Factories and Farms: How does economic growth impact rural incomes and education?

Reena Badiani

Duke and World Bank

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Two Related Questions:

1. What are the effects of household incomes and returns to education on household educational investment?

2. What are the effects of growth in skilled and unskilled labor demand on household incomes and inequality?

→ jointly answer these questions using data from rural India.
Educational Investment, Income and Returns

- Economic growth associated with rising investment in education.
- Return to education channel (Foster and Rosenzweig (96), Kochar (04))
- Income channel (Jacoby (94), Behrman et al. (99), Edmonds (09))
Motivation

Educational Investment, Income and Returns

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Demand for Skill, Income and Inequality

- Skill biased growth alters wage structure (Card et al (02); Katz et al (92))
- Developing country context: non-agricultural growth in agrarian areas. (Foster and Rosenzweig (04); Lanjouw and Murgai (09))
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Approach of this paper, jointly examine questions:
- Examine how variation in skilled and unskilled labor demand affects household income and labor market returns, and examine how variation in incomes and returns feed through to educational investment.
Aggregate Production Changes:

Return to Literacy - Skilled & Unskilled Wages

Household Income, by Land and Skill

Educational Investment – Primary School

* Acquire Lit = F(Household Incomes, Returns to Literacy)
* Nest HHs in a two sector, small, open economy GE model
Educational Investment – Primary School

Aggregate Production Changes:

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Challenge 1: Independent Variation in Incomes and Returns.
-> Agriculture v Manufacturing.
Educational Investment – Primary School Return to Literacy - Skilled & Unskilled Wages

Aggregate Production Changes:
A. Agricultural TFP
B. Exogenous Variation in Manufacturing Labor Demand, by Skill

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Challenge 1: Independent Variation in Incomes and Returns. -> Agriculture v Manufacturing.
Aggregate Production Changes:

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Estimates: capture how an expanding non-agricultural sector alters income and inequality in agricultural areas.
Aggregate Production Changes:

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Challenge 2: Endogenous Manufacturing Employment -> Instrumental Variables Approach
Aggregate Production Changes:

A. Agricultural TFP
B. Exogenous Variation in Manufacturing Labor Demand, by Skill

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Educational Investment – Primary School

Household Income, by Land and Skill

Results Preview: Two drivers differ in effect on returns and have heterogeneous income effects.
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Educational Investment – Primary School

Results Preview: Income Growth Explains a Larger Fraction of Growth in Primary School Enrolment than Returns.
Results Preview: Agricultural TFP versus Manufacturing Growth
1 Setting the Scene: Rural India

2 Model

3 Empirical Strategy
   - First Stage: Manufacturing Employment
   - Wages and Incomes
   - Education

4 Conclusion
Education and Incomes

Income and Wages, 1983 - 1999:


- Real household income: ↑ 70% (REDS)

- Ratio of Skilled to Unskilled wages: ↓ 14%, from 1.72 to 1.47

Fraction Starting School

- 1983: 70% boys, 50% girls.

- 1999: 91% boys, 86% girls.
Rural Economies In Which Education Choices are Made

Low migration

Sectors

- **Agriculture**: 78% of males in 1983.

- **Manufacturing**: 8% males in 1983.

- **Services** (Retail, Construction, Transport): 13%.
Rural Economies In Which Education Choices are Made

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Tasks by Sector

- **Agriculture**:
  - Skilled: Crop and Input decisions. Family labor.

- **Manufacturing**: Hired unskilled and skilled.
Setting the Scene: Rural India

Model

Empirical Strategy
- First Stage: Manufacturing Employment
- Wages and Incomes
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Conclusion
Households

- 2 period, 2 generation model of education choices.
- Four household types: landed and landless, literate and illiterate.
- **First period:** Literate or illiterate adult earns income. No credit market.
  - → Choice: child goes to school or produces domestic consumption good.
- **Second period:** Literate or illiterate child works.

Educational investment:
- ↑ with:
  - Period 1 Income
  - Labor Market Returns to Education
  - Opportunity Cost of Child Time
- ↓ with:
  - Direct Cost of Schooling
Model Overview

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- Households maximize utility from consumption subject to household budget constraints, choose education if \( V(s_{1}^{\text{Child}} = 1) > V(s_{1}^{\text{Child}} = 0) \)

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Model Overview

Small, open, two-sector economy

- Labor market active; land market shut down.
- Specific Factors: sectors overlap in labor market.
- Endowments: Land, Agricultural TFP (Agriculture); Two Raw Materials (Manufacturing), Labor (Both)

Agriculture: \( HH Prod = f(Skilled \& Unskilled \, Labor; \, Land, Ag \, TFP, Edu) \)

\[ f'(Skilled, Edu) > 0; \ f'(Unskilled, Edu) = 0 \]

Manufacturing - 2 traded industries, \( \text{Output Price} = fn(\text{World Price, Policies}) \)

Ind Prod = \( g_i(Skilled \& Unskilled \, Labor; \, 2 \, Raw \, Materials) \)

Changes to environment (Ag TFP and industrial policy) alters sectoral demand for skilled and unskilled labor.

Equilibrium Outcomes

- Wages and Cultivation Profits
- Sectoral Employment
- Education Choices
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Production (Foster and Rosenzweig, 1996; Elisson and Glaeser, 1999)

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Equilibrium Outcomes

- Wages and Cultivation Profits; Sectoral Employment; Education Choices.
Comparative Statics

Wages:

- **Agricultural TFP:** \(\uparrow\) both skilled and unskilled wages.
- **Unskilled manufacturing labor demand:** \(\uparrow\) unskilled wages, \(\downarrow\) skilled wages.
- **Skilled manufacturing labor demand:** vice versa.
Comparative Statics

Wages:
- **Agricultural TFP**: ↑ both skilled and unskilled wages.
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Incomes
- **Agricultural TFP**: ↑ cultivation profits.
- **Unskilled manufacturing labor demand**: ↓ cultivation profits.
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Incomes
- **Agricultural TFP:** $\uparrow$ cultivation profits.
- **Unskilled manufacturing labor demand:** $\downarrow$ cultivation profits

Policy Induced Variation in Manufacturing Labor Demand
- Increasing a **raw material endowment** increases the demand for labor most in the industry that uses that endowment most intensively.
- A change in **industry import tariffs and regulations:** alters employment in districts endowed with the raw materials that those industries use.
- **Within a district,** employment responses across industries to policy changes varies according to their raw material input share.
1 Setting the Scene: Rural India

2 Model

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4 Conclusion
Empirical Specification: Education

Linear-Log Specification

\[ S_{ht} = 1 \quad \text{if} \quad \kappa_0 + \kappa_1 \text{Income}_{ht}(w) + \kappa_2 \text{Return to Literacy}_{dt} + \kappa_3 \text{Opportunity Cost} + \kappa_4 \text{Direct Cost}_{dt} + \kappa_5 HH_{ht} + u_{hdt} > 0 \]

- Where \( S = \) start primary school or not.
- Predict: \( \kappa_1 > 0, \kappa_2 > 0, \kappa_3 < 0, \kappa_4 < 0 \)
Empirical Specification: Education

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Challenge

- Income and returns correlated with unobserved determinants of educational investment.
  - \( \rightarrow \) Instrumental variables strategy.
Empirical Specification: Wages and Incomes

\[
\begin{align*}
 w_{Unskilled,dt} &= \alpha_0 + \alpha_1 E_{Manu Unskilled,dt} + \alpha_2 E_{Manu Skilled,dt} + \alpha_3 Ag TFP_{dt} + \alpha_4 A_{dt} + \epsilon_{dt} \\
 w_{Skilled,dt} &= \beta_0 + \beta_1 E_{Manu Unskilled,dt} + \beta_2 E_{Manu Skilled,dt} + \beta_3 Ag TFP_{dt} + \beta_4 A_{dt} + \psi_{dt} \\
 y_{hdt} &= \gamma_0 + \gamma_1 E_{Manu Unskilled,dt} + \gamma_2 E_{Manu Skilled,dt} + \gamma_3 Ag TFP_{dt} + \gamma_4 A_{dt} + \gamma_5 HH_{hdt} + \epsilon_{hdt}
\end{align*}
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where \( w_{dt} \) = district level skilled and unskilled wages; \( y_{hdt} \) = household income. 
\( \alpha_1 > 0, \alpha_2 < \alpha_1 \)
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Challenge - Manufacturing Employment Endogenous

- **Solution:** IV strategy - industrial policy reforms predicted to have greatest effect where industries are expected to be found.
Intuition for IV Strategy

First Stage Results

IV Strategy

\[
\frac{w_{dt}}{y_{ht}} = \alpha_0 + \alpha_1 E^{\text{Manu Unskilled}, dt} + \alpha_2 E^{\text{Manu Skilled}, dt} + \alpha_3 A g \ TFP_{dt} + \alpha_4 A_{dt} + \mu_d + \delta_d + \epsilon_{dt}
\]

\[
E^{\text{Manu}}_{U/S, dt} = \gamma_0 + \gamma_1 n_d + \gamma_2 \bar{r}^n * n_d + ... + \gamma_7 X_{d,t} + \nu_{d,t}
\]

- \(r^n_i\) - measures whether industry \(i\) uses raw material \(n\).
- \(\bar{r}^n * n_d\) - average use of input \(n\) interacted with district’s endowment of \(n\).
IV Strategy

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- \(\bar{r}^n \ast n_d\) - average use of input \(n\) interacted with district’s endowment of \(n\).
  - Captures response of employment to variation in a district’s endowment among industries that use this material.
IV Strategy

\[
\frac{w_{dt}}{y_{ht}} = \alpha_0 + \alpha_1 E_{Manu Unskilled, dt} + \alpha_2 E_{Manu Skilled, dt} + \alpha_3 \text{Ag TFP}_{dt} + \alpha_4 A_{dt} \\
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\[
E_{Manu U/S, dt} = \gamma_0 + \gamma_1 n_d + \gamma_2 \bar{\tau}^n * n_d + \gamma_3 \bar{\tau}_t + \gamma_4 \bar{\tau}^n + \gamma_5 \bar{\tau}^n * n_d + \gamma_6 \bar{\tau}_t * n_d + \gamma_7 X_{d, t} + \nu_{d, t}
\]

- \(\bar{\tau}_t\) - average industrial tariffs/regulations at time \(t\).
- \(\bar{\tau}^n_t\) - raw material \(n\) weighted industrial tariffs/regulations.
- \(\bar{\tau}^n_t * n_d\) - input weighted policy interacted with a district’s endowment of \(n\).
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- \(\bar{\tau}_t\) - average industrial tariffs/regulations at time \(t\).
- \(\bar{\tau}^n_r\) - raw material \(n\) weighted industrial tariffs/regulations.
- \(\bar{\tau}_t^n * n_d\) - input weighted policy interacted with a district’s endowment of \(n\).
  \(\rightarrow\) Captures response of manufacturing employment to changes in industrial policies among industries that use the material present in a district.
IV Strategy

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\quad + \gamma_6 \bar{r} t \ast n_d + \gamma_7 X_{dt} + \nu_{dt}
\]

- Specific Factors: Can Exclude Policy and Endowments
- However, this is far more than I need. Included variables:
  - Time varying
  - District varying
  - Time-District

IV: \( \tau r \ast n_d \) - variation from industry level technologies and differences across industries in the timing and depth of policy changes.
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Potential Issues:

1. Wages - Overlapping inputs, vertical or horizontal links between sectors, [district price vector].
2. Incomes - Demand for services, Self-Employed manufacturing.
3. Education - education supply responses.
Empirical Specification and Data, 1983-99

\[ E^M_{T/S,dt} = \gamma_0 + \gamma_5 \tau r^n_t \ast n_d + \gamma_6 t \ast n_d + \gamma_7 X_{dt} + \mu_d + \delta_t + \nu_{dt} \]

- Skilled Employment: Literate Workers (NSSO)
- Policy: Import Tariffs and 0/1 Industry Regulations (Aghion et al, 2009)
- Natural Resources: Mineral Map of India (Gov of India, 1990)
Interpretation of Results:

- F-stats between 25 and 40.

- Intuitive results: Bulkiest commodities.

- A 65% drop in import tariffs in the:
  - **Ceramics industry**: 12% employment decrease in top quartile of ceramics areas and a 3% increase in the bottom quartile of ceramics areas.
  
  - In low electricity price regions: employment in electricity intensive industries drops 48.9% more than in non-electricity intensive industries.
Aggregate Production Changes:

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Educational Investment – Primary School

Results Preview: Two drivers differ in effect on returns and have heterogeneous income effects.
Empirical Specification and Data:

\[ Y = \alpha_0 + \alpha_1 \hat{E}_{\text{Total}, dt} + (\alpha_2 - \alpha_1) \hat{E}_{\text{skilled}, dt} + \alpha_3 \text{Ag Prod}_{dt} + \alpha_4 A_{dt} + \mu_d + \delta_t + \epsilon_{dt} \]

**Y is:**

- **A** Unskilled Wages: agricultural wage, wage of illiterate workers.
- **B** Skilled Wages: literate non-agricultural workers.
- **C** Household Income: consumption per capita.
- **Other Determinants:** Agricultural Productivity, district FE, time dummies, population, by landholding bracket, rainfall, lower-order interactions from first stage.
$w_{udt}/w_{sdt} = \alpha_0 + \alpha_1 \hat{E}_\text{Total,dt} + (\alpha_2 - \alpha_1) \hat{E}_\text{skilled,dt} + \alpha_3 \text{Ag Prod}_{dt} + \alpha_4 A_{dt} + \mu_d + \delta_t + \epsilon_{dt}$

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<thead>
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<th>Log(Unskilled Wage)</th>
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<td>Log Total Manu Employment</td>
<td>0.025**</td>
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Note: Standard errors are in parentheses. All specifications include district fixed effects, measures of rainfall and population, by landholding class, and lower order interaction terms from the first stage regressions.
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**Skilled and Unskilled Wage Responses to Manufacturing and Agricultural Productivity Growth.**

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</tr>
</tbody>
</table>

Note: Standard errors are in parentheses. All specifications include district fixed effects, measures of rainfall and population, by landholding class, and lower order interaction terms from the first stage regressions.
$c_{hdt} = \gamma_0 + \gamma_1 E_{\text{Manu total}, dt} + \gamma_2 E_{\text{Manu skilled}, dt} + \gamma_3 \text{Ag Prod}_{dt} + \gamma_4 A_{dt} + \mu_d + \delta_t + \epsilon_{hdt}$

Does Consumption Increase with Manufacturing Growth and Agricultural Productivity?

**Dependent Variable:** Log(Household Consumption)  
**Specification:** FE-IV

<table>
<thead>
<tr>
<th>By Land Status</th>
<th>Landless</th>
<th>Landed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log Total Manu Employment</td>
<td>0.302***</td>
<td>0.029</td>
</tr>
<tr>
<td></td>
<td>(0.104)</td>
<td>(0.056)</td>
</tr>
<tr>
<td>Log Skilled Manufacturing</td>
<td>0.035</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td>(0.086)</td>
<td>(0.045)</td>
</tr>
<tr>
<td>Log Agricultural Potential</td>
<td>0.184***</td>
<td>0.165**</td>
</tr>
<tr>
<td></td>
<td>(0.066)</td>
<td>(0.082)</td>
</tr>
<tr>
<td>Observations</td>
<td>64855</td>
<td>127860</td>
</tr>
</tbody>
</table>

Note: Standard errors are in parentheses. All specifications include district fixed effects, measures of rainfall and population, by landholding class, and lower order interaction terms from the first stage regressions.
\[ c_{h dt} = \gamma_0 + \gamma_1 E_{Manu_{total}, dt}^\text{Manu} + \gamma_2 E_{Manu_{skilled}, dt}^\text{Manu} + \gamma_3 \text{Ag Prod}_{dt} + \gamma_4 A_{dt} + \mu_d + \delta_t + \epsilon_{h dt} \]

<table>
<thead>
<tr>
<th>Does Consumption Increase with Manufacturing Growth and Agricultural Productivity?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent Variable:</strong> Log(Household Consumption)</td>
</tr>
<tr>
<td><strong>Specification:</strong> FE-IV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>By Land Status</th>
<th>By Education</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Landless</td>
<td>Landed</td>
</tr>
<tr>
<td>Log Total Manu Employment</td>
<td>0.302*** (0.104)</td>
<td>0.029 (0.056)</td>
</tr>
<tr>
<td>Log Skilled Manufacturing</td>
<td>0.035 (0.086)</td>
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</tr>
<tr>
<td>Log Agricultural Potential</td>
<td>0.184*** (0.066)</td>
<td>0.165** (0.082)</td>
</tr>
</tbody>
</table>

**Observations:** 64855 127860 94650 98065

Note: Standard errors are in parentheses. All specifications include district fixed effects, measures of rainfall and population, by landholding class, and lower order interaction terms from the first stage regressions.
$c_{ht} = \gamma_0 + \gamma_1 E_{\text{Manu}, \text{total}, dt} + \gamma_2 E_{\text{Manu}, \text{skilled}, dt} + \gamma_3 \text{Ag Prod}_{dt} + \gamma_4 A_{dt} + \mu_d + \delta_t + \epsilon_{ht}$

---

**Does Consumption Increase with Manufacturing Growth and Agricultural Productivity?**

**Dependent Variable:** Log( Household Consumption)

**Specification:** FE-IV

<table>
<thead>
<tr>
<th></th>
<th>Landless</th>
<th></th>
<th>Illiterate</th>
<th>Literate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log Total Manu Employment</td>
<td></td>
<td></td>
<td>0.370**</td>
<td>0.284**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.112)</td>
<td>(0.126)</td>
</tr>
<tr>
<td>Log Skilled Manufacturing</td>
<td>-0.288*</td>
<td></td>
<td>0.185*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.081)</td>
<td></td>
<td>(0.102)</td>
<td></td>
</tr>
<tr>
<td>Log Agricultural Potential</td>
<td>0.202***</td>
<td></td>
<td>0.155*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.075)</td>
<td></td>
<td>(0.086)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>36042</td>
<td></td>
<td>28813</td>
<td></td>
</tr>
</tbody>
</table>

Note: Standard errors are in parentheses. All specifications include district fixed effects, measures of rainfall and population, by landholding class, and lower order interaction terms from the first stage regressions.
Results Preview: Income Growth Explains a Larger Fraction of Growth in Primary School Enrolment than Returns.
Empirical Specification - Education

Education Specification

\[ S_{hdt} = 1 \quad \text{if} \quad \kappa_0 + \kappa_1 y_{hdt} + \kappa_2 (w_{sd,t+1} - w_{ud,t+1}) + \kappa_3 \text{Ag Prod}_{dt} \times \text{Land}_h \]
\[ + \kappa_4 \text{Opp Cost}\_dt + \kappa_5 \text{Direct Cost}\_dt + \kappa_6 H H_{ht} + u_{hdt} > 0 \]

Predict: \( \kappa_1 > 0, \kappa_2 > 0, \kappa_3 > 0, \kappa_4 < 0, \kappa_5 < 0 \)

Simplifications

- **Static Expectations:** \( w_{udt} = w_{ud,t+1} \).
- **Opportunity Cost:** unskilled wage.
- **Direct Cost:** State*Year interactions.
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Education Specification

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Predict: \( \kappa_1 > 0, \kappa_2 > 0, \kappa_3 > 0, \kappa_4 < 0, \kappa_5 < 0 \)

Simplifications

- **Static Expectations:** \( w_{udt} = w_{ud,t+1} \).
- **Opportunity Cost:** unskilled wage.
- **Direct Cost:** State*Year interactions.
- **Approach:** for landless households, use IV.
Empirical Specification 1: Landless Households - IV approach

\[ S_{hdt} = 1 \quad \text{if} \quad \kappa_0 + \kappa_1 y_{hdt} + \kappa_2 w_{sdt} - \kappa_2 w_{udt} + \kappa_3 \text{Ag Prod}_{dt} \times \text{Land}_h \]
\[ + \kappa_4 w_{udt} + \kappa_6 \text{HH}_ht + \delta_{s^*t} + u_{hdt} > 0 \]

\[ Y_{\text{illiterate Landless}} = w_{udt} \]
\[ S_{idt} = 1 \quad \text{if} \quad \kappa_0 + (\kappa_1 - \kappa_2 + \kappa_4) w_{udt} + \kappa_2 w_{sdt} + \kappa_6 \text{HH}_ht \]
\[ + \delta_{s^*t} + u_{hdt} > 0 \]
Empirical Specification 1: Landless Households - IV approach

\[ S_{hdt} = 1 \quad \text{if} \quad \kappa_0 + \kappa_1 y_{hdt} + \kappa_2 w_{sdt} - \kappa_2 w_{udt} + \kappa_3 \text{Ag Prod}_{dt} \times Land_h \]
\[ + \kappa_4 w_{udt} + \kappa_6 HH_{ht} + \delta_{s*t} + u_{hdt} > 0 \]

\[ Y_{\text{Illiterate Landless}} = w_{udt} \]
\[ S_{idt} = 1 \quad \text{if} \quad \kappa_0 + (\kappa_1 - \kappa_2 + \kappa_4) w_{udt} + \kappa_2 w_{sdt} + \kappa_6 HH_{ht} \]
\[ + \delta_{s*t} + u_{hdt} > 0 \]

\[ Y_{\text{Literate Landless}} = w_{udt}(1 - \tau) + w_{sdt}\tau \]
\[ S_{idt} = 1 \quad \text{if} \quad \kappa_0 + (\kappa_1(1 - \tau) - \kappa_2 + \kappa_4) w_{udt} + (\kappa_1 \tau + \kappa_2) w_{sdt} \]
\[ + \kappa_6 HH_{ht} + \delta_{s*t} + u_{hdt} > 0 \]
### What in the Relative Size of the Income, Returns to Education and Opportunity Cost Effects?

**Dependent Variable: Individual Aged 5-9 Started School**

<table>
<thead>
<tr>
<th></th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Illiterate</td>
<td>Literate</td>
</tr>
<tr>
<td>Income</td>
<td>1.079**</td>
<td>0.904***</td>
</tr>
<tr>
<td></td>
<td>(0.416)</td>
<td>(0.202)</td>
</tr>
<tr>
<td>Returns to Ed</td>
<td>0.497**</td>
<td>0.442**</td>
</tr>
<tr>
<td></td>
<td>(0.213)</td>
<td>(0.134)</td>
</tr>
<tr>
<td>Opportunity Cost</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses.
### What in the Relative Size of the Income, Returns to Education and Opportunity Cost Effects?

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<table>
<thead>
<tr>
<th></th>
<th>Boys</th>
<th></th>
<th>Girls</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Illiterate</td>
<td>Literate</td>
<td>Illiterate</td>
<td>Literate</td>
</tr>
<tr>
<td>Income</td>
<td>0.935***</td>
<td>0.879*</td>
<td>0.791**</td>
<td>0.534*</td>
</tr>
<tr>
<td></td>
<td>(0.197)</td>
<td>(0.495)</td>
<td>(0.341)</td>
<td>(0.456)</td>
</tr>
<tr>
<td>Returns to Education</td>
<td>0.497***</td>
<td>0.220</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.213)</td>
<td>(0.178)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opportunity Cost</td>
<td>-0.225</td>
<td>0.257</td>
<td></td>
<td>0.533</td>
</tr>
<tr>
<td></td>
<td>(0.394)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: Standard errors in parentheses.*
Interpretation of Results

Education

- One s.d. increase in incomes raises male enrollment by 0.05, in returns by 0.02.

- Illiterate landless households:
  - Male enrollment ↑ 0.45 to 0.79
    Income channel ↑ by 0.52, returns ↓ by -0.07
  - Female enrollment ↑ 0.26 to 0.72
    Income channel ↑ by 0.43

Estimated income elasticities 0.35 and 0.57, slightly larger than those found in the literature:
- Income elasticity ≈ 0.1-0.3 (Behrman and Knowles, 99)
- Returns elasticity: 0.3 (Kochar, 2004)

However, Edmonds et al (2005) find similarly high figures (0.7) for a similar time frame in India.
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Wages and Incomes

- **Agricultural Potential**: ↑ 54% explains:
  - 50% of increase in unskilled wages and poverty.
Interpretation of Results

Wages and Incomes

- **Agricultural Potential**: $\uparrow$ 54% explains:
  - 50% of increase in unskilled wages and poverty.

- **Total Manufacturing Employment**: $\uparrow$ 43%; 30% of new employment in skilled occupations:
  - 15% of increase in unskilled wages and 27% of the reduction in poverty.

- Had all employment growth between unskilled:
  - 9% greater increase in unskilled wages
  - 12% greater reduction in poverty.
Conclusion

Education

- Demand for education rises strongly with incomes amongst the poorest households in rural India.

- The income response is greater than the returns to education response.

Drivers of Growth, Poverty and Inequality

- Agricultural technical change explains a larger portion of unskilled wage growth and poverty reduction over the period than manufacturing growth.

- Partly explained by skill biased manufacturing growth in India.
Migration In Rural India, 25-35 Males

Permanent Migration - REDS, NSSO
- REDS: 8% 1990-1999; 80% within district
- NSSO: 5.9% moved 1990-1999, 6.8% for those above primary, 55% within district.

Temporary Migration - NSSO
- 1983: 1.96% migrated, 1.5% among primary and above, 50.3% within district.
- 1999: 3.0% migrated, 2.6% among primary and above, 4% among illiterates.
Definition

- Def of factor intensity: technical conditions of production such that the Marginal Rate of Technical Substitution of $x$ for $y$ is equalised between two industries by using a higher ratio $\frac{x}{y}$ in one of the industries (the $x$ intensive one) and a lower ratio in the other industry (the $y$ intensive one) (Rybczynski, 1955).
Groups from Mineral Atlas of India/NCAER Economic Plans (1960s-90s)

- **Forestry**: Proportion of District Covered in Forests
- **Metal**: Aluminium, Chromium, Copper, Iron Ore, Lead, Manganese, Zinc.
- **Ceramics**: Kaolin, Feldspar, Glass and Foundry Sand.
- **Construction Sector**: Calcite, China Clay, Limestone, Sandstone.
- **“Strategic” Chemicals**: Asbestos, Baryte, Dolomite, Flourite and Limenite.
- **Energy**: Coking and Non-Coking Coal and Electricity Prices


3 Tariff Data: From Aghion, Burgess, Redding and Zilibotti (AER, 2008).

4 Minerals and Natural Resources: Geological Map of India; National Mineral Inventory; Yearly Report by the Indian Bureau of Mines; Reports from the Planning Commission and Department of Water.


\[
\text{Factor Intensity}_{k,l} = \frac{\text{Cost Share of Input } k}{\text{Cost Share of Labor}}
\]

Three measures: quintile, above median dummy, continuous.
Empirical Specification

Deriving Wages: Labor Demand \((w^*_u, w^*_s)\) = Labor Supply \((w^*_u, w^*_s)\)

\[
\text{Labor Demand}^M_{\text{unskilled}} = a_0 + a_1 w_u + a_2 w_s + a_3 X + a_4 Z_M + u^a \\
\text{Labor Demand}^M_{\text{skilled}} = b_0 + b_1 w_u + b_2 w_s + b_3 X + b_4 Z_M + u^b \\
\text{Labor Demand}^A_{\text{unskilled}} = c_0 + c_1 w_u + c_2 w_s + c_3 X + c_4 Z_A + u^c \\
\text{Labor Demand}^A_{\text{skilled}} = d_0 + d_1 w_u + d_2 w_s + d_3 X + d_4 Z_A + u^d \\
\text{Labor Supply}_{\text{unskilled}} = f_0 + f_1 w_u + f_2 w_s + f_3 X + f_4 Z_S + u^f \\
\text{Labor Supply}_{\text{skilled}} = g_0 + g_1 w_u + g_2 w_s + g_3 X + g_4 Z_S + u^g
\]

Setting Labor Demand equal to Labor Supply for both manual and skilled labor, but keeping manufacturing labor demand in its raw form, we get wages for skilled and manual labor:

\[
w_u = \left(\frac{1}{f_1 - c_1}\right) \left[ (c_0 - f_0) + (c_2 - f_2) w_s + (c_3 - f_3) X + c_4 Z_A - f_4 Z_S + \text{LD}^M_M + u^c - u^f \right]
\]

\[
w_s = \left(\frac{1}{g_2 - d_2}\right) \left[ (d_0 - g_0) + (d_1 - g_1) w_u + (d_3 - g_3) X + d_4 Z_A - g_4 Z_S + \text{LD}^M_S + u^f - u^c \right]
\]
Empirical Specification

Solving the system of simultaneous equations, we get:

\[ w_{udt} = \alpha_0 + \alpha_1 E_{unskilled}^M + \alpha_2 E_{Skilled}^M + \alpha_3 X + \alpha_4 Z^A + \alpha_5 Z^S + \epsilon_{d,t} \]

\[ w_{sdt} = \beta_0 + \beta_1 E_{unskilled}^M + \beta_2 E_{Skilled}^M + \beta_3 X + \beta_4 Z^A + \beta_5 Z^S + \epsilon_{d,t} \]

where

\[ \xi = \left( \frac{(g_2 - d_2)(f_1 - c_1)}{(g_2 - d_2)(f_1 - c_1) - (c_2 - f_2)(d_1 - g_1)} \right) \]

\[ \alpha_1 = \xi \ast \frac{1}{f_1 - c_1} \]

\[ \alpha_2 = \alpha_1 \ast \left( \frac{c_2 - f_2}{g_2 - d_2} \right) \]

\[ \beta_2 = \xi \ast \frac{1}{g_2 - d_2} \]

\[ \beta_1 = \beta_2 \ast \left( \frac{d_1 - g_1}{f_1 - c_1} \right) \]
Do instruments only affect wages through shifts in manufacturing demand?

A Prices of agricultural products (Atkin, 2008).
   ▶ Check: Correlation of agricultural prices with instruments.

B Overlap in other input markets?
   ▶ Check 1: Groundwater levels.
   ▶ Check 2: Proportion of predicted workforce in water-intensive industries (Keskin, 2009)

C Agriculture consuming manufactured inputs?
   ▶ Check 1: Fertilizer and pesticide markets regulated.
   ▶ Check 2: Proportion of backwardly linked industries.
Results - Skilled and Unskilled Wages

\[ \frac{w_{udt}}{w_{sdt}} = \alpha_0 + \alpha_1 \hat{E}_{Manu}^{Total, dt} + (\alpha_2 - \alpha_1) \hat{E}_{skilled, dt}^{Manu} + \alpha_3 Ag \text{ Prod}_{dt} + \alpha_4 A_{dt} + \mu_d + \delta_t + \epsilon_{dt} \]

---

### Skilled and Unskilled Wage Responses to Manufacturing and Agricultural Productivity Growth.

<table>
<thead>
<tr>
<th></th>
<th>Log(Unskilled Wage)</th>
<th>Log(Skilled Wage)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FE</td>
<td>FE-IV</td>
</tr>
<tr>
<td>Log(Manufacturing Employment)</td>
<td>0.309***</td>
<td>0.288*</td>
</tr>
<tr>
<td></td>
<td>(0.138)</td>
<td>(0.129)</td>
</tr>
<tr>
<td>Log(&gt; Primary Manufacturing)</td>
<td>-0.259**</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(0.151)</td>
<td>-</td>
</tr>
<tr>
<td>Log(Skilled Manufacturing)</td>
<td>-</td>
<td>-0.226</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>(0.222)</td>
</tr>
<tr>
<td>Log(Agricultural Productivity)</td>
<td>0.371*</td>
<td>0.386*</td>
</tr>
<tr>
<td></td>
<td>(0.215)</td>
<td>(0.216)</td>
</tr>
</tbody>
</table>

| Observations | 930 | 930 | 1034 | 1034 |
| Data Source  | AWI | AWI | NSS  | NSS  |

Note: Standard errors are in parentheses. All specifications include district fixed effects, measures of rainfall and population, by landholding class, and lower order interaction terms from the first stage regressions.
### Income, Manufacturing Growth and Agricultural Productivity

<table>
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<tr>
<th></th>
<th>Landless</th>
<th></th>
<th>Net Exporters</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Illiterate</td>
<td>Literate</td>
<td>Illiterate</td>
<td>Literate</td>
</tr>
<tr>
<td>Log(Total Manufacturing)</td>
<td>0.362** 0.145***</td>
<td>0.230* 0.106** 0.134</td>
<td>0.145*** 0.106** 0.134</td>
<td>0.230* 0.106** 0.134</td>
</tr>
<tr>
<td></td>
<td>(0.162) (0.043)</td>
<td>(0.132) (0.042)</td>
<td>(0.162) (0.043)</td>
<td>(0.132) (0.042)</td>
</tr>
<tr>
<td>Log(Skilled)</td>
<td>-0.289*</td>
<td>0.194* -0.119</td>
<td>-0.289*</td>
<td>0.194* -0.119</td>
</tr>
<tr>
<td></td>
<td>(0.173) (0.098)</td>
<td>(0.106) (0.082)</td>
<td>(0.173) (0.098)</td>
<td>(0.106) (0.082)</td>
</tr>
<tr>
<td>Log(Agricultural Productivity)</td>
<td>0.216*** 0.178**</td>
<td>0.146 0.176*</td>
<td>0.216*** 0.178**</td>
<td>0.146 0.176*</td>
</tr>
<tr>
<td></td>
<td>(0.081) (0.090)</td>
<td>(0.125) (0.105)</td>
<td>(0.081) (0.090)</td>
<td>(0.125) (0.105)</td>
</tr>
<tr>
<td>Observations</td>
<td>36042 26600</td>
<td>24382 21173</td>
<td>36042 26600</td>
<td>24382 21173</td>
</tr>
</tbody>
</table>

Note: Standard errors are in parentheses. All specifications include district fixed effects, measures of rainfall and population, by landholding class, and lower order interaction terms from the first stage regressions.
### Service Sector Employment, Manufacturing Growth and Agricultural Productivity

<table>
<thead>
<tr>
<th></th>
<th>Log(Construction)</th>
<th>Log(Retail)</th>
<th>Log(Transport)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Productivity</td>
<td>-0.99</td>
<td>0.122</td>
<td>-0.412</td>
</tr>
<tr>
<td></td>
<td>(0.723)</td>
<td>(0.442)</td>
<td>(0.485)</td>
</tr>
<tr>
<td>Deregulated*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest Cover*Wood Intensity</td>
<td>30.978</td>
<td>-19.070</td>
<td>8.390</td>
</tr>
<tr>
<td></td>
<td>(25.202)</td>
<td>(24.896)</td>
<td>(13.965)</td>
</tr>
<tr>
<td>Ceramics*Ceramics Intensity</td>
<td>0.089</td>
<td>0.208</td>
<td>0.028</td>
</tr>
<tr>
<td></td>
<td>(0.209)</td>
<td>(0.163)</td>
<td>(0.155)</td>
</tr>
<tr>
<td>Construction*Construction Intensity</td>
<td>0.008**</td>
<td>0.000</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Coal*Energy Intensity</td>
<td>-40.156</td>
<td>45.085</td>
<td>42.874</td>
</tr>
<tr>
<td></td>
<td>(62.847)</td>
<td>(62.620)</td>
<td>(42.756)</td>
</tr>
<tr>
<td>Electricity*Energy Intensity</td>
<td>-0.848</td>
<td>-2.307*</td>
<td>0.812</td>
</tr>
<tr>
<td></td>
<td>(1.417)</td>
<td>(1.288)</td>
<td>(0.542)</td>
</tr>
<tr>
<td>Observations</td>
<td>867</td>
<td>867</td>
<td>867</td>
</tr>
<tr>
<td>F-Statistic</td>
<td>1.78</td>
<td>0.78</td>
<td>1.12</td>
</tr>
</tbody>
</table>

Note: Standard errors are in parentheses. All specifications include district fixed effects, measures of rainfall and population, by landholding class, and lower order interaction terms from the first stage regressions.
\[ s_{ht} = a_0 + a_1 \hat{E}_{total,dt} + a_2 \hat{E}_{skilled,dt} + a_3 \text{Ag Prod}_{dt} + a_4 \text{Direct Cost}_t + a_5 HH_{ht} + a_6 X_{d,t} + u^a \]

### Educational Enrollment, Manufacturing Growth and Agricultural Productivity

**Dependent Variable: Individual Aged 5-9 Started School**

**Additional Controls:**
1. Time Trend*Initial Education Characteristics
2. Education Infrastructure incl Teachers, free meals, books and scholarships

<table>
<thead>
<tr>
<th></th>
<th>Boys</th>
<th></th>
<th>Girls</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Illiterate</td>
<td>Literate</td>
<td>Iliterate</td>
<td>Literate</td>
</tr>
<tr>
<td>Log(Manufacturing Employment)</td>
<td>0.279***</td>
<td>0.057**</td>
<td>0.093*</td>
<td>0.258***</td>
</tr>
<tr>
<td></td>
<td>(0.102)</td>
<td>(0.029)</td>
<td>(0.048)</td>
<td>(0.046)</td>
</tr>
<tr>
<td>Log(Manufacturing Literate)</td>
<td>-0.197***</td>
<td>0.172***</td>
<td>-0.036</td>
<td>-0.221***</td>
</tr>
<tr>
<td></td>
<td>(0.076)</td>
<td>(0.043)</td>
<td>(0.045)</td>
<td>(0.043)</td>
</tr>
<tr>
<td>Log(Agricultural Productivity)</td>
<td>0.327*</td>
<td>0.125**</td>
<td>0.251*</td>
<td>0.127</td>
</tr>
<tr>
<td></td>
<td>(0.175)</td>
<td>(0.063)</td>
<td>(0.134)</td>
<td>(0.088)</td>
</tr>
</tbody>
</table>

| Observations                  | 14207   | 12524      | 13849    | 12865      |
| Data Source                   | NSS     | NSS        | NSS      | NSS        |

Note: Standard errors are in parentheses. All specifications include district fixed effects, measures of rainfall and population, by landholding class, and lower order interaction terms from the first stage regressions.
### Educational Infrastructure

**Dependent Variable: Measure of Educational Infrastructure**

<table>
<thead>
<tr>
<th></th>
<th>F-Stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Teachers</td>
<td>2.67**</td>
</tr>
<tr>
<td>Average Distance from School</td>
<td>3.31***</td>
</tr>
<tr>
<td>Cost of Transport</td>
<td>1.63</td>
</tr>
<tr>
<td>Average Total Cost Per Student</td>
<td>0.55</td>
</tr>
<tr>
<td>Average Tuition Per Student</td>
<td>0.94</td>
</tr>
<tr>
<td>Free Tuition</td>
<td>1.77</td>
</tr>
<tr>
<td>Midday Meal</td>
<td>3.42***</td>
</tr>
<tr>
<td>Books</td>
<td>6.73***</td>
</tr>
<tr>
<td>Transport</td>
<td>1.76</td>
</tr>
<tr>
<td>Scholarship</td>
<td>6.98***</td>
</tr>
</tbody>
</table>