of capital, mechanization

#### Mechanization: Modern Machines vs Manual Tools



(c) Thickness Planer (Mechanized) (d) Manual Planer (Not Mechanized)

## Key Facts on Production in Urban Uganda

#### 1. **Production in clusters** of small and (quite) similar firms



- average firm size: 5 workers
- average carpentry firm has other 16 carpenters within 500m radius
- same products, same steps (i.e. no specialization), different capital intensity

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3. Active inter-firm rental market for large machines



(a) Owners



(b) Owners and Renters



- machines mostly used at owner premises  $\Rightarrow$  transaction and time costs





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- rental markets less important in metal fabrication and grain milling



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 $\rightarrow$  whether 2. is meaningful, depends on transaction costs to access rented capital

# $\mathbf{Model}$

Note: assumptions are motivated by extensive empirical evidence shown in the paper

Individuals with managerial ability  $\zeta$ 

All individuals make an entry choice



All individuals make an entry choice Each manager has to make two production choices

















# The rental mkt wedge, $\tau$

## Proposition 1: Choices to Invest and Mechanize $(\tau = 0)$



- investment choice only depends on cost of capital
- mechanization choice only depends on return to capital

Introduction

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# Bringing the Model to Data

#### Model to Data: Approach

We extend the model to make it amenable to estimation
 add sector of specialized lenders + preference shocks

We use our data to pin down the parameters (for carpentry)
 1. rental market wedge (τ) exactly identified by model restrictions
 2. a number of parameters calibrated outside the model (e.g. p<sub>r</sub>, p<sub>b</sub>)
 3. remaining parameters jointly estimated through SMM

#### Estimating the Rental Market Wedge $\tau$

 $\blacktriangleright$  Model's result:  $\tau$  modulates gap in marginal costs of capital

- for renters:  $(1 + \tau)p_r$
- for owners:  $p_r$  [opportunity cost of renting out]

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Run the following regression for step s in firm j:

$$\log(K_{sj}) = \beta_0 + \beta_1 Rent_{sj} + \beta_2 \log(w_j \times L_{sj}) + \vartheta_s + \gamma X_j + \delta Z_{sj} + \epsilon_{sj}$$

- $Rent_{sj}$ : share of machines used in step s that are rented
- $\vartheta_s$ : steps FE;  $X_j$ : firm controls;  $Z_{sj}$ : characteristics of machines in step s
- can also run the specification with firm fixed effects

#### Rental Market Wedge $\tau$ : Results

2	I	Dependent variable:	Log Monthly Machi	ne Hours	
	Step-Level				
_	Baseline	Firm FE	No Controls	Only Labor Controls	
	(1)	(2)	(3)	(4)	
Share of Rented Machines (0-1)	-0.339***	-0.385***	-0.655***	-0.530***	
	(0.092)	(0.089)	(0.110)	(0.094)	
				• F 22	
Labor Cost Control	Yes	Yes	No	Yes	
Machine Controls	Yes	Yes	No	No	
Firm Controls	Yes	No	No	No	
Machine Type FE	No	No	No	No	
Step FE	Yes	Yes	Yes	Yes	
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Adjusted $R^2$	0.374	0.608	0.277	0.308	
Observations	1,536	1,536	1,536	1,536	

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- model implies:  $\beta_1 = -\log(1+\tau) \rightarrow \hat{\tau} = 0.41$  (from column 1)
- rental market wedge is  $\approx 40\%$  of direct machine rental price
- validation: direct transport and time costs explain  $\approx 2/3$  of the wedge



### A Few Estimated Parameters (out of 23)

	Parameter	Value	Description
(8)	$A_M$	1.431	Relative productivity of mechanized process
(9)	$\mu$	1.589	Relative quality of mechanized goods
(11)	$-\eta$	- 0.075	Elasticity of output to price
(12)	ν	0.162	Labor market frictions
(18)	$Corr(\log \rho, \log \zeta)$	- 0.330	Correlation cost and returns of capital

▶ Parameters identification discussed at lenght in the paper

- i.e. we link each primitive to one or few key empirical moments

# Effects of the Rental Market

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2.  $\tau = 0.40$  reaps more than half of the gains  $\rightarrow$  firms achieve scale collectively

# Beyond Uganda

## Beyond Uganda

▶ Where should we expect rental markets to be important?

- how does the importance of rental markets vary as the economy develops?

Recompute the equilibrium varying strength of other frictions
 - frictions in labor, output and financial market

#### Rental Mkts Attenuate Other Imperfections



- rental mkts attenuate other imperfections: labor, output, financial mkt

Other

#### Rental Mkts Attenuate Other Imperfections



- rental mkts attenuate other imperfections: labor, output, financial mkt  $\Rightarrow$  Rental markets matter for economic development

### Conclusion

- ► This project: new survey + model to interpret the data → study role of economies of scale and indivisibilities for development
- ► Key results:
  - 1. active rental market  $\Rightarrow$  indivisible machines can be shared by many firms
  - 2. large aggregate and distributional effects of the rental market
- ▶ Three broad lessons:
  - 1. shift focus from size of individual firms to size of clusters for tech. adoption
  - 2. shifting the boundaries, we may find the missing medium firms in the LDC
  - 3. rental markets can attenuate costs of other market imperfections

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  - 2. shifting the boundaries, we may find the missing medium firms in the LDC
  - 3. rental markets can attenuate costs of other market imperfections
- $\Rightarrow$  Rental mkts are important and there is still a lot to learn

# Thanks!