Firms and Farms

The Local Effects of Farm Income on Firms' Demand

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Presented by: Sai Zhang

January 18, 2023

Outline

Introduction

Motivation

- rural labor markets in developing countries

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- agricultural development in the growth of non-farm sectors

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  - ↑ increasing **demand** for manufacturing goods

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  - $\downarrow$ increasing **cost of labor**, crowding out non-farm production

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model how firms are affected by **agricultural productivity shock**

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model how firms are affected by **agricultural productivity shock**	test model predictions with **quasi-experimental** settings

Roadmap: Theory and Tests

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Empirical Test

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3 sectors

- agriculture
- spatially **tradable** non-farm
- **non-tradable** non-farm

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- agriculture (↑)
- spatially **tradable** (↓)
  non-farm
- **non-tradable** (↓↑) non-farm

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2 settings

- productivity shock: rainfall realizations
- wage-floor policy: NREGA program

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2 settings

- **exogenous** productivity shock: rainfall realizations
- **staggered** wage-floor policy: NREGA program

Literature

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- productivity shocks in LICs
- trade and volatility
- local economic growth; sectoral shocks and macro fluctuations

Model

Setup

- good market:
  - 3 sectors: A (agricultural), M (non-farm tradable), S (non-farm **non-tradable**)
  - production with labor $Y_j = \theta_j n_j^{\alpha}$: agricultural productivity θ_A
  - price: p_A,p_M (price-taking, exogenous), p_S endogenous

Setup

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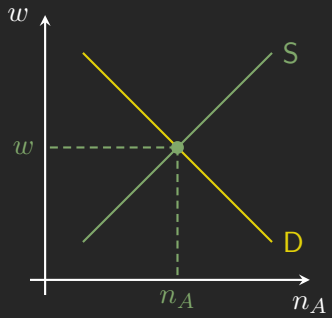
  - price: p_A,p_M (price-taking, exogenous), p_S endogenous
- labor market:
  - mobile across sectors, immobile across districts (at least partially **inelastic** supply)
  - wage w

Prediction: Agricultural Labor Market A

Positive productivity shock $\theta_A \uparrow$



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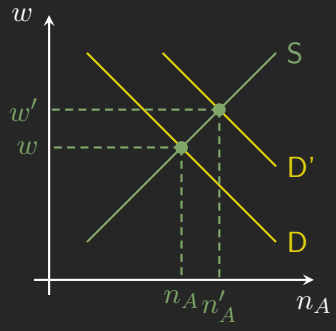

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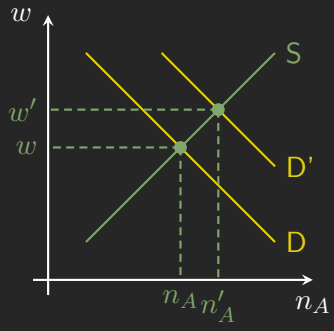
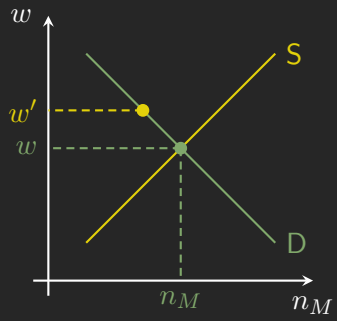


essentially, a positive **demand** shock, increasing algricultural income

Prediction: Local Tradable Non-farm Labor Market M

Positive productivity shock $\theta_A \uparrow$, leading to $w, n_A \uparrow$



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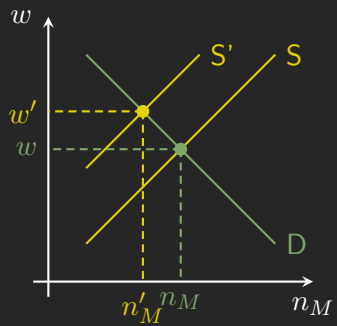
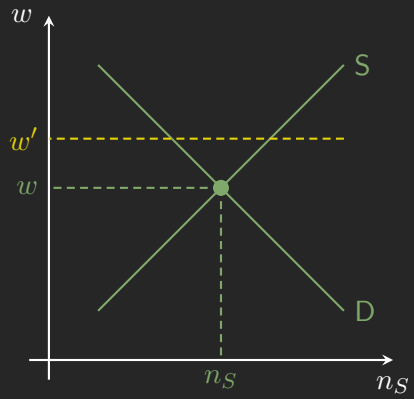


labor **supply** shrinks to clear market

Prediction: Local Non-tradable Non-farm Labor Market S

Positive productivity shock $\theta_A \uparrow$, leading to $w \uparrow$ and income $\uparrow$



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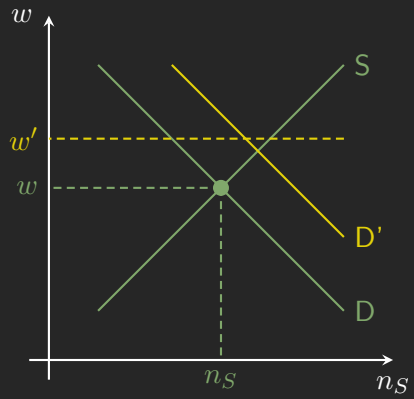

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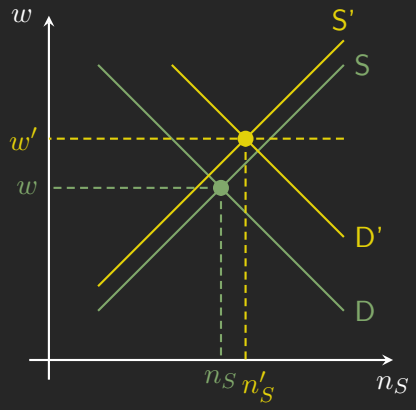

Prediction: Agricultural Productivity Shock

$$w = \frac{\alpha\left[(p_A\theta_A)^{\frac{1}{1-\alpha}} + C(p_M\theta_M)^{\frac{1}{1-\alpha}}\right]^{1-\alpha}}{(1-\gamma)^{1-\alpha}} \qquad \partial w/\partial\theta_A > 0$$

$$n_j = \frac{(1-\gamma)(p_j\theta_j)^{\frac{1}{1-\alpha}}}{(p_A\theta_A)^{\frac{1}{1-\alpha}} + C(p_M\theta_M)^{\frac{1}{1-\alpha}}},\ j \in \{A, M\} \qquad \partial n_A/\partial\theta_A > 0, \partial n_M/\partial\theta_A < 0$$

$$n_S = \frac{\gamma\left[(p_A\theta_A)^{\frac{1}{1-\alpha}} + \alpha(p_M\theta_M)^{\frac{1}{1-\alpha}}\right]}{(p_A\theta_A)^{\frac{1}{1-\alpha}} + C(p_M\theta_M)^{\frac{1}{1-\alpha}}} \qquad \partial n_S/\partial\theta_A > 0$$

$$p_S = \frac{1}{\theta_S}\left[\frac{\gamma}{1-\gamma}\right]^{1-\alpha}\left[(p_A\theta_A)^{\frac{1}{1-\alpha}} + \alpha(p_M\theta_M)^{\frac{1}{1-\alpha}}\right]^{1-\alpha} \qquad \partial p_S/\partial\theta_A > 0$$

$$I = \pi_A + \pi_S + w \qquad \partial I/\partial\theta_A > 0$$

The Theory of NREGA

Reality

Theory

The Theory of NREGA

Reality

- all housholds, at state-level minimum wage

Theory

- wage floor: $w \geq w^N, \forall \theta_A \Rightarrow \exists \bar{\theta}_A^N$

The Theory of NREGA

Reality

- all housholds, at state-level minimum wage
- 100 days of public work per year

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- wage floor: $w \geq w^N, \forall \theta_A \Rightarrow \exists \bar{\theta}_A^N$
- NREGA labor demand at w^N is infinite

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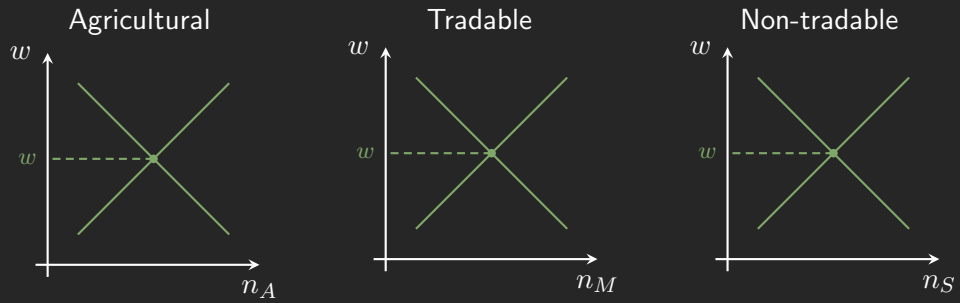
The core insight: for some bad productivity realizations, NREGA **increases** equilibrium wage

The Theory of NREGA



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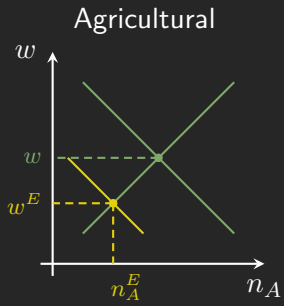

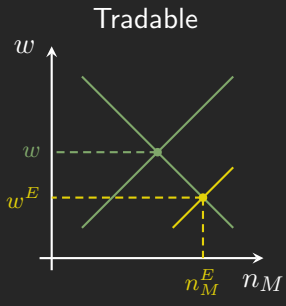

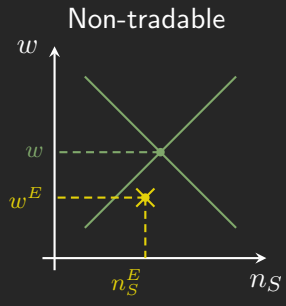

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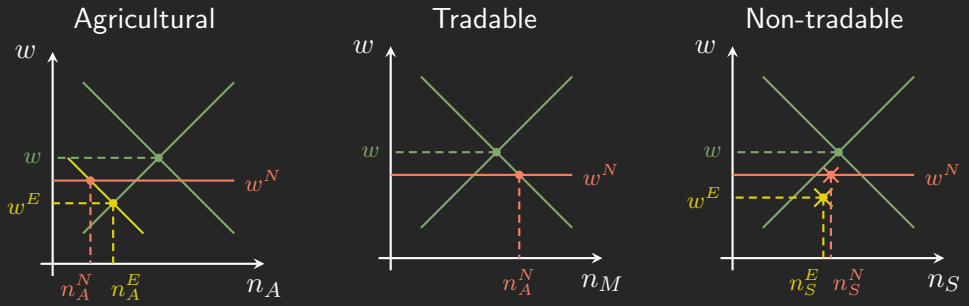

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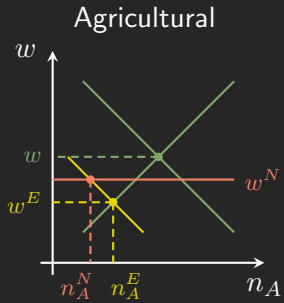

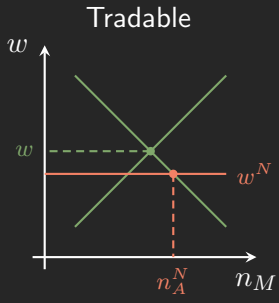

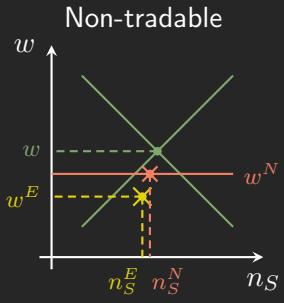

labor market clearing:

$$n_N + n_A^N + n_M^N + n_A^S = 1$$

Prediction: The Impact of NREGA and Productivity Shock

- $\partial n_N / \partial \theta_A < 0$: NREGA take-up is **counter-cyclical**
- $|\epsilon^N_{i,\theta_A}| < |\epsilon_{i,\theta_A}|, \forall i \in \{w, I, c_A, c_M, c_S, n_M, n_S\}$: NREGA is a **stabilizer**

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- with NREGA, also: w increases, tradable firms shrink, non-tradable sector grows

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Together with:

- w, n_A, n_S, p_S, I are cyclical ($\partial / \partial \theta_A > 0$)
- n_M is counter-cyclical ($\partial / \partial \theta_A < 0$)

Data

Data

- *Non-farm sectors*: Annual Survey of Industries (ASI)
  10 waves from 2000-2001 to 2009-2010 fiscal years, firm-level data
- *Consumption*: National Sample Survey (NSS) Consumer Expenditure Survey
  7 waves from 2003-2004 to 2011-2012
- *Wages and Employment*: NSS Employment and Unemployment Survey
- *Agricultural*: Ministry of Agriculture
  unbalanced panel (2000-2010, crop-by-year) and other district-level measures

Data: Treatment

- *Rainfall*: Topical Rainfall Measuring Mission (TRMM)
  - daily rainfall measures, 0.25-by-0.25 degree grid-cell size
  - aggregate to district-year total monsoon rainfall (Jun. to Sep.)
  - nonlinearlity as Jayachandran (2006)

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- *NREGA*: NSS Employment and Unemployment Survey
  - compared with state-level statutory NREGA wages from administrative sources

Variables: Industry

- *traded vs. non-traded classifier*:
  - Holmes and Stevens (2014) Commodity Flow Survey (CFS) industry classification by transportation cost
  - Mian and Sufi (2014) and Kothari (2014):
    - geographical concentration of industrial production across counties
    - degree of international trade

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- *agricultural linkage classifier*: upstream/downstream/non-linked industries of agriculture (MOSPI, 2004-2005)
- *financial performance indicator*:
  - capital intensity
  - dependence on external finance

Variables: Firm

- *firms' production*: value of total output
- *firms' employment*: total number of works and total number of man-days employed
- *daily wage*: $\frac{\text{total compensation paid}}{\text{number of man-days}}$

Empirical Strategy and Results

Rainfall and Agricultural Productivity

Prediction: $\beta > 0$

$$\log(y_{d,p,t}) = \beta \log(R_{d,p,t}) + \delta_d + \tau_{p,t} + \epsilon_{d,p,t}$$

where

- $y_{d,p,t}$: district crop yields
- d indexes district, p indexes NREGA phrases, t indexes time
- $\epsilon_{d,p,t}$: district-clustered (robust to region-year clustering)

Rainfall and Agricultural Productivity

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	log(Crop Yield)	
	(1)	(2)
log(Rainfall)	0.178^{***}	0.192^{***}
	(0.020)	(0.019)
log(Rainfall) × Share Irrigated Land		-0.150^{***}
		(0.017)
N	6763	6469
FEs: district, year	Yes	Yes

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Rainfall and Individual Wage

Prediction: $\beta > 0$

$$\log(w_{i,d,p,t}) = \beta \log(R_{d,p,t}) + \rho X_{i,d,p,t} + \delta_d + \tau_{p,t} + \epsilon_{i,d,p,t}$$

where

- $X_{i,d,p,t}$: individual i's demographic characteristics
- robustness: state-specific time trends, time trends interacted with district conditions
- wage measures: all wages; high-/low-skilled; agricultural/non-agricultural

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	log(Wage)		
	All	Agricultural	Non-Agricultural
	(1)	(2)	(3)
log(Rainfall)	0.080^{***}	0.050^{***}	0.111^{***}
	(0.020)	(0.019)	(0.030)
N	89429	44955	44474
FEs: district, phase-time	Yes	Yes	Yes

Rainfall and Individual Wage

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Rainfall and Household Consumption

Prediction: $\beta > 0$

$$\log(c_{h,d,p,t}) = \beta \log(R_{d,p,t}) + \rho X_{h,t,p,t} + \delta_d + \tau_{p,t} + \epsilon_{h,d,p,t}$$

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	log(per capita Consumption Expenditure)			
	All Goods	Food	Non-Food	Manufactured Goods
	(1)	(2)	(3)	(4)
log(Rainfall)	0.069^{***}	0.015	0.125^{***}	0.079^{***}
	(0.021)	(0.023)	(0.029)	(0.022)
N	83212	83176	83206	83205
FEs: district, phase-time	Yes	Yes	Yes	Yes

Rainfall and Firm Outcomes

Prediction: $\beta > 0$

$$\log(y_{j,d,p,t}) = \beta \log(R_{d,p,t}) + \delta_d + \tau_{p,t} + v_{p,j} + \rho_{j,t} + \epsilon_{i,d,p,t}$$

where

- j indexes industries
- $v_{p,j}$: NREGA-phase specific industry FEs
- $\rho_{j,t}$: industry-time FEs
- T_j: dummy for tradability of a given industry

Rainfall and Firm Outcomes

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	$\log(\cdot)$			
	Value of Output	Man-days	Workers	Wage
	(1)	(2)	(3)	(4)
log(Rainfall)	0.122^{**}	0.066^{***}	0.058^{***}	0.056^{***}
	(0.049)	(0.025)	(0.022)	(0.017)
N	17296	17270	17284	17270
FEs: district, phase-year	Yes	Yes	Yes	Yes
FEs: phase-industry, year-industry	Yes	Yes	Yes	Yes

Rainfall and Firm Outcomes: Tradable vs. Non-tradable

Prediction: non-tradable $\beta > 0$

$$\log(y_{j,d,p,t}) = \beta \log(R_{d,p,t}) + \delta_d + \tau_{p,t} + v_{p,j} + \rho_{j,t} + \epsilon_{i,d,p,t}$$

	$\log(\cdot)$			
	Value of Output		Man-days	
	Non-tradable	Tradable	Non-tradable	Tradable
	(1)	(2)	(3)	(4)
log(Rainfall)	0.164^{***}	-0.060	0.118^{***}	-0.079
	(0.059)	(0.065)	(0.033)	(0.064)
N	13514	3782	13497	3773
FEs: district, phase-year	Yes	Yes	Yes	Yes
FEs: phase-industry, year-industry	Yes	Yes	Yes	Yes

Rainfall and Firm Outcomes: Tradable vs. Non-tradable

Prediction: non-tradable $\beta > 0$

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	$\log(\cdot)$			
	Workers		Wage	
	Non-tradable	Tradable	Non-tradable	Tradable
	(1)	(2)	(3)	(4)
log(Rainfall)	0.110^{***}	-0.090	0.063^{***}	0.036^{*}
	(0.028)	(0.066)	(0.018)	(0.021)
N	13504	3780	13497	3773
FEs: district, phase-year	Yes	Yes	Yes	Yes
FEs: phase-industry, year-industry	Yes	Yes	Yes	Yes

Rainfall Exogeneity Validation: Placebo Tests

	$\log(\cdot)$				
	Crop Yield	Value of Output	Man-days	Workers	Wage
Panel A: Poorly Irrigated					
log(Rainfall)	0.352^{***}	0.264^{***}	0.151^{***}	0.119^{***}	0.052^{***}
	(0.048)	(0.053)	(0.032)	(0.030)	(0.017)
N	1972	5481	5471	5474	5471
Panel B: Highly Irrigated					
log(Rainfall)	0.027^{*}	0.032	0.036	0.042	0.038
	(0.015)	(0.075)	(0.045)	(0.044)	(0.040)
N	2262	5034	5028	5029	5028
Panel C: Non-Monsoon Rainfall					
log(N-M Rainfall)	0.015^{**}	-0.026	-0.033	-0.027	-0.016
	(0.007)	(0.023)	(0.023)	(0.020)	(0.010)
N	6763	17296	17270	17284	17270

NREGA: Take-Up

Prediction: $\beta = 0$, $\gamma < 0$

$$\log(y_{i,d,p,t}) = \beta \log(R_{d,p,t}) + \gamma \log(R_{d,p,t}) \times \underbrace{N_{d,p,t}}_{=\mathbf{1}(\text{NREGA})} + \rho X_{i,d,p,t} + \delta_d + \tau_{p,t} + \epsilon_{i,d,p,t}$$

NREGA: Take-Up

Prediction: $\beta = 0$, $\gamma < 0$

$$\log(y_{i,d,p,t}) = \beta \log(R_{d,p,t}) + \gamma \log(R_{d,p,t}) \times N_{d,p,t} + \rho X_{i,d,p,t} + \delta_d + \tau_{p,t} + \epsilon_{i,d,p,t}$$

	log(Days in Public Employment)
log(Rainfall)	-0.008
	(0.013)
log(Rainfall) × NREGA	-0.026^{***}
	(0.009)
N	881601
FEs: district, phase-year	Yes

NREGA: Agricultural Yields

Prediction: $\beta > 0$, $\gamma = 0$

$$\log(y_{d,p,t}) = \beta \log(R_{d,p,t}) + \gamma \log(R_{d,p,t}) \times N_{d,p,t} + \delta_d + \tau_{p,t} + \epsilon_{d,p,t}$$

NREGA: Agricultural Yields

Prediction: $\beta > 0$, $\gamma = 0$

$$\log(y_{d,p,t}) = \beta \log(R_{d,p,t}) + \gamma \log(R_{d,p,t}) \times N_{d,p,t} + \delta_d + \tau_{p,t} + \epsilon_{d,p,t}$$

	log(Crop Yield)
log(Rainfall)	0.178^{***}
	(0.020)
log(Rainfall) × NREGA	0.000
	(0.003)
N	6763
FEs: district, phase-year	Yes

NREGA: Wage Elasticity

Prediction: $\beta > 0$, $\gamma < 0$

$$\log(w_{i,d,p,t}) = \beta \log(R_{d,p,t}) + \gamma \log(R_{d,p,t}) \times N_{d,p,t} + \rho X_{i,d,p,t} + \delta_d + \tau_{p,t} + \epsilon_{i,d,p,t}$$

NREGA: Wage Elasticity

Prediction: $\beta > 0$, $\gamma < 0$

$$\log(w_{i,d,p,t}) = \beta \log(R_{d,p,t}) + \gamma \log(R_{d,p,t}) \times N_{d,p,t} + \rho X_{i,d,p,t} + \delta_d + \tau_{p,t} + \epsilon_{i,d,p,t}$$

	log(Wage)		
	All	Agricultural	Non-Agricultural
log(Rainfall)	0.062^{***}	0.057^{***}	0.075^{***}
	(0.018)	(0.018)	(0.021)
log(Rainfall) × NREGA	-0.053^{***}	-0.047^{***}	-0.049^{***}
	(0.013)	(0.018)	(0.018)
N	193602	92106	101496
FEs: district, phase-year	Yes	Yes	Yes

NREGA: Consumption Volatility

Prediction: $\beta > 0$, $\gamma < 0$

$$\log(w_{h,d,p,t}) = \beta \log(R_{d,p,t}) + \gamma \log(R_{d,p,t}) \times N_{d,p,t} + \rho X_{h,d,p,t} + \delta_d + \tau_{p,t} + \epsilon_{h,d,p,t}$$

	log(per capita Consumption Expenditure)			
	All Goods	Food	Non-Food	Manufactured Goods
log(Rainfall)	0.056^{***}	0.028^{**}	0.083^{***}	0.063^{***}
	(0.013)	(0.012)	(0.017)	(0.014)
log(Rainfall) × NREGA	-0.052^{***}	-0.043^{***}	-0.060^{***}	-0.034^{***}
	(0.011)	(0.010)	(0.015)	(0.012)
N	223323	223254	223315	223313
FEs: district, phase-year	Yes	Yes	Yes	Yes

NREGA: Local Industrial Production and Employment

Prediction: non-tradable $\beta > 0$, $\gamma < 0$

$$\log(y_{j,d,p,t}) = \beta \log(R_{d,p,t}) + \gamma \log(R_{d,p,t}) \times N_{d,p,t} + \delta_d + \tau_{p,t} + \upsilon_{p,j} + \rho_{j,t} + \epsilon_{j,d,p,t}$$

NREGA: Local Industrial Production and Employment

Prediction: non-tradable $\beta > 0$, $\gamma < 0$

$$\log(y_{j,d,p,t}) = \beta \log(R_{d,p,t}) + \gamma \log(R_{d,p,t}) \times N_{d,p,t} + \delta_d + \tau_{p,t} + v_{p,j} + \rho_{j,t} + \epsilon_{j,d,p,t}$$

	log(Wage)	log(Value of Ouput)		
		All	Non-tradable	Tradable
log(Rainfall)	0.043^{***}	0.096^{***}	0.126^{***}	0.011
	(0.012)	(0.035)	(0.041)	(0.078)
log(Rainfall) × NREGA	-0.032^{**}	-0.038	-0.086^{*}	0.138
	(0.014)	(0.037)	(0.044)	(0.091)
N	31911	31984	25097	6887
FEs: district, phase-year	Yes	Yes	Yes	Yes
FEs: phase-industry, industry-year	Yes	Yes	Yes	Yes

NREGA: Local Industrial Production and Employment

Prediction: non-tradable $\beta > 0$, $\gamma < 0$

$$\log(y_{j,d,p,t}) = \beta \log(R_{d,p,t}) + \gamma \log(R_{d,p,t}) \times N_{d,p,t} + \delta_d + \tau_{p,t} + v_{p,j} + \rho_{j,t} + \epsilon_{j,d,p,t}$$

	log(Man-days)		
	All	Non-tradable	Tradable
log(Rainfall)	0.044^{***}	0.069^{***}	-0.020
	(0.020)	(0.025)	(0.061)
log(Rainfall) × NREGA	-0.016	-0.044	0.042
	(0.027)	(0.028)	(0.060)
N	31911	25046	6865
FEs: district, phase-year	Yes	Yes	Yes
FEs: phase-industry, industry-year	Yes	Yes	Yes

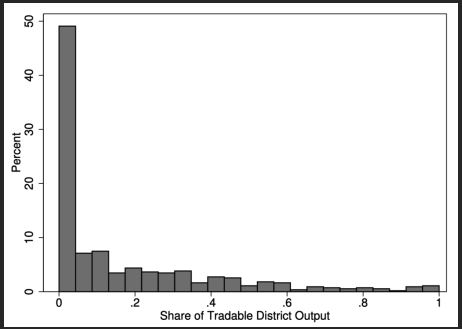
NREGA: Local Industrial Production and Employment

Prediction: non-tradable $\beta > 0$, $\gamma < 0$

$$\log(y_{j,d,p,t}) = \beta \log(R_{d,p,t}) + \gamma \log(R_{d,p,t}) \times N_{d,p,t} + \delta_d + \tau_{p,t} + v_{p,j} + \rho_{j,t} + \epsilon_{j,d,p,t}$$

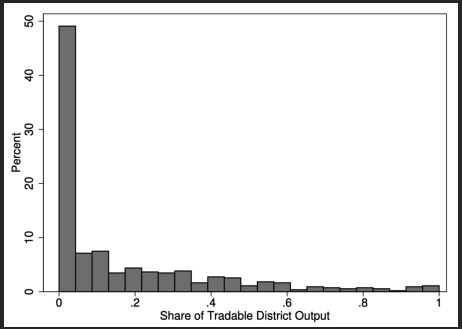
	log(Workers)		
	All	Non-tradable	Tradable
log(Rainfall)	0.040^{***}	0.062^{***}	-0.027
	(0.018)	(0.023)	(0.057)
log(Rainfall) × NREGA	-0.005	-0.030	0.031
	(0.026)	(0.027)	(0.057)
N	31940	25063	6877
FEs: district, phase-year	Yes	Yes	Yes
FEs: phase-industry, industry-year	Yes	Yes	Yes

NREGA Phase: Local Industrial Production and Employment

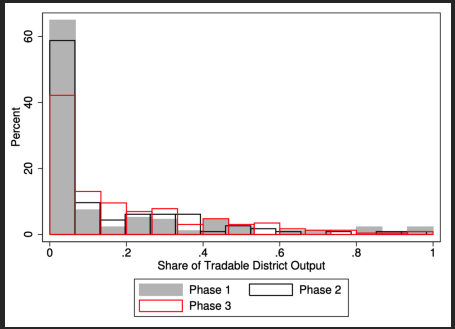


Distribution of Tradable Level
All Districts

NREGA Phase: Local Industrial Production and Employment



Distribution of Tradable Level
All Districts



Distribution of Tradable Level
By NREGA Phases

NREGA Phase: Local Industrial Production and Employment

Prediction: non-tradable $\beta > 0$, $\gamma < 0$

The effect is more pronounce in Phase 1-2 of NREGA, due to the *pre-treatment* volatility differences.

	log(Value of Output)		
	All	Non-tradable	Tradable
log(Rainfall)×Phase 1-2	0.321^{***}	0.355^{***}	-0.046
	(0.073)	(0.074)	(0.174)
log(Rainfall)×Phase 1-2 × NREGA	-0.104^{*}	-0.160^{**}	0.121
	(0.054)	(0.075)	(0.143)
log(Rainfall)×Phase 3	0.031	0.055	0.024
	(0.039)	(0.044)	(0.082)
log(Rainfall)×Phase 3 × NREGA	-0.020	-0.063	0.163
	(0.042)	(0.051)	(0.119)

NREGA Phase: Local Industrial Production and Employment

Prediction: non-tradable $\beta > 0$, $\gamma < 0$

The effect is more pronounce in Phase 1-2 of NREGA, due to the *pre-treatment* volatility differences.

	log(Value of Man-days)		
	All	Non-tradable	Tradable
log(Rainfall)×Phase 1-2	0.153^{***}	0.195^{***}	-0.032
	(0.050)	(0.050)	(0.116)
log(Rainfall)×Phase 1-2 × NREGA	-0.079^{*}	-0.119^{**}	-0.030
	(0.041)	(0.046)	(0.095)
log(Rainfall)×Phase 3	0.014	0.032	-0.017
	(0.021)	(0.026)	(0.064)
log(Rainfall)×Phase 3 × NREGA	0.015	-0.007	0.101
	(0.032)	(0.032)	(0.084)

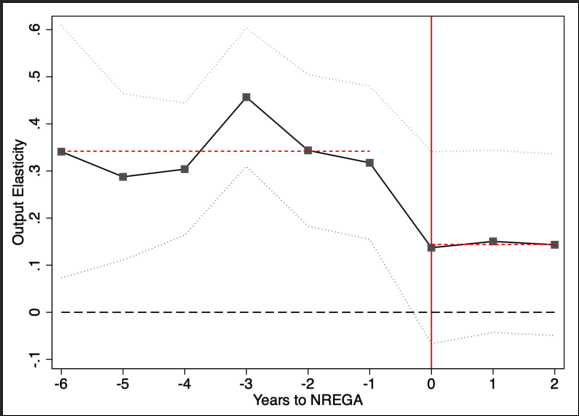
NREGA Phase: Local Industrial Production and Employment

Prediction: non-tradable $\beta > 0$, $\gamma < 0$

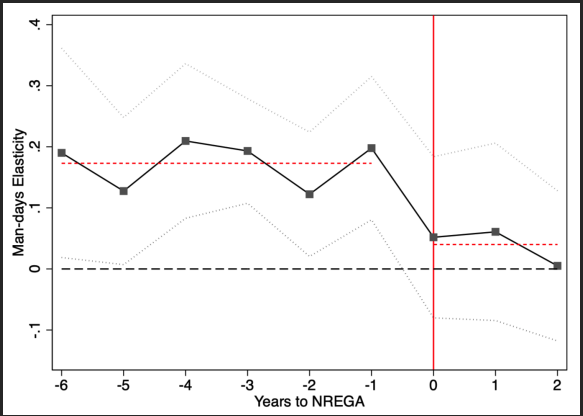
The effect is more pronounce in Phase 1-2 of NREGA, due to the *pre-treatment* volatility differences.

	log(Workers)		
	All	Non-tradable	Tradable
log(Rainfall)×Phase 1-2	0.139^{***}	0.185^{***}	-0.047
	(0.042)	(0.039)	(0.110)
log(Rainfall)×Phase 1-2 × NREGA	-0.063^{*}	-0.105^{**}	-0.018
	(0.037)	(0.041)	(0.089)
log(Rainfall)×Phase 3	0.012	0.026	-0.022
	(0.020)	(0.025)	(0.059)
log(Rainfall)×Phase 3 × NREGA	0.022	0.005	0.074
	(0.031)	(0.030)	(0.081)

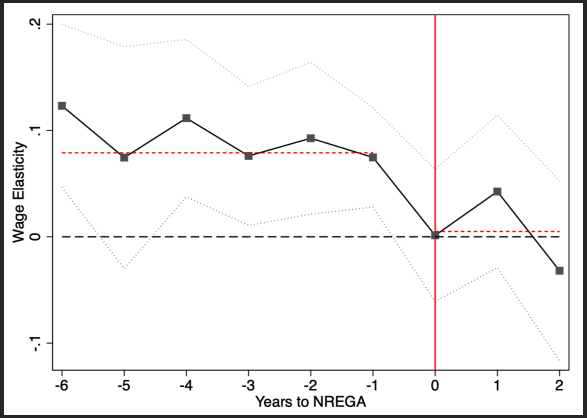
DiD Validation: Pre-Trends



DiD Validation: Pre-Trends



DiD Validation: Pre-Trends



Discussion

About This Paper

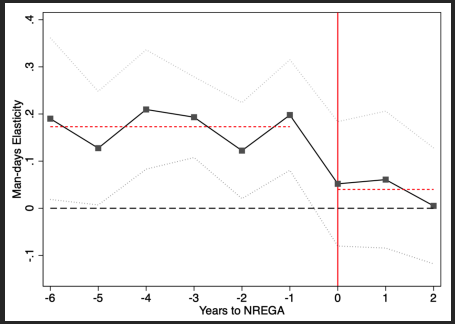
Pros

- simple and intuitive model
- very good data
- solid empirical strategy
- clean results

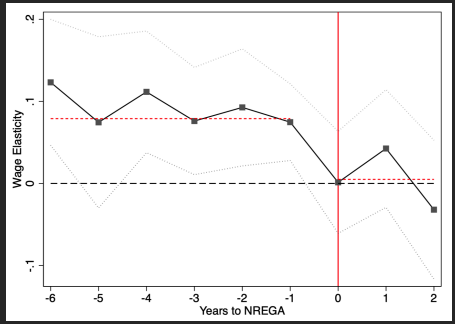
Debatables

- impact of NREGA
- exogeneity, choice of FEs
- firm performances
- organization of the paper

Further Thoughts: Dynamics

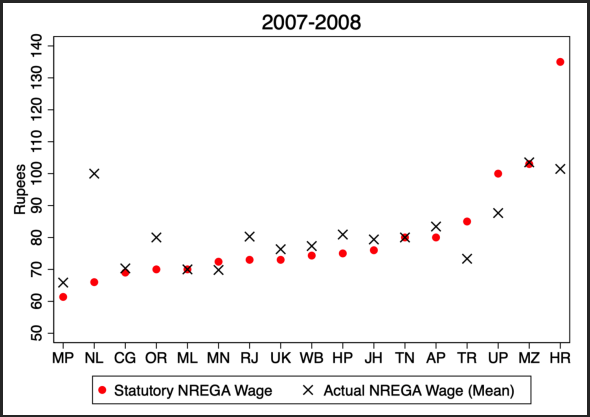


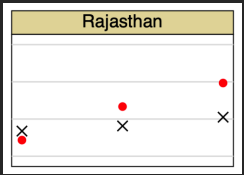
Non-tradable Employment Elasticity

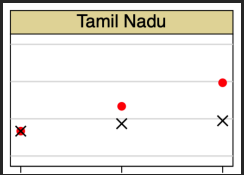


Non-tradable Wage Elasticity

Further Thoughts: Actual vs. Statutory NREGA Wages







Further Thoughts: Other Potentials

- Manufacture versus Service (Table 4)
- How to understand the tradable good sector?
- Targeting of NREGA
- Spillover: Household/Geographic/Industrial/Sectoral
- Other stablizing channels: Finance
- Welfare: Is it worth it?

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Thank you!