Minimum Wage, Automation, and Offshoring in India

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Motivation

- How do **firms** adjust their **employment** and **capital investment** in response to **rising minimum wages**? $\rightarrow$ input mix and structural transformation in developing countries?

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- Why? In part because **firms are heterogeneous** and respond differently
- Aggregate effect is important, but **minimum wage is not a one-size-fits-all**
  - Politicians → their state given industry mix
  - Labor unions and firms → their firm given their worker mix
  - To generalize to other countries/industries need to understand heterogeneity

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- How firms adjust is not trivial because there are **many channels**
  - Unclear effects on employment and capital
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    - Substitution between workers: Card & Krueger (1992)
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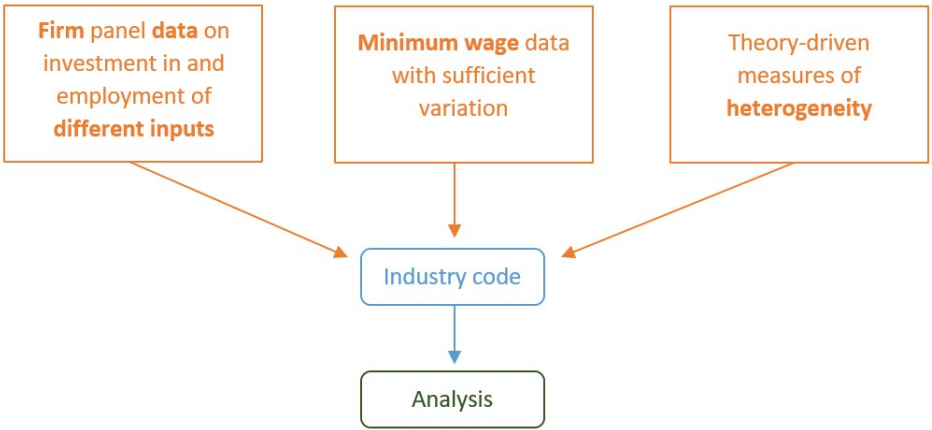
- To understand why firms adjust differently= data challenge

Motivation


Firm panel **data** on investment in and employment of **different inputs**
Minimum wage data with sufficient variation
Theory-driven measures of **heterogeneity**
Industry code
Analysis

Data

- Ideal context → formal **firms in India** between 2002 and 2008
- Minimum wages → **state, year, and industry level**
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  - Automation-Industries intensive in codable tasks (Autor and Dorn(2013))
    - Tasks: Repetitive assembly, repetitive accounting, sorting and packaging
    - Industries: Manuf of beverages or bakery prod, printing and publishing
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- Empirical strategy→ continuous difference-in-difference

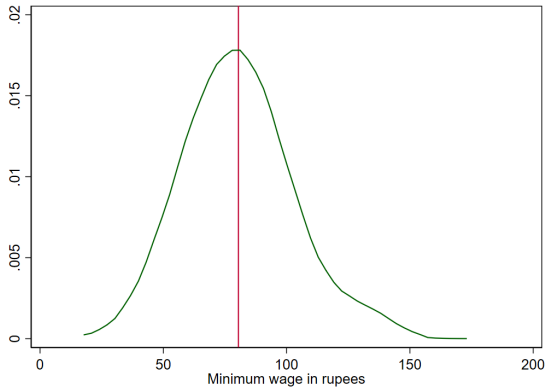
Context-Minimum wage setting

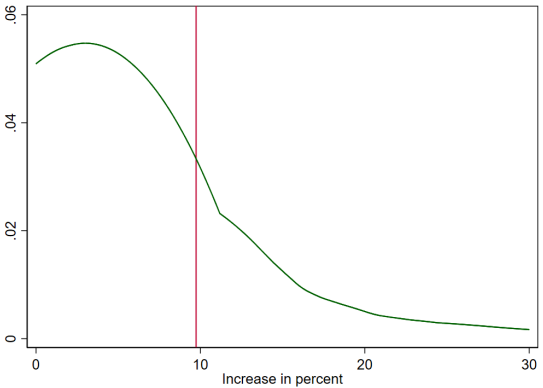
Minimum Wage Act of 1948

- Federal govt. mandates **states** to **select 4-digit industries** to be subject to a minimum wage
  - Must revise at least every 5 years
  - Must publish in state gazette a few months before take effect in January
- **Legislation does not dictate the methodology** for wage revisions
  - Process opaque and hard to predict. Adhvaryu et al. (2021)
  - Not tied to inflation
- **Compliance** through random **audits** and audits triggered by worker complaints
  - Penalty for every violation is up to 3 years of imprisonment and/or payment of a fine
  - Up to 3X worker's yearly wage income per violation

1-Reports on the Working of the Minimum Wage Act of 1948

- 6,325 4-digit industry minimum wages data points with 2,587 nominal increases





Compared to other countries
Minimum wage binds

Model

- Effect of minimum wages on inputs is not trivial! **Model → predictions**
  - Production: Y $\underbrace{\leftarrow}_{CES}$ Tasks $\underbrace{\leftarrow}_{CES}$ Inputs (Payroll, Contract, Managers, K, Computers)

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- Consider $\Delta\$Payroll > \Delta\$Contract > \Delta\$Managers, \Delta\$K, Computers < 0$
  - Incentive to substitute away from (towards) input with largest (smallest) price increase in every task

No scope:	$\Delta Payroll < 0$	$\Delta managers > 0$	$\Delta K = 0$
Scope automation:	$\Delta Payroll < 0$		$\Delta K > 0$
Scope offshoring:	$\Delta Payroll < 0$		$\Delta K \leq 0$

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  - What happens to labor inputs with intermediate price increase is unclear
    - $\downarrow$ *Payroll* $\uparrow$ *Contract* in tasks using Payroll and Contract as substitutes
    - $\uparrow$ *Managers* $\downarrow$ *Contract* in tasks using Contract and Managers as substitutes
    - $\downarrow$ *Managers* $\uparrow$ *Capital* in tasks using Managers and Capital as substitutes

Empirical strategy- continuous difference-in-difference

$$y_{ft} = \alpha + \beta M_{sit} + \eta X_{ft} + \delta_f + \delta_{d \times t} + \delta_{i \times t} + \varepsilon_{ft}$$

- $y_{ft} \rightarrow$ Investment/employment for firm f in year t
- $M_{sit} \rightarrow$ **Real** minimum wage
- δ_f, $\delta_{d \times t}$, $\delta_{i \times t} \rightarrow$ **Firm, district-by-year, and industry-by-year fixed effects** Plenty of variation
- Standard errors $\rightarrow$ Clustered at the industry-by-state level

Heterogeneity

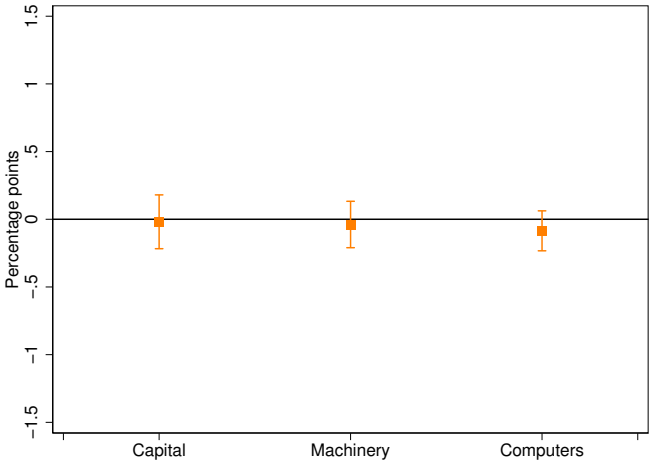
$$y_{ft} = \alpha + \beta_0 M_{sit} + \beta_1 M_{sit} Auto_i + \beta_2 M_{sit} Off_i + \eta X_{ft} + \delta_f + \delta_{d \times t} + \delta_{i \times t} + \varepsilon_{ft}$$

- $Auto_i$ and $Off_i \rightarrow$ Scope for automation and offshoring (in SD of national average)
- Employment: further interact with type of employee

Threat to identification

- **Pretrend differentials:** If a firm were to be treated by a minimum wage, its outcomes would evolve the same way as firms who were actually treated by that minimum wage.
  - Visual test using event-study specifications
  - δ_f, $\delta_{d\times t}$, $\delta_{i\times t} \rightarrow$ confounding policies, local economic shocks, and industry shocks
- **Spillover across states (SUTVA):**
  - "Migration between states is very low in India, both in absolute terms as well as relative to other countries" -Munshi and Rosenzweig(2016)
  - Aggregate industry-level employment in a state not affected by min wage of other states
- **Spillover within states (SUTVA):** Min wage in other industries can affect outside option
  - Control for min wage in other industry of my state$\times$ firm density in my district -Clarke(2017), Butts(2021), Forastiere et al.(2020)

Average effect of a typical increase (3%) on K investment



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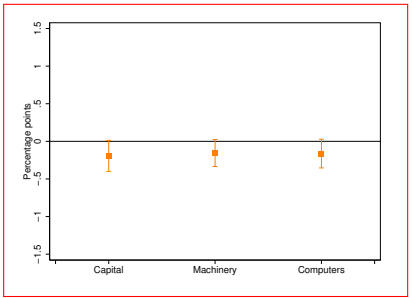
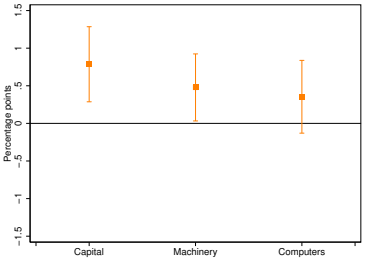
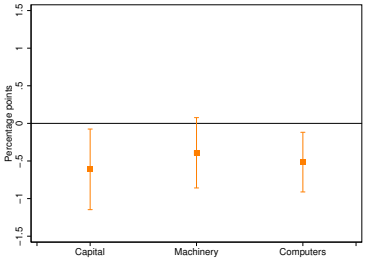


Less scope for automation and offshring



Scope for automation (1sd)



Scope for offshoring (1sd)

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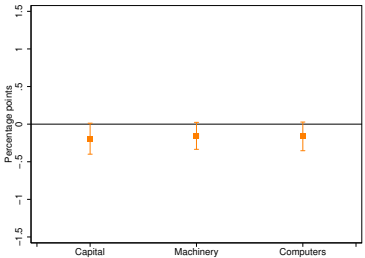

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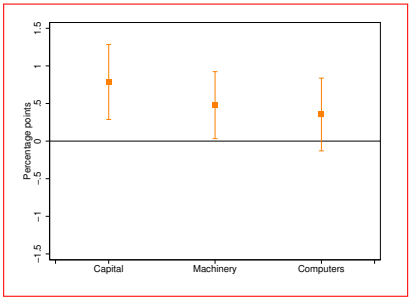

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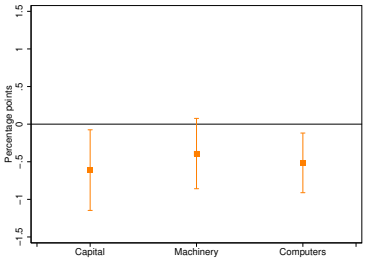

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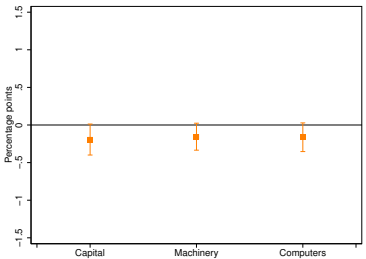

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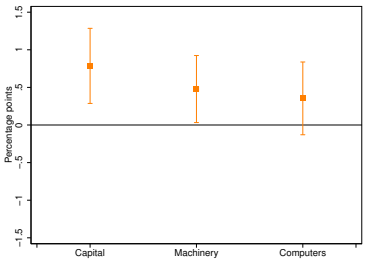

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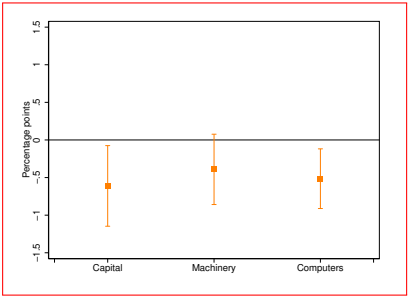

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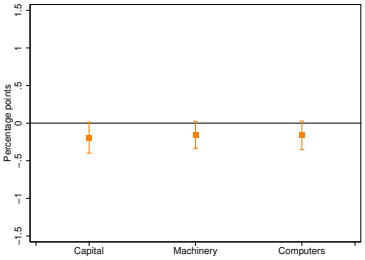
Effect of a typical increase (3%) on K investment Table Event



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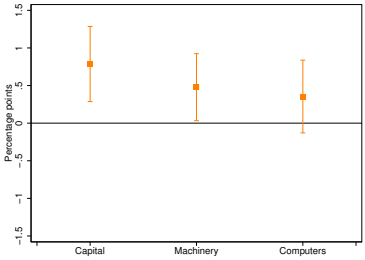

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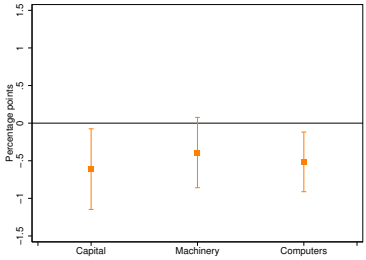

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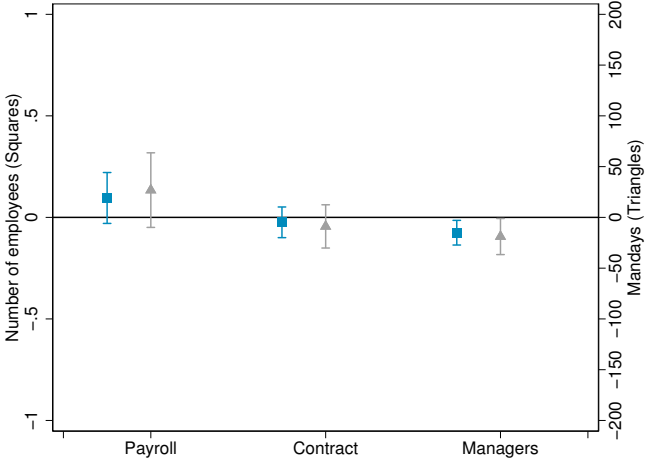
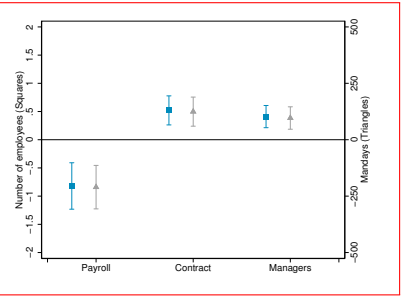
Average effect for a typical increase of 3% (number workers, mandays)



Average across all types of firms

Binds for payroll workers (number workers, mandays)



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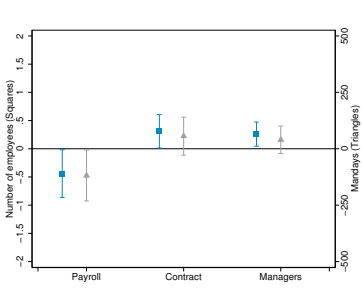

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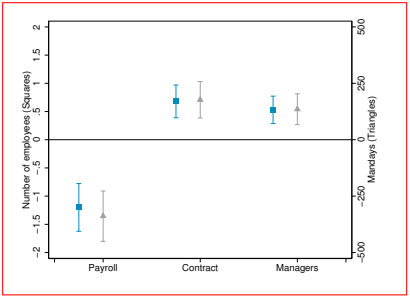

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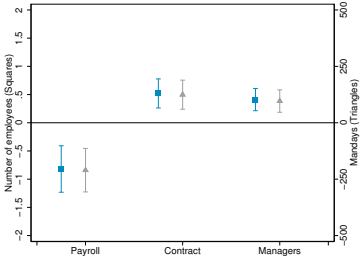

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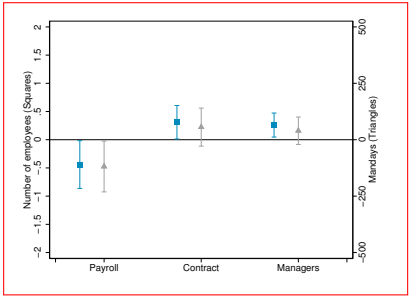

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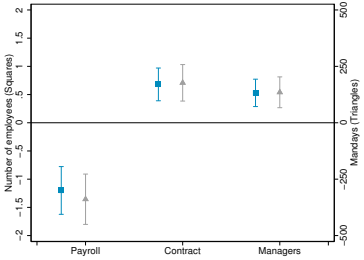
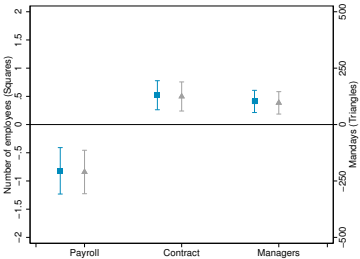


Scope for offshoring (1sd)

Binds for payroll workers (number workers, mandays) Details Tables



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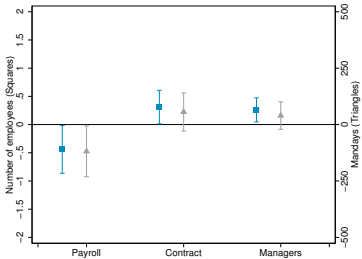

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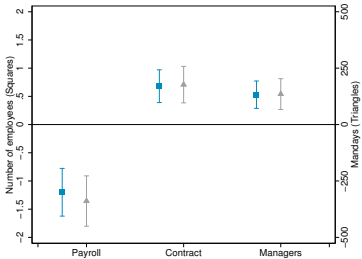

Scope for offshoring (1sd)

- **Binds less for payroll workers** Results
  - Evidence of substitution away from contract workers instead
  - Effect on managers is ambiguous

Conclusion

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  - **Scope for automation**: ↓ Payroll ↑ Machinery ↑ Computers
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- Ignoring firm or worker heterogeneity→ miss these effects

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  - Substitute away from contract if min wage binds more for them
- Aggregate employment falls for younger workers and older workers (scope for automation)
- Ignoring firm or worker heterogeneity→ miss these effects
- Larger employment adjustments in states where cheaper to lay off workers Lay off results

Conclusion

- Continuous difference approach→ how formal Indian **firms adjust** their employment and their K investment in response to rising **minimum wages**
  - **Scope for automation**: ↓ Payroll ↑ Machinery ↑ Computers
  - **Less scope**: ↓ Payroll ↑ Contract ↑ Managers
  - **Scope for offshoring**: ↓ Payroll ↑ Contract ↑ Managers ↓ Computers
  - Substitute away from contract if min wage binds more for them
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- Next→ ?

Robustness

- **Robustness**
  - Controlling for minimum wages of other industries (outside option) Results
  - Using hikes exceeding inflation Results
  - Contiguous districts design Results
  - Staggered design using clean controls Results
  - Discreet ranking (75th percentile) Results
  - Event study graphs Results
- **Profit, output, outsourcing unaffected** Results
- **Aggregate employment** Results
  - Ignore firm/industry heterogeneity$\rightarrow$ no effect
  - $\downarrow$ Young workers in all industries and $\downarrow$ old workers where scope for automation

Thank you!

Indian workforce

- Workforce is composed 500 million people
  - 250 million people are employed in non-agriculture sectors
  - 100 million people are employed in formal firms
  - 61 million of workers in formal firms are in minimum wage industries (eligible)
  - 42 million of eligible workers are paid $\leq$120% of prevailing minimum wage (69% of eligible and 17% of total non-ag workforce)
- Firms in my data sets represent at least 50% of all employment in formal firms

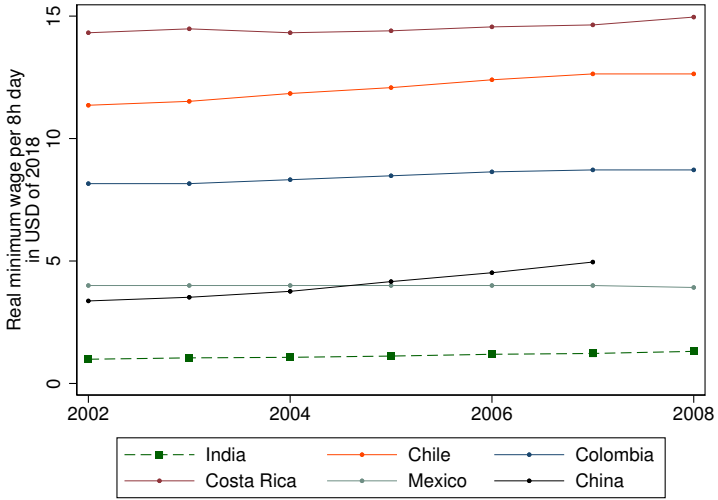
Context-Minimum wage setting

The analysis takes place between 2002 and 2008 and another program is rolled out at the end of that period

- National Rural Employment Guarantee Act (NREGA) rolled out between 2006 and 2008
- Individuals in poor rural districts are "guaranteed" public work at a minimum wage
- Not related to formal sector studied here, but could affect outside option -Imbert and Papp(2015)
- Include district-by-year fixed effects to account for this policy
- Minimum wage setting

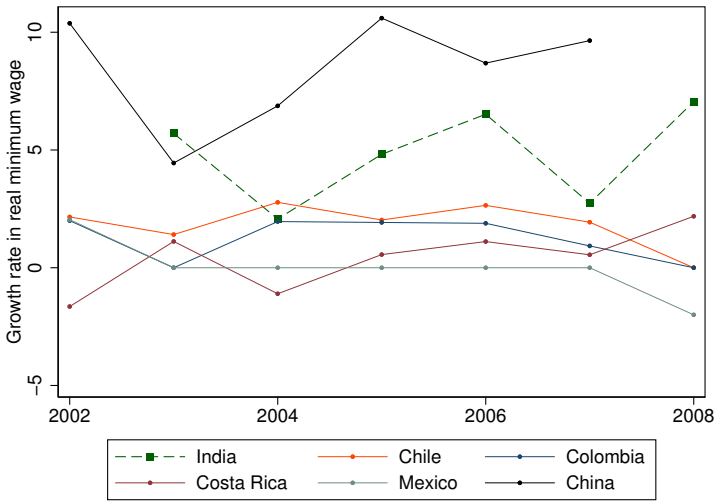
Comparison with other developing countries

Real minimum wage in 2018 USD



Comparison with other developing countries

Growth rate in real minimum wage



Minimum wage binds for many workers

Minimum wage

	(1) Daily wage	(2) Daily wage
Minimum wage	0.281**	0.312**
	(0.118)	(0.131)
Minimum wage X Auto		-0.185
		(0.132)
Minimum wage X Offshore		0.272***
		(0.0868)

Investment-Prowess

Prowess

- Follow macro finance and take the change in the net value over the average net value of the previous year (dampens jumps in net value due to inflation)

Investment in capital, K

$$I_{ft}^{K} = \frac{\text{Net Val of } K_t - \text{Net Val of } K_{t-1}}{0.5(\text{Net Val of } K_{t-1} + \text{Net Val of } K_{t-2})}$$

Investment in machinery, K^m

$$I_{ft}^{K^m} = \frac{\text{Net Val of } K_t^m - \text{Net Val of } K_{t-1}^m}{0.5(\text{Net Val of } K_{t-1}^m + \text{Net Val of } K_{t-2}^m)}$$

Investment in computers, K^c

$$I_{ft}^{K^c} = \frac{\text{Net Val of } K_t^c - \text{Net Val of } K_{t-1}^c}{0.5(\text{Net Val of } K_{t-1}^c + \text{Net Val of } K_{t-2}^c)}$$

Industries where firms have scope for automation

- Intensive in **tasks easy to code** (routine)- clear and known set of actions to achieve the task Autor and Dorn(2013)
  - Tasks: Filling identical bottles, low-level accounting, repetitive assembly
  - Industries: Manuf of beverages or bakery prod, printing and publishing

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Industries where firms have scope for offshoring

- Intensive in **tasks that can be done off site**- don't need face-to-face interactions or to be done at specific location. Acemoglu and Autor(2011)
  - Tasks: Data analysis, quality verification, software debugging
  - Industries: Game and toys manuf, software, call centers

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  - Tasks: Data analysis, quality verification, software debugging
  - Industries: Game and toys manuf, software, call centers

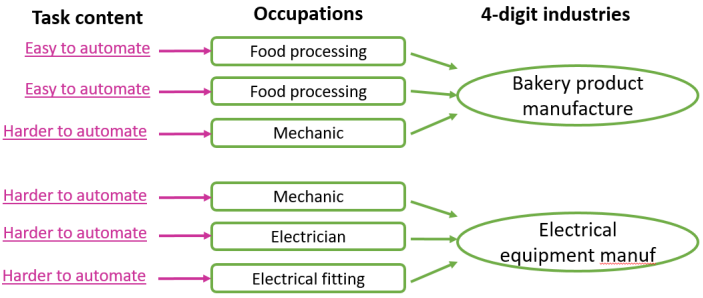
Industries where firms have less scope for automating or offshoring

  - Tasks: Electrical fitting, repair fixed equipment, cleaning, transportation
  - Industries: Manuf electrical equipment, maintenance of vehicles

Data

Scope for automation and offshoring

2000 round of the NSS survey→ contains **occupation** and **industry** of employed



Measures to be mean 0 and SD 1 at the 4-digit industry level. Details

Data

Model-Predictions

Model

- **Input demand function of:** input prices, output, productivity, task composition, and ease of substitution between inputs
- **Special case holds** in the data$\rightarrow$ output and productivity unaffected by min wages

When min wage binds more for payroll ($\Delta\$Payroll > \Delta\$Contract$)

- Incentive to substitute away from priciest input (payroll)

No scope:	$\Delta Payroll < 0$	$\Delta K = 0$
Scope automation:	$\Delta Payroll < 0$	$\Delta K > 0$
Scope offshoring:	$\Delta Payroll < 0$	$\Delta K \leq 0$

- What happens to labor inputs with intermediate price increase is unclear
  - $\downarrow$ *Payroll* $\uparrow$ *Contract* in tasks using Payroll and Contract as substitutes
  - $\uparrow$ *Managers* $\downarrow$ *Contract* in tasks using Contract and Managers as substitutes
  - $\downarrow$ *Managers* $\uparrow$ *Capital* in tasks using Managers and Capital as substitutes

Model-overview

- In the spirit of Goos et al.(2014), and Acemoglu and Restrepo(2018)
- Firms produce a final output, Y, by combining a continuum of tasks, $y(i)$ with $i \in [0,1]$

$$Y = \left(\int_0^1 y(i)^{\frac{\sigma-1}{\sigma}} di\right)^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

- σ is the elasticity of substitution between tasks
- $\sigma \to 0$ perfect complements, $\sigma = 1$ Cobb-Douglas, $\sigma \to \infty$ perfect substitutes

Model-overview

- Allow for many inputs in a flexible CES production function
- Tasks can potentially be done by different inputs: contract workers (c), payroll workers (r), managers (m), and capital (k).

$$y(i) = \Big(\sum_{j \in \{c,r,m,k\}} [\delta_j(i) \times j(i)]^{\frac{\varepsilon_i - 1}{\varepsilon_i}} \Big)^{\frac{\varepsilon_i}{\varepsilon_i - 1}}. \tag{2}$$

- ε_i is the elasticity of substitution between inputs in task i
- $\delta_j \geq 0$ is the productivity of input j in task i

Model-overview

Assumptions:

- Firms take the wages as given. Minimize cost of producing each task by choosing inputs, then minimize cost of producing the output by choosing the number of tasks

Implications:

- The log-demand for input j in task i conditional on output is:

$$\mathcal{L}_j(i) = \underbrace{ln(Y)}_{\text{Output}} + (\varepsilon_i - 1) \underbrace{ln(\delta_j(i))}_{\text{Productivity}} - \varepsilon_i \underbrace{ln(w_j)}_{\text{Own wage}} + (\varepsilon_i - \sigma) \underbrace{ln(p(i))}_{\text{Task price}}.$$

- If output, productivity, and wages change, then no clear predictions at the firm level

Special case: output and productivity are unaffected by wages

- The total derivative of the log-input demand becomes:
  - $dp(i)$ depends on the change in wage of all inputs used in that task

$$d\mathcal{L}_j(i) = \underbrace{\varepsilon_i\left(\frac{dp(i)}{p(i)} - \frac{dw_j}{w_j}\right)}_{\text{Substitution within tasks}} \underbrace{-\sigma\frac{dp(i)}{p(i)}}_{\text{Substitution between tasks}} \tag{3}$$

- Firm-level demand ↑ (↓) for input with smallest (largest) wage increase

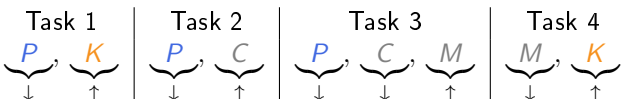
Comparative statics

- The minimum wage can affect the wage of all local labor inputs
- $\Delta\$K$ falls at a **constant** rate worldwide (Karabarbounis et al(2014)), $\Delta\$$ foreign labor=0

Model-overview

Firms with scope for automation when $\Delta\$Payroll > \Delta\$Contract$

- Firm level→ **use less** input with largest wage increase - ↓ Payroll
- Firm level→ **use more** input with smallest wage increase- ↑ Capital (↑ with scope for auto)
- What happens to other inputs depends on task composition and ε_i

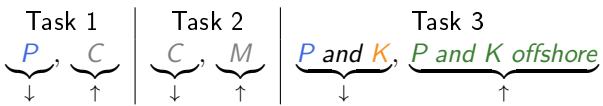


Model-Predictions

Model-overview

Firms with scope for offshoring when $\Delta\$Payroll > \Delta\$Contract$

- Firm level$\rightarrow$ **use less** input with largest wage increase - $\downarrow$ Payroll
- Firm level $\rightarrow$ $\Delta K \leq 0$ depends on whether offshorable tasks require capital

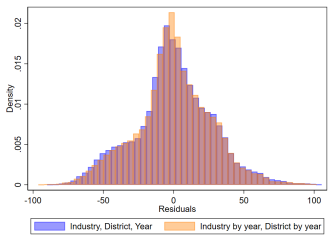


Firms without scope for automation and offshoring when $\Delta\$Payroll > \Delta\$Contract$

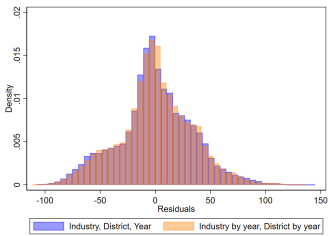
- Firm level$\rightarrow$ $\downarrow$ Payroll, $\Delta K = 0$

Variation in residuals

Variation in residuals



Nominal minimum wage



Real minimum wage

- There is substantial variation in the minimum wages event when accounting for stringent fixed effects

Results-Investment

Return

	Capital		Machinery	Computers
	(1)	(2)	(3)	(4)
Minimum wage	-0.00742	-0.0773	-0.0621	-0.0651
	(0.0484)	(0.0501)	(0.0436)	(0.0464)
Minimum wage X Auto		0.392***	0.253**	0.207
		(0.142)	(0.124)	(0.145)
Minimum wage X Offshore		-0.167	-0.0943	-0.141
		(0.121)	(0.104)	(0.0872)
Observations	54997	54997	54997	54997
Mean of Y	12.29%	12.29%	7.76%	8.33%

Results-Number of employees

Graphs

	Pooled
Minimum wage	-.03
	(.052)
MinXContract	.06
	(.04)
MinXManager	-.04*
	(.025)
MinXAuto	.45***
	(.135)
MinXAutoXContract	-.27***
	(.082)
MinXAutoXManager	-.25***
	(.062)
MinXOff	-.45***
	(.124)
MinXOffXContract	.4***
	(.081)
MinXOffXManager	.24***
	(.059)
Observations	433770

Results-Number of employees

Graphs

	Group 1	Group 2	Group 3	Group 4
	Median firm compensation $< 105\%$ of minwage	Median firm compensation $[105\%, 130\%)$ of minwage	Median firm compensation $[130\%, 180\%)$ of minwage	Median firm compensation $> 180\%$ of minwage
Minimum wage	-.82***	-.15*	-.13	.29***
	(.251)	(.088)	(.091)	(.081)
MinXContract	.52***	.09	.11	-.01
	(.157)	(.063)	(.071)	(.048)
MinXManager	.41***	.01	-.08*	-.15***
	(.12)	(.043)	(.043)	(.043)
MinXRTI	-.44*	.29*	.63***	.5***
	(.258)	(.17)	(.271)	(.164)
MinXRTIXContract	.31*	-.09	-.34**	-.32***
	(.181)	(.125)	(.153)	(.105)
MinXRTIXManager	.26**	-.12	-.39***	-.34***
	(.13)	(.084)	(.106)	(.083)
MinXOff	-1.2***	-.76***	-.46***	-.23
	(.258)	(.214)	(.164)	(.183)
MinXOffXContract	.68***	.35**	.27**	.38***
	(.177)	(.153)	(.12)	(.116)
MinXOffXManager	.53***	.21**	.01	.21***
	(.148)	(.102)	(.085)	(.086)

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Results-Number of mandays worked by each type of employee

Graphs

	Pooled	Group 1	Group 2	Group 3	Group 4
		Median firm compensation $< 105\%$ of minwage	Median firm compensation [105%, 130%) of minwage	Median firm compensation [130%, 180%) of minwage	Median firm compensation $> 180\%$ of minwage
Minimum wage	-9.11	-210.18***	-33.2	-40.1	79.31***
	(13.983)	(58.748)	(26.146)	(26.865)	(20.06)
MinXContract	11.96	124.49***	21.17	25.61	.5
	(9.993)	(39.311)	(16.856)	(18.997)	(12.263)
MinXManager	-8.73	96.19***	7.87	-23.71*	-39.74***
	(6.887)	(30.265)	(12.971)	(13.103)	(11.182)
MinXAuto	132.02***	-118.63*	111.29**	188.44***	141.6***
	(40.294)	(68.629)	(53.424)	(81.025)	(47.957)
MinXAutoXContract	-78.67***	55.9	-27.61	-105.97**	-90.59***
	(23.894)	(51.376)	(37.065)	(45.794)	(30.983)
MinXAutoXManager	-73.75***	39.88	-33.34	-120.12***	-99.01***
	(18.283)	(37.055)	(26.817)	(32.862)	(24.246)
MinXOff	-147.83***	-338.89***	-248.29***	-138.99***	-89.93*
	(38.79)	(67.991)	(72.602)	(51.815)	(52.527)
MinXOffXContract	119.93***	177.07***	93.37*	82.54***	127.98***
	(24.711)	(49.318)	(48.974)	(34.952)	(33.775)
MinXOffXManager	84.69***	135.04***	64.57*	14.99	79.98***
	(18.142)	(41.63)	(35.225)	(26.128)	(23.851)

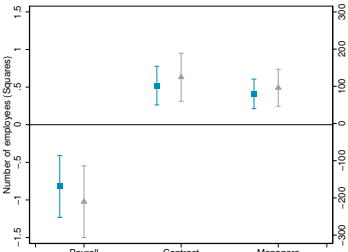
Log(real prices/unit)

Return

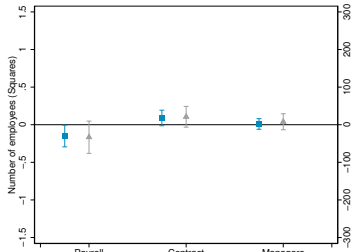
	(1) Pooled	(2) Group 1	(3) Group 2	(4) Group 3	(5) Group 4
Minimum wage	0.000222	0.00176*	0.000355	-0.000513	0.00186
	(0.000316)	(0.00106)	(0.000834)	(0.000743)	(0.00212)
MinXAuto	0.000772	-0.000775	0.000788	0.000374	0.00144
	(0.000475)	(0.00191)	(0.00135)	(0.00106)	(0.00382)
MinXOff	-0.000132	0.0000546	-0.00219	-0.000268	0.00201
	(0.000499)	(0.00214)	(0.00176)	(0.000964)	(0.00258)

Firms with smaller scope for automation and offshoring (number workers, mandays)

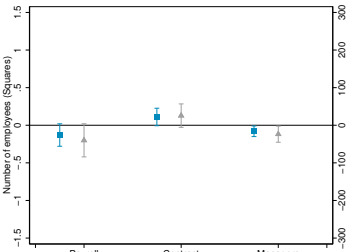
Results



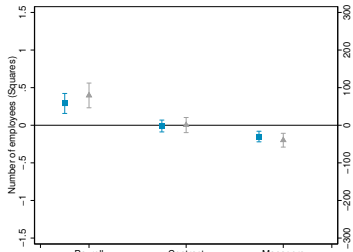
Median firm comp. $< 105\%$ of minwage



Median firm comp. $[105\%, 130\%)$ of minwage



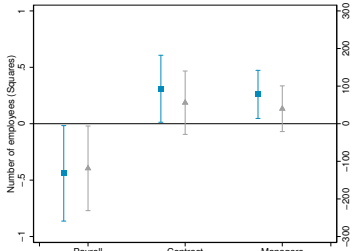
Median firm comp. $[130\%, 180\%)$ of minwage



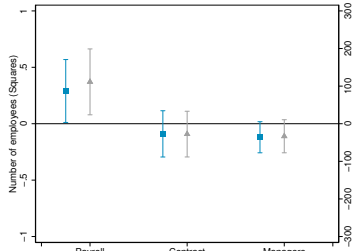
Median firm comp. $> 180\%$ of minwage

Firms with scope for automation (number workers, mandays)

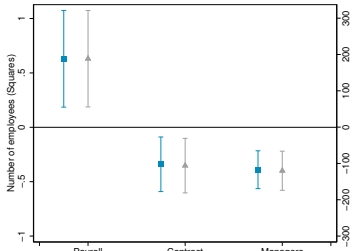
Results



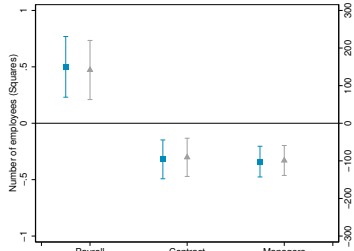
Median firm comp. $<$ 105% of minwage



Median firm comp. [105%, 130%) of minwage

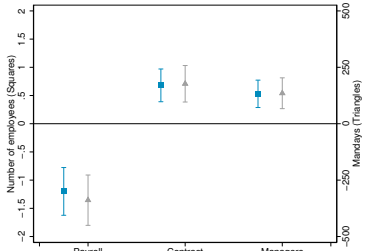


Median firm comp. [130%, 180%) of minwage



Median firm comp. $>$ 180% of minwage

Firms with scope for offshoring (number workers, mandays) Results



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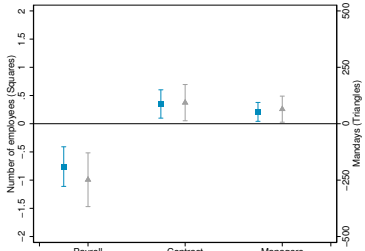

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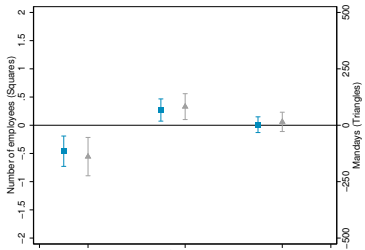

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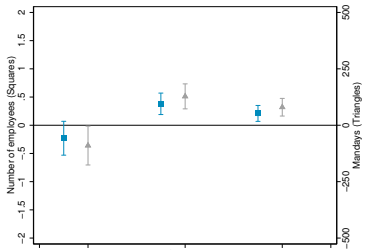


Median firm comp. $> 180\%$ of minwage

Binding

Graphs

- Total compensation bill$\rightarrow$ how binding is min wage by district and industry

$$\textbf{Binding for payroll} = \frac{\text{Median payroll worker compensation}}{\text{Minimum wage}}$$

- **Split into quartiles**$\rightarrow$ 25% of district-industry per group
- **Total compensation bill**= everything
  - Wages, salaries, bonuses, payment of overtime +
  - Dearness, compensatory, house rent and other allowances +
  - Paid leaves, paid holiday, lay-off payments, and compensation for unemployment

Robustness controlling for the outside option wage-Capital

Return

	Capital		Machinery	Computers
	(1)	(2)	(3)	(4)
Minimum wage	-0.00936	-0.0698	-0.0571	-0.0485
	(0.0488)	(0.0513)	(0.0440)	(0.0459)
Minimum wage X Auto		0.358**	0.248**	0.227
		(0.146)	(0.126)	(0.145)
Minimum wage X Offshore		-0.175	-0.118	-0.222***
		(0.125)	(0.107)	(0.0923)
Observations	54997	54997	54997	54997
Mean of Y	12.29%	12.29%	7.76%	8.33%

Robustness controlling for the outside option wage-Employment

Return

	(1) Pooled	(2) Group 1	(3) Group 2	(4) Group 3	(5) Group 4
Minimum wage	-.03	-.8***	-.15*	-.13	.29***
	(.052)	(.252)	(.089)	(.091)	(.081)
MinXContract	.06	.53***	.09	.12	-.01
	(.04)	(.154)	(.063)	(.071)	(.048)
MinXManager	-.04*	.43***	.01	-.07*	-.15***
	(.025)	(.116)	(.043)	(.043)	(.043)
MinXRTI	.45***	-.46*	.31*	.63***	.51***
	(.135)	(.258)	(.167)	(.271)	(.164)
MinXRTIXContract	-.27***	.29	-.08	-.34**	-.31***
	(.082)	(.186)	(.13)	(.152)	(.106)
MinXRTIXManager	-.25***	.24*	-.1	-.39***	-.33***
	(.063)	(.139)	(.088)	(.106)	(.084)
MinXOff	-.44***	-1.21***	-.8***	-.44***	-.24
	(.124)	(.268)	(.217)	(.163)	(.182)
MinXOffXContract	.4***	.68***	.3**	.29***	.37***
	(.081)	(.184)	(.152)	(.121)	(.118)
MinXOffXManager	.25***	.53***	.17	.03	.2**
	(.059)	(.163)	(.102)	(.086)	(.087)

Robustness using minimum wage changes exceeding inflation-Capital

Return

	Capital		Machinery	Computers
	(1)	(2)	(3)	(4)
Minimum wage	-0.00989	-0.0808	-0.0672	-0.0390
	(0.0530)	(0.0533)	(0.0465)	(0.0344)
Minimum wage X Auto		0.391**	0.270*	0.140
		(0.153)	(0.138)	(0.154)
Minimum wage X Offshore		-0.159	-0.103	-0.0780
		(0.133)	(0.132)	(0.0876)
Observations	54997	54997	54997	54997

Robustness using minimum wage changes exceeding inflation-Employment

Return

	(1) Pooled	(2) Group 1	(3) Group 2	(4) Group 3	(5) Group 4
Minimum wage	-.01	-.6**	-.05	-.1	.25***
	(.051)	(.281)	(.102)	(.092)	(.077)
MinXContract	.05	.51***	-.01	.13*	-.01
	(.038)	(.168)	(.071)	(.067)	(.046)
MinXManager	-.05**	.47***	-.1*	-.05	-.15***
	(.025)	(.126)	(.053)	(.041)	(.042)
MinXAuto	.5***	-.2	.35*	.7***	.51***
	(.133)	(.368)	(.205)	(.235)	(.164)
MinXAutoXContract	-.26***	.29	-.26*	-.24	-.31***
	(.084)	(.242)	(.143)	(.168)	(.109)
MinXAutoXManager	-.23***	.31*	-.3***	-.28**	-.32***
	(.063)	(.17)	(.111)	(.125)	(.084)
MinXOff	-.4***	-.86***	-.49*	-.53***	-.17
	(.123)	(.313)	(.254)	(.166)	(.178)
MinXOffXContract	.31***	.76***	.33*	.14	.3***
	(.082)	(.196)	(.176)	(.112)	(.118)
MinXOffXManager	.17***	.68***	.18	-.1	.14
	(.059)	(.161)	(.127)	(.089)	(.087)

Robustness using variation from firms in districts along state borders-Capital

Return

I find neighboring districts using shape files. Because Prowess has its own district codes, I need to match counties on their names and lose 20% of firmXyear observations.

	Capital		Machinery	Computers
	(1)	(2)	(3)	(4)
Minimum wage	-0.00954	-0.0585	-0.0411	-0.0412
	(0.0539)	(0.0643)	(0.0539)	(0.0474)
Minimum wage X Auto		0.276*	0.143	0.118
		(0.164)	(0.141)	(0.165)
Minimum wage X Offshore		-0.141	-0.0916	-0.202**
		(0.126)	(0.106)	(0.0989)
FirmXYear Obs.	45032	45032	45032	45032

Robustness using variation from firms in districts along state borders-Employment

Return

	(1) Pooled	(2) Group 1	(3) Group 2	(4) Group 3	(5) Group 4
Minimum wage	-.06	-.72***	-.08	-.17***	.24***
	(.046)	(.193)	(.081)	(.065)	(.079)
MinXContract	.05	.34***	.15**	.04	.01
	(.036)	(.125)	(.066)	(.052)	(.047)
MinXManager	-.02	.25***	.06	-.05	-.12***
	(.023)	(.097)	(.046)	(.04)	(.048)
MinXAuto	.21**	-.61***	.36***	.22*	.35***
	(.089)	(.225)	(.135)	(.115)	(.151)
MinXAutoXContract	-.12**	.19	.06	-.16*	-.15
	(.056)	(.148)	(.121)	(.098)	(.096)
MinXAutoXManager	-.13***	.1	.02	-.19**	-.21***
	(.051)	(.112)	(.083)	(.084)	(.09)
MinXOff	-.24***	-.69***	-.61***	-.38***	.1
	(.096)	(.201)	(.16)	(.12)	(.167)
MinXOffXContract	.29***	.65***	.3***	.17*	.17
	(.065)	(.151)	(.126)	(.091)	(.104)
MinXOffXManager	.17***	.54***	.14	-.03	.06
	(.055)	(.131)	(.092)	(.079)	(.096)

Robustness using only clean controls-Capital

Return

Clean controls for industryXstates treated at t: never treated and observations up to t for those treated at $t+1$ onward

	Capital		Machinery	Computers
	(1)	(2)	(3)	(4)
Minimum wage	-0.00922	-0.0589	-0.0652	-0.0897
	(0.0523)	(0.0572)	(0.0483)	(0.0562)
Minimum wage X RTI		0.330**	0.220*	0.243
		(0.151)	(0.130)	(0.164)
Minimum wage X Offshore		-0.260*	-0.143	-0.216
		(0.135)	(0.102)	(0.137)
FirmXYear Obs.	196854	196854	196854	196854

Robustness using only clean controls-Employment

Return

	(1) Pooled	(2) Group 1	(3) Group 2	(4) Group 3	(5) Group 4
Minimum wage	.02	-.84***	-.1	-.04	.22***
	(.051)	(.312)	(.063)	(.06)	(.081)
MinXContract	.04	.49***	.04	.03	.03
	(.035)	(.193)	(.052)	(.044)	(.048)
MinXManager	-.05*	.39***	-.04	-.1***	-.07*
	(.026)	(.142)	(.042)	(.031)	(.041)
MinXRTI	.45***	-.47	.35**	.62**	.44***
	(.128)	(.294)	(.159)	(.281)	(.158)
MinXRTIXContract	-.26***	.27	-.07	-.3*	-.27***
	(.077)	(.209)	(.126)	(.165)	(.103)
MinXRTIXManager	-.26***	.28**	-.12	-.37***	-.28***
	(.058)	(.141)	(.094)	(.114)	(.081)
MinXOff	-.4***	-1.16***	-.61***	-.42***	-.28*
	(.115)	(.303)	(.16)	(.154)	(.164)
MinXOffXContract	.36***	.66***	.22*	.22**	.38***
	(.071)	(.201)	(.122)	(.104)	(.109)
MinXOffXManager	.24***	.5***	.1	.04	.26***
	(.053)	(.159)	(.094)	(.08)	(.078)

Robustness using discrete ranking-Capital

Return

RTI and Off equal 1 for industries in the 75th percentile (about 1SD above the mean)

	Capital			
	(1)	(2)	(3)	(4)
Minimum wage	-0.00742	-0.0264	-0.000153	-0.0144
	(0.0484)	(0.0528)	(0.0514)	(0.0522)
Minimum wage X RTI		0.286*		0.377**
		(0.146)		(0.171)
Minimum wage X Offshore			-0.0651	-0.162
			(0.115)	(0.130)
Observations	54997	54997	54997	54997
Mean of Y	12.29	12.29	12.29	12.29
SD	68.30	68.30	68.30	68.30

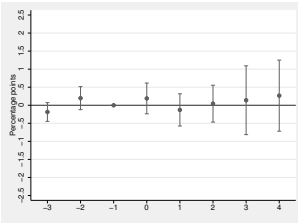
Robustness using using discrete ranking-Employment

Return

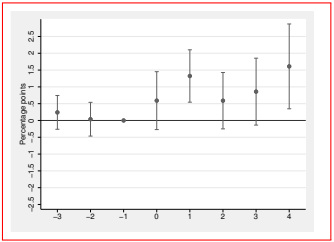
	(1) Pooled	(2) Group 1	(3) Group 2	(4) Group 3	(5) Group 4
Minimum wage	.13	-.75***	-.17*	-.01	.58***
	(.093)	(.277)	(.092)	(.135)	(.136)
MinXContract	-.04	.54***	.09	.05	-.17**
	(.06)	(.168)	(.066)	(.098)	(.079)
MinXManager	-.12***	.43***	.01	-.1*	-.28***
	(.042)	(.133)	(.047)	(.062)	(.067)
MinXRTI	.28***	-.52**	.08	.39***	.3**
	(.108)	(.262)	(.14)	(.161)	(.136)
MinXRTIXContract	-.14**	.54***	.32***	-.22***	-.08
	(.068)	(.184)	(.11)	(.088)	(.104)
MinXRTIXManager	-.25***	.35**	.09	-.34***	-.29***
	(.062)	(.157)	(.09)	(.087)	(.066)
MinXOff	-.07	-.99***	-.47***	-.01	.13
	(.093)	(.267)	(.127)	(.228)	(.115)
MinXOffXContract	.1*	.44***	-.06	.05	.01
	(.057)	(.179)	(.108)	(.134)	(.081)
MinXOffXManager	.1*	.42***	-.03	-.1	.03
	(.05)	(.144)	(.09)	(.098)	(.058)
Observations	433770	42309	45804	85929	257019
Mean of Y	39.591	36.439	30.74	44.882	40.169
SD	76.502	76.337	67.741	85.369	74.971

Investment in machinery

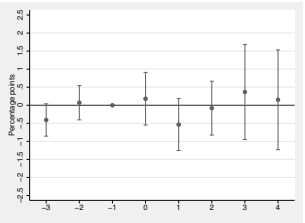
Return



Less scope automation or offshoring

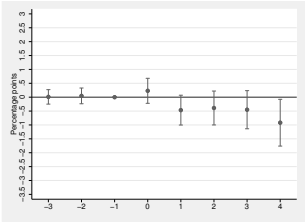


Scope for automation

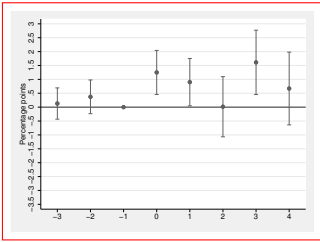


Scope for offshoring

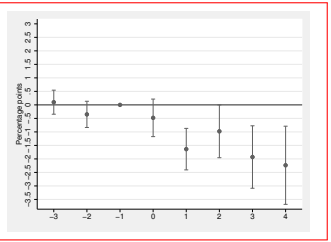
Investment in computers



Less scope automation or offshoring



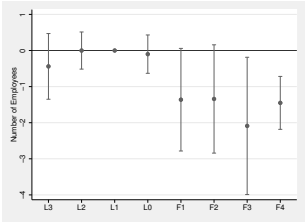
Scope for automation



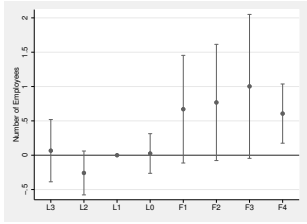
Scope for offshoring

Results-Employment-Event studies

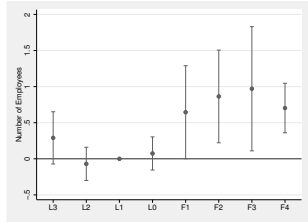
Firms with less scope for automation or offshoring



Payroll Workers

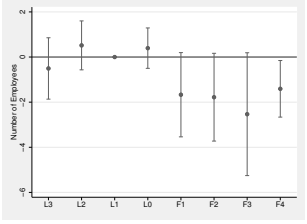


Contract Workers

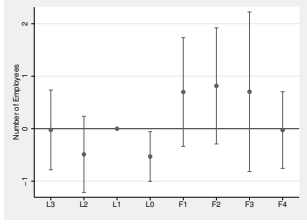


Managers

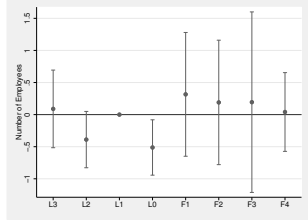
Firms with scope for automation



Payroll Workers

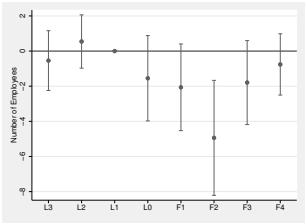


Contract Workers

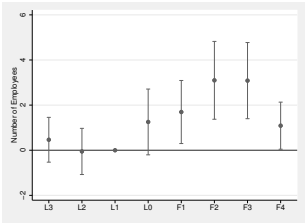


Managers

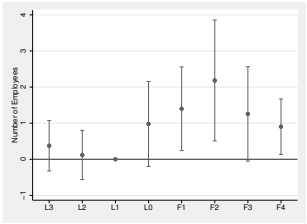
Firms with scope for offshoring



Payroll Workers



Contract Workers



Managers

Return

Robustness age control only-Capital

Return

	Capital		Machinery	Computers
	(1)	(2)	(3)	(4)
Minimum wage	-0.00577	-0.0745	-0.0599	-0.0650
	(0.0482)	(0.0500)	(0.0434)	(0.0462)
Minimum wage X Auto		0.387***	0.248**	0.208
		(0.141)	(0.124)	(0.145)
Minimum wage X Offshore		-0.167	-0.0944	-0.141
		(0.121)	(0.104)	(0.0872)
Observations	54997	54997	54997	54997

Results-Profit, Output, Outsourcing

Return

	Profit Margin (1)	Output Growth (2)	Outsourcing Growth (3)
Minimum wage	0.0183	-0.00901	0.00837
	(0.0130)	(0.0162)	(0.0918)
Minimum wage X Auto	-0.0351	-0.0178	0.242
	(0.0356)	(0.0446)	(0.266)
Minimum wage X Offshore	0.0414	0.0332	-0.276
	(0.0305)	(0.0335)	(0.200)
Observations	54997	54997	54997
Mean of Y	2.09%	7.80%	8.60%

- **Profit margin:** Percentage of profit generated from the total income after expenses
- **Output growth:** growth in sales of output
- **Outsourcing growth:** growth in outsourcing expenditure

Results-Log Aggregate Employment

National Sample Survey→ Aggregate employment at the industry-state-year level

	(1)	(2)	(3)	(4)	(5)
	Pooled	14-24 years old	25-32 years old	33-43 years old	44-65 years old
Minimum wage	-0.000282	-0.00115**	-0.000157	-0.000217	0.000345
	(0.000245)	(0.000498)	(0.000479)	(0.000486)	(0.000531)
Minimum wage X Auto	-0.000285	0.0000226	0.000723	-0.000667	-0.00146*
	(0.000392)	(0.000781)	(0.000772)	(0.000795)	(0.000836)
Minimum wage X Offshore	-0.000437	-0.000101	-0.000740	0.000168	-0.000803
	(0.000376)	(0.000791)	(0.000749)	(0.000736)	(0.000769)

- **Typical increase (3%):** ↓ Employment by 0.3% for 14-24 years old
  - If all industries were to see this change, employment would fall by 140,000 for this age group
- **Scope for automation:** ↓ Employment by 0.3% for 44-65 years old
  - If all industries with scope for automation were to see this change, employment would fall by 30,000 for this age group

Return

Results-Log Aggregate Employment

	(1) Pooled	(2) 14-24 years old	(3) 25-32 years old	(4) 33-43 years old	(5) 44-65 years old
Minimum wage	-0.000358	-0.00125**	-0.000384	-0.000362	0.000152
	(0.000263)	(0.000535)	(0.000511)	(0.000644)	(0.000582)
Minimum wage X Auto	-0.000221	-0.000150	0.000994	0.000120	-0.00134
	(0.000436)	(0.000868)	(0.000848)	(0.00100)	(0.000959)
Minimum wage X Offshore	-0.000538	-0.000323	-0.000469	0.000396	-0.00144
	(0.000429)	(0.000892)	(0.000851)	(0.000877)	(0.000899)
Minwage other	-0.000225	-0.000503	-0.00106	0.0000931	-0.00149
	(0.000678)	(0.00136)	(0.00123)	(0.00307)	(0.00164)
Minwage other X Auto	0.000629	-0.00139	0.000369	0.00610	0.00191
	(0.00157)	(0.00313)	(0.00283)	(0.00538)	(0.00391)
Minwage other X Offshore	-0.00158	-0.00236	0.00324	0.00227	-0.00842
	(0.00264)	(0.00519)	(0.00496)	(0.00630)	(0.00607)

Return

Costly to lay off workers-Capital

Conclusion

	Capital	
	Costly	Cheap
Minimum wage	0.00109	0.0355
	(0.0866)	(0.144)
Minimum wage X Auto	0.278	0.525
	(0.284)	(0.346)
Minimum wage X Offshore	0.190	-0.266
	(0.390)	(0.197)
Observations	26101	11813
Mean of Y	12.01%	11.31%

Costly to lay-off workers-Employment

	(1) Group 1	(2) Group 2	(3) Group 3	(4) Group 4
Minimum wage	.39	.21	.13	.2*
	(.97)	(.364)	(.125)	(.116)
MinXContract	.09	.29	-.03	.04
	(.99)	(.32)	(.092)	(.071)
MinXManager	.7	.3	-.15*	-.07
	(.96)	(.335)	(.087)	(.062)
MinXAuto	-.67	2.08**	.64***	.61***
	(.74)	(1.05)	(.256)	(.229)
MinXAutoXContract	-1.2	1.5	-.02	-.03
	(.86)	(.992)	(.184)	(.155)
MinXAutoXManager	-.59	1.62	-.11	-.01
	(.803)	(1.014)	(.19)	(.109)
MinXOff	2.65***	-1.24	-.55**	-.46
	(.995)	(.922)	(.256)	(.319)
MinXOffXContract	2.82***	-.41	.06	.19
	(1.013)	(.922)	(.175)	(.203)
MinXOffXManager	3.37***	-.37	-.08	.12
	(.992)	(.887)	(.153)	(.143)

Cheaper to lay-off workers-Employment

	(1) Group 1	(2) Group 2	(3) Group 3	(4) Group 4
Minimum wage	-1***	-.28	.09	.35***
	(.337)	(.326)	(.168)	(.121)
MinXContract	.7***	.36*	.15	-.08
	(.175)	(.215)	(.111)	(.074)
MinXManager	.58***	.15	-.02	-.2***
	(.176)	(.191)	(.105)	(.059)
MinXAuto	-.69**	.87***	1.53**	.53**
	(.35)	(.331)	(.758)	(.247)
MinXAutoXContract	.62***	.69***	-.87***	-.47***
	(.223)	(.265)	(.348)	(.138)
MinXAutoXManager	.32	.51**	-.66***	-.48***
	(.223)	(.231)	(.242)	(.131)
MinXOff	-1.48***	-1.86***	-.09	-.3
	(.38)	(.384)	(.366)	(.211)
MinXOffXContract	.8***	-.03	.25	.36***
	(.252)	(.277)	(.237)	(.134)
MinXOffXManager	.69***	-.31	.08	.15
	(.262)	(.267)	(.197)	(.107)

Definitions

Routineness- how easy it is to code a task

- Tasks requiring limited and well-defined set of cognitive and manual activities that can be accomplished by following explicit rules. Autor, Lavy and Murnane(2003)
  - Examples: record-keeping, picking and sorting of objects, repetitive assembly
  - Counter examples: managing, medical treatment

Offshorability- how easy it is to relocate a task

- The ability to perform at least part of the task remotely while supplying the task's output at the place of production, at little or no cost. This measure captures the degree to which face-to-face interactions and on-site presence are necessary. Acemoglu and Autor(2011)
  - Examples: Gathering, processing and analyzing data, responding to customers online, writing emails, programming, software debugging
  - Counter examples: Commuting services (taxis), medical treatment, repairing fixed machinery

Scope for automation and offshoring

Mapping

- Autor and Dorn(2013), and Acemoglu and Autor(2011) use O*Net data detailing the task content of U.S. occupations in 1998
- They construct measures capturing how easy it is to code tasks (routineness) and relocate tasks (offshorability) in these occupations Details
- No other country has mapped tasks to occupations as far as I know
- Follow the literature and use the same measures by mapping the U.S. occupations to the Indian ones (1-1 mapping) using harmonized occupation code tables. Goos et al.(2014)
- Assume that task content of occupations is similar in India
- The National Career Services of India refers job seekers who seek to find if their skill matches certain occupations to the O*NET interest profiler. Bhatnagar(2018)

Motivation

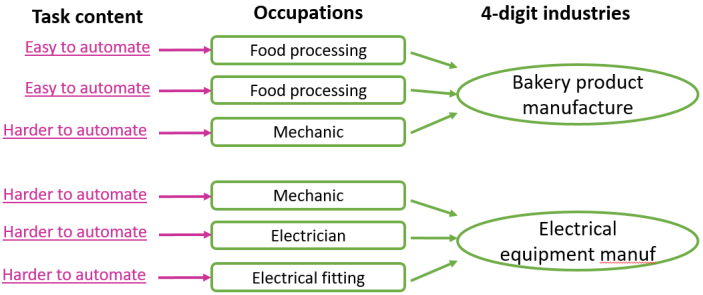
National Sample Survey (NSS)

- India's nationally representative survey of households
- Repeated cross-section with employment modules every 3-5 years or so
- Contains the **occupation** and **4-digit industry** of the workers
- With this information, I can compute the scope for automation and offshoring in different industries

Scope for automation and offshoring

Motivation

Using the 2000 round of the NSS survey, I compute the weighted average measures of scope for automation and offshoring for the Indian industries using sampling weights



Raw measures have little meaning so I standardize the measures to be mean 0 and SD 1 at the 4-digit industry level. Interpret in terms of standard deviation above or below the average national level.

Industries where firms have scope for automation and offshoring

Routineness and offshorability

Routineness

Autor and Dorn(2013): Measure of routineness for each U.S. occupations based on their task content

- Routine=set limits, tolerances and standards and finger dexterity
- Manual=eye-hand-foot coordination
- Abstract= direction control and planning and GED Math

$$\overbrace{RTI_j}^{\text{Routineness Task Intensity}} = log(Routine_j) - log(Manual_j) - log(Abstract_j)$$

Acemoglu and Autor (2011): Similar but for Offshorability

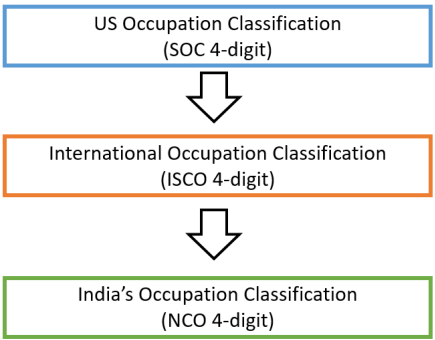
- Offshorability= little need face-to-face interactions and work to be done in a specific location

Routineness and offshorability

- Goos et al(2014) map measures above to European occupation classification. They find that job polarization seen throughout Europe can be largely explained by the disappearance of of routine intensive tasks (routine-biased technological change) and partly because of offshoring.
- I follow their approach and map the U.S. measures to India's classification of occupations.
- India's occupation classification is a combination of the U.S. classification and international classification (1-1 mapping at 4-digit level)
- The National Career Services of India refers job seekers who seek to find if their skill matches certain occupations to the O*NET interest profiler (Bhatnagar(2018)).

Routineness and offshorability

Using a series of official crosswalk, I match the U.S. occupations to the India's occupation classification (1-to-1 mapping)



Occupations/industries with scope for automation and offshoring

Scope for automation and offshoring

- Occupations with most scope for automation: office and numerical clerks, cashiers, bank tellers, food processing workers, and textile machine operators
- Industries with most scope for automation: Pasta manufacturing, the production and preserving of meat products, bakery products manufacturing, and man-made fiber manufacturing
- Occupations with most scope for offshoring: social science professionals, mathematicians and statisticians, numerical clerks, and computing professionals
- Industries with most scope for offshoring: Man-made fiber manufacturing, game and toy manufacturing, software development, activities of call centers