THE PRODUCTIVITY EFFECTS OF LABOUR REALLOCATION: EVIDENCE FROM INDIA

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What happens to productivity and wages in destination sectors when workers move out of agriculture?

What does this imply about the allocation of talent across sectors in the local economy?
Motivation

For decades, economists have sought to understand why wages and output per worker are much lower in the agricultural sector than in non-agricultural sectors (Rosenstein-Road, 1943; Lewis, 1955; Rostow, 1960)

| Average Wage Gap (Agriculture vs. Non-Agriculture) |
|------------------|------------------|------------------|
|                  | India Wide       | Within District  | Within District Skill Adjusted |
| Average Wage Gap | 2.321            | 1.956            | 1.406                         |
| District Fixed Effects | No            | Yes              | Yes                           |
| Individual Controls       | No              | No               | Yes                           |
| Observations               | 95,328           | 95,328           | 95,311                        |

Notes: Significance levels are indicated as * 0.10 ** 0.05 *** 0.01. Estimates are based on individual-level mincerian wage regressions controlling for a sector dummy specifying whether the individual is engaged in agricultural or non-agricultural labour. The wage gap is calculated as \( \exp(\beta) \).
Motivation

How should these “gaps” be interpreted?

- Gaps represent arbitrage opportunities to increase productivity impeded by frictions - a misallocation of talent (Restuccia and Rogerson, 2008; Moretti, 2011; Gollin et al., 2013; Burgess et al., 2013; Morten, 2013; Bryan et al., 2014; Hsieh et al., 2014; Morten and Oliviera, 2014; Bryan and Morten, 2015)

- Gaps represent the rational selection of heterogeneous workers (Roy, 1951; Heckman and Sedlacek, 1985; Heckman and Honoré, 1990; Miguel and Hamory, 2009; Beegle et al., 2011; Lagakos and Waugh, 2013; Young, 2013; 2015)

Understanding the relative importance of each channel has clear implications for policy making in developing countries.
How should these “gaps” be interpreted?

- Labour is misallocated across sectors.
  - Misallocation arises due to frictions that impede the movement of labour between skill groups.
  - Within skill groups the marginal product of labour is equalised across sectors.

- A simple decomposition of the wage gap suggests that adjustment frictions account for \( \approx 38\% \) of the average wage gap between agriculture and manufacturing in India.
I present and extend a simple multi-sector heterogenous worker model that provides a set of competing theoretical predictions used to guide the interpretation of the empirical results.

- **Absent labour market frictions** workers sort efficiently across sectors and tasks.
  - A reallocation of workers from one sector into another strictly decreases productivity and average wages in destination sectors.

- **In the presence of labour market frictions** workers are misallocated across sectors and tasks.
  - A reallocation of workers from one sector into another weakly increases productivity and the average wages in destination sectors.
The Objective:

- To identify the existence, and economic consequences, of labour reallocation.
- We need localised, exogenous variation in: (1) the demand for agricultural labour that (2) doesn’t affect other sectors.
Empirics: Identifying Labour Reallocation

The Objective:

- To identify the existence, and economic consequences, of labour reallocation.

- We need localised, exogenous variation in: (1) the demand for agricultural labour that (2) doesn’t affect other sectors.

- Year-to-year variation in weather is:
  - A strong driver of short-run agricultural productivity
  - Plausibly exogenous and localised satisfying condition (1)
  - Agriculture is arguably more sensitive to weather variation than other sectors . . . (2 ish)
The Problem:

- There are potentially many empirically relevant channels.
- This is a common issue that relates to research using weather data.
**Empirics: Identifying Labour Reallocation**

- **The Problem:**
  - There are potentially many empirically relevant channels.
  - This is a common issue that relates to research using weather data.
  - How do we interpret empirical estimates of weather variation in a meaningful way?
  - Any estimate of the reduced form elasticity between weather and outcomes of interest will provide the net effect of all the competing and complementary channels.
A Solution:

- “Switch off” the labour reallocation effect for a subsample of the data.

- I exploit spatial variation, and firm-level exposure to, India’s labour regulation environment.
Empirics: Identifying Labour Reallocation

A Solution:

- “Switch off” the labour reallocation effect for a subsample of the data.

- I exploit spatial variation, and firm-level exposure to, India’s labour regulation environment.

  - In the raw data I observe bunching just below the firm-size threshold in rigid labour markets.

  - No differential effect of the regulation on unregulated sectors.
Empirics: Identifying Labour Reallocation

- The main empirical analysis compares regulated firms in rigid labour markets to regulated firms in flexible markets.

- The difference in net effects between regulated firms across labour regulation environments backs out the sign and magnitude of the labour reallocation effect:

\[
\begin{align*}
\text{Flexible} &= \text{Labour Reallocation} + \text{Other Channels} \\
\text{Rigid} &= \text{Other Channels} \\
\text{Flexible} - \text{Rigid} &= \text{Labour Reallocation}
\end{align*}
\]
Agriculture plays an important role in India’s economy:

- Roughly 50-60% of employment.
- 60-70% of land use.
- 15-20% of GDP.

Less than half of agricultural land is irrigated with yields dependent on the timing and intensity of the monsoon.

Very limited insurance available beyond rural banks (Burgess and Pande, 2005; Fulford, 2013).
An increase in temperature is associated with:

- a reduction in agricultural yields and the value of agricultural production.
- No effect on agricultural prices consistent with a “law of one price”.

These results suggest that local agricultural markets are at least integrated with national markets. Consequently, reductions in agricultural productivity should result in an outflow of workers into other sectors of the local economy (Matsuyama, 1992; Foster and Rosenzweig, 2004; Costinot et al., forthcoming).
The Empirical Context – Agriculture in India

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An increase in temperature is associated with:
- a reduction in the average agricultural day wage
- a reduction in the share of agricultural employment

However, this is offset by an increase in the district share of employment in the manufacturing sector.

There is no significant effect of weather on the average day wage of rural non-agricultural, or urban, workers.

These results:
- Provide direct evidence of labour reallocation,
- Suggest that labour reallocation can act as a safety valve,
- Highlight the importance of diversification and market integration in the management of idiosyncratic productivity shocks.
The Empirical Context – Wages and Employment

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Industrial Regulation is largely the consequence of central planning.

The only exception to this is in the area of industrial relations.

The key piece of regulation is the Industrial Disputes Act of 1947.

- Regulates Indian labour law concerning trade unions.
- Amended heavily at the state level up until the early 1990s.
- Directly applies to the formal manufacturing sector.
- Only firms with more than 100 workers (50 in West Bengal and 300 in Uttar Pradesh) are directly regulated.
**Codifying the Labour Regulation Environment**

- Besley and Burgess (2004) code each IDA amendment providing spatial and temporal variation in the labour regulation environment.

- I extend their approach by incorporating firm-level exposure to the regulation.

- The only binding constraint (identification wise) is in pro-worker states so I combine the remaining categories:

  - Rigid = 0 [West Bengal, Maharashtra, Orissa]
  - Flexible = 1 [Remaining States]
Establishment-level microdata from the Annual Survey of Industries (2001-2007)

- covers the formal manufacturing sector.
- comparable to manufacturing surveys in developed countries.
- Dependent variables: Total Output, Productivity (Labour and measured TFPR), Employment (by type), Average Day Wages (by type).
**Data**

- Establishment-level microdata from the Annual Survey of Industries (2001-2007)
  - covers the formal manufacturing sector.
  - comparable to manufacturing surveys in developed countries.
  - Dependent variables: Total Output, Productivity (Labour and measured TFPR), Employment (by type), Average Day Wages (by type).

- High-resolution daily climate reanalysis data (ERA-Interim)
  - Combines observational data with global climate models to provide a consistent best estimate of atmospheric parameters over time and space.
  - Useful in developing countries where there are quality/quantity concerns surrounding the measurement of weather.
Empirical Specification

\[ \log Y_{ijdt} = \beta f(w_{dt}) + \gamma f(w_{dt}) \times \text{FLEXIBLE} + \alpha_{jd} + \alpha_{jt} + \phi_{st} + \epsilon_{ijdt} \]

- The labour reallocation channel:

  \[ \text{Flexible} - \text{Rigid} = \gamma + \beta - \beta = \gamma \]

- The remaining net effect:

  \[ \text{Rigid} = \beta \]
# Main Results

<table>
<thead>
<tr>
<th>Production and Employment</th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Output</td>
<td>Employment Contract</td>
<td>Employment Permanent</td>
<td></td>
</tr>
<tr>
<td>Daily Average Temperature (°C)</td>
<td>-0.0641 (0.0428)</td>
<td>-0.0998** (0.0475)</td>
<td>-0.000253 (0.0281)</td>
<td></td>
</tr>
<tr>
<td>Temperature x Flexible</td>
<td>0.0974** (0.0484)</td>
<td>0.113** (0.0494)</td>
<td>0.0298 (0.0282)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Productivity and Wages</th>
<th>Output Per Worker</th>
<th>TFPR</th>
<th>Day Wage Contract</th>
<th>Day Wage Permanent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.0693* (0.0385)</td>
<td>-0.0731*** (0.0241)</td>
<td>0.0150 (0.0240)</td>
<td>-0.0663*** (0.0153)</td>
</tr>
<tr>
<td></td>
<td>0.0932** (0.0432)</td>
<td>0.0505** (0.0246)</td>
<td>-0.0451* (0.0260)</td>
<td>0.0709*** (0.0184)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Rainfall Controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sector x District, Sector x Year, and State-Year Time Trends</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Observations:**

- Total Output: 49,264
- Employment Contract: 24,631
- Employment Permanent: 47,510
- Output Per Worker: 49,264
- TFPR: 44,565
- Day Wage Contract: 24,631
- Day Wage Permanent: 47,510

Notes: Significance levels are indicated as * 0.10 ** 0.05 *** 0.01. Standard errors are adjusted to reflect spatial dependence as modelled in Conley (1999). Spatial autocorrelation is assumed to linearly decrease in distance up to 500km. The distance is selected for each sector following a decision rule in which we choose the distance that provides the most conservative standard errors, looped over all distances between 10 and 1000km.
By examining the differential effect of weather on unregulated firms below the regulatory threshold I test the assumption that the “other channels” are constant across space:

\[
\text{Flexible} = \text{Labour Reallocation} + \text{Other Channels} \\
\text{Rigid} = \text{Labour Reallocation} + \text{Other Channels}
\]

\[
\text{Flexible} - \text{Rigid} = 0
\]
## Supporting Results

<table>
<thead>
<tr>
<th></th>
<th>Production and Employment</th>
<th></th>
<th>Productivity and Wages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Output</td>
<td>Employment Contract</td>
<td>Employment Permanent</td>
</tr>
<tr>
<td>Daily Average</td>
<td>0.144**</td>
<td>0.0214</td>
<td>0.0847***</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>(0.0571)</td>
<td>(0.0587)</td>
<td>(0.0233)</td>
</tr>
<tr>
<td>Temperature × Flexible</td>
<td>-0.0772</td>
<td>-0.0598</td>
<td>-0.0460*</td>
</tr>
<tr>
<td></td>
<td>(0.0594)</td>
<td>(0.0615)</td>
<td>(0.0247)</td>
</tr>
<tr>
<td>Rainfall Controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Fixed Effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>89,271</td>
<td>25,248</td>
<td>78,830</td>
</tr>
</tbody>
</table>

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# Agricultural Productivity Gap Decomposition

<table>
<thead>
<tr>
<th></th>
<th>Wage Gap</th>
<th>Wage Gap Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worker Self Selection + Misallocation</td>
<td>3.830</td>
<td>100%</td>
</tr>
<tr>
<td>Worker Self Selection</td>
<td>2.382</td>
<td>62.19%</td>
</tr>
<tr>
<td>Misallocation</td>
<td>1.448</td>
<td>37.81%</td>
</tr>
</tbody>
</table>

**Notes:** Significance levels are indicated as * 0.10 ** 0.05 *** 0.01. Estimates are based on the within-district log-difference of the average the average permanent worker manufacturing wage and average agricultural worker wage (Worker Self Selection + Misallocation); the average contract worker manufacturing wage and average agricultural worker wage (Worker Self Selection); The wage gap is calculated as exp(β). The difference between the two wage gap estimates provides the estimate of misallocation.
Conclusions

- Reallocating workers from agriculture into manufacturing increases productivity and the average wage in destination sectors.
  - The average wage for casual workers falls consistent with worker self-selection (high sectoral mobility within skill groups)
  - However, the average wage for permanent workers and productivity increases consistent with the presence of misallocation.

- A decomposition of the average wage gap between agriculture and manufacturing suggests that misallocation accounts for \( \approx 38\% \) of the wage differences, with worker self-selection accounting for the remaining 62\%.
IMPLICATION FOR POLICY AND FUTURE RESEARCH

- What are the labour market frictions that impede the movement of workers between skill groups?

- What affect would eliminating these frictions have on aggregate productivity (Restuccia and Rogerson, 2008; 2013; Hsieh and Klenow, 2009)?

- How much of the sectoral productivity gap is amenable to policy?
What do these results mean in the context of climate change?

- It is important to think carefully about the interpretation of empirical results when using weather data.
- Mechanisms matter more than magnitudes.

Understanding the channels through which climate change could have an effect allows us to better design interventions to minimise the costs of climate change.

- The reallocation of labour across sectors and space as a market-based adaptation response.

Understanding the constraints that impede the response of individuals to any transitory or persistent change is of first-order importance.
Thank you for listening

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