Why is Measured Productivity so Low in Agriculture?

Berthold Herrendorf and Todd Schoellman
Arizona State University

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Motivation

Key Fact about Poor Countries

- Value added per worker is much lower in agriculture than in non-agriculture
- Sizeable part of the labor force is in agriculture
Questions

• What accounts for the large productivity gaps between non–ag and ag?
  ○ Are the productivity gaps due to distortions?
  ○ Would it be beneficial to reallocate labor?

Data limitations make answering these questions hard

• Measuring labor productivity in agriculture is challenging

• Distinguishing among different explanatory factors is challenging
We introduce two new ideas to this literature

(i) We can learn about the forces behind productivity gaps by studying US states
   ○ Most models assume that US is the undistorted benchmark without productivity gaps
   ○ Detailed and comparable data allow us to assess whether this is the case

(ii) We can check plausibility of productivity gaps by studying wage gaps
   ○ Wages and productivity are linked through an accounting identity
   ○ We calculate the components of this identity for US states and selected countries
   ○ The selection criterion for the countries is data availability
Our Results

- **In US states**
  1) There are large productivity gaps and large wage gaps
  2) The productivity gaps are inconsistent with the wage gaps
  3) There is a measurement problem in agriculture
  4) After correcting for it, productivity gaps are roughly consistent with wage gaps
  5) Wage gaps are mostly accounted for by sectoral differences in human capital

- **In selected countries**
  - 1)–3) and 5) hold
Outline

• Motivation

• Evidence for US States
  1) Measuring Productivity Gaps
  2) Comparing Gaps in Productivity and Wages
  3) Locating the Measurement Problem
  4) Re–measuring Agricultural Productivity
  5) Human Capital

• Evidence for Selected Countries

• Conclusion
1) Evidence for US States – Measuring Productivity Gaps

Terminology and Definitions

- Sectors
  - Agriculture: crop and animal production, forestry, fishing, and hunting
  - Non-agriculture: all industries other than agriculture

- Productivity gaps
  - Productivity: value added in current $’s per employment (either workers or hours)
  - Gaps: ratio of productivities in non–agriculture and agriculture
Data Sources

- **Value added: BEA’s regional accounts**
  - Basis of NIPA

- **Hours worked: Current Population Survey (CPS)**
  - Create ten–year bins: 1980s, 1990s, 2000s
    - Increases number of observations
    - Averages out bad harvests
  - Exclude the five states with the smallest samples in agriculture
    - Alaska, Connecticut, Massachusetts, Rhode Island, West Virginia
Why is Measured Labor Productivity so Low in Agriculture?

There are large measured productivity gaps in US states

The productivity gaps are of the same order of magnitude as for poor countries


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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Median</td>
<td>1.9</td>
</tr>
<tr>
<td>90th Percentile</td>
<td>3.0</td>
</tr>
<tr>
<td>Maximum</td>
<td>5.7</td>
</tr>
</tbody>
</table>
2) Evidence for US States – Comparing Gaps in Productivity and Wages

Notation

- Productivity (in current dollars): \( Y/L \)
- Wage (in current dollars): \( W \)
- Gap in variable \( X \): \( \text{Gap}(X) \equiv X_n/X_a \)
A first identity

• Definition of labor share

\[ LS \equiv \frac{WL}{Y} = \frac{W}{Y/L} \]

• This implies that

\[ \frac{Y_i}{L_i} = LS_i^{-1} \cdot W_i \]

\[ \text{Gap}(Y/L) = \text{Gap}(LS)^{-1} \cdot \text{Gap}(W) \]

• Sectoral labor shares determine relationship between productivity and wage gaps
Wage gaps should be larger than productivity gaps

- **NIPA Evidence on labor shares for aggregate US economy 1980–2009**

  \[
  LS_a = 0.44 \quad \text{and} \quad LS_n = 0.66
  \]

  \[\Rightarrow \quad \text{Gap}(LS)^{-1} = \frac{LS_a}{LS_n} = 0.7\]

  \[\Rightarrow \quad \text{Gap}(Y/L) = 0.7 \cdot \text{Gap}(W) < \text{Gap}(W)\]

- **Next, measure wage gaps and check whether they are in the ballpark**
Measuring Wage Gaps

Data

- CPS Matched Outgoing Rotation Groups
  - Information on hourly nominal wages, age, education, gender etc
  - No information on wages of self-employed, proprietors, non-wage workers

- Impute nominal hourly wages of individuals with missing wages
  - Use reported wages of individuals in same state and sector with same characteristics
  - This takes care of selection with respect to observable characteristics
Comparing gaps in productivity and wages

Why is Measured Labor Productivity so Low in Agriculture?

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### Summary statistics for gaps in wages and productivity for US states

<table>
<thead>
<tr>
<th></th>
<th>Gap($Y/L$)</th>
<th>Gap($W$)</th>
<th>Implied Gap($LS^{-1}$)</th>
</tr>
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<tbody>
<tr>
<td>Median</td>
<td>1.9</td>
<td>1.9</td>
<td>1.0</td>
</tr>
<tr>
<td>90th Percentile</td>
<td>3.0</td>
<td>2.2</td>
<td>1.7</td>
</tr>
<tr>
<td>Maximum</td>
<td>5.7</td>
<td>2.8</td>
<td>2.9</td>
</tr>
</tbody>
</table>

- **Productivity and wage gaps are not in the ballpark**
  - Productivity gaps are larger than the wage gaps
  - Inverse of implied labor share gaps considerably larger than 0.7
- **This suggests a measurement problem**
3) Evidence for US States – Locating the Measurement Problem

Implied labor shares in non-agriculture by decade

- Average 59 – 64% is reasonable compared to data
  \implies\text{Plausible}
Why is Measured Labor Productivity so Low in Agriculture?

Implied labor shares in agriculture by decade

- Average of 60 – 61% is large compared to 44% in the data
- Several observations larger than 1
  \[ \Rightarrow \text{Implausible, measurement problem in agriculture} \]
- We will establish for US states that agricultural value added is under-estimated
4) Evidence for US States – Re-measuring Agricultural Productivity

Farm Value Added

- **SNA convention:**
  count some factor payments accruing on farms to non-farmers elsewhere
  - Rental payments to agricultural land are counted in real estate
  - Payments to contract labor are counted in farm services

- **Correction:**
  construct our own farm value added from USDA Data
Summary statistics BEA and USDA value added 1980–2009

<table>
<thead>
<tr>
<th></th>
<th>BEA</th>
<th>USDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>1.9</td>
<td>1.6</td>
</tr>
<tr>
<td>90th Percentile</td>
<td>3.0</td>
<td>2.8</td>
</tr>
<tr>
<td>Maximum</td>
<td>5.7</td>
<td>5.7</td>
</tr>
</tbody>
</table>
Proprietors’ Income

- IRS re-audits find that proprietors severely underreport income

Table 1: Actual divided by Reported Proprietors’ Income

<table>
<thead>
<tr>
<th></th>
<th>Nonfarm</th>
<th>Farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980s</td>
<td>1.4 – 1.5</td>
<td>1.4 – 1.5</td>
</tr>
<tr>
<td>2001</td>
<td>2.3</td>
<td>3.6</td>
</tr>
</tbody>
</table>

- BEA makes adjustments
  - Nonfarm proprietors’ income using IRS findings: factor 1.4–2.3
  - Farm proprietors’ income using reported revenues – expenses: factor 1.2

- If the BEA is missing proprietors’ income in ag, then productivity gap correlated with share of reported proprietors’ income

- Positive slope (significant at 99% confidence level)

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Summary Statistics after both Corrections 1980–2009

<table>
<thead>
<tr>
<th></th>
<th>Gap($Y/L$)</th>
<th>Gap($W$)</th>
<th>Gap($LS)^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>1.3</td>
<td>1.9</td>
<td>0.7</td>
</tr>
<tr>
<td>90th Percentile</td>
<td>2.0</td>
<td>2.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Maximum</td>
<td>3.6</td>
<td>2.8</td>
<td>1.8</td>
</tr>
</tbody>
</table>

- Corrected measure resolves puzzle for the median state
- Somewhat of a puzzle remains for the upper tail
Summary

- The corrected productivity gaps are broadly consistent with wage gaps
- This leaves the question what accounts for the wage gaps
- The last step is to show that gaps in human capital account for most of them
5) Evidence for US States – Human Capital

Measuring human capital

- We construct human capital in the standard Mincer way
  - From the previous log–wage regressions, we use the estimated coefficients on
    - education
    - gender
    - potential experience
  - We don’t use estimated intercepts and year or state fixed effects
  - Recall: regressions are at the sector level, which turns out to be important
Wage Profiles by Sector, 2000 CPS

(a) Years of Schooling

(b) Potential Experience
Summary statistics human capital

<table>
<thead>
<tr>
<th></th>
<th>Gap($W$)</th>
<th>Gap($H$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td>90$^{th}$ Percentile</td>
<td>2.2</td>
<td>2.1</td>
</tr>
<tr>
<td>Maximum</td>
<td>2.8</td>
<td>2.1</td>
</tr>
</tbody>
</table>

- The sizes of the gaps in wages and human capital are surprisingly close
- There don’t seem to be barriers to the movement of labor
Evidence for Selected Countries

Selection Criteria

- **Country–year pairs which have**
  - NIPA info in UN database on value added in agriculture as share of GDP
  - Census info in IPUMS on sectoral employment and wages

- **Country–year list**

<table>
<thead>
<tr>
<th>Country</th>
<th>Year Pair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>(1991,2000)</td>
</tr>
<tr>
<td>India</td>
<td>(1993,1999)</td>
</tr>
<tr>
<td>Israel</td>
<td>(1995)</td>
</tr>
<tr>
<td>Mexico</td>
<td>(1990,2000)</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>(1990,2000)</td>
</tr>
<tr>
<td>United States</td>
<td>(1990,2000)</td>
</tr>
<tr>
<td>Canada</td>
<td>(1991,2001)</td>
</tr>
<tr>
<td>Indonesia</td>
<td>(1995)</td>
</tr>
<tr>
<td>Jamaica</td>
<td>(1991,2001)</td>
</tr>
<tr>
<td>Panama</td>
<td>(1990,2000)</td>
</tr>
<tr>
<td>Uruguay</td>
<td>(2006)</td>
</tr>
<tr>
<td>Venezuela</td>
<td>(1990,2001)</td>
</tr>
</tbody>
</table>
1) Summary statistics selected countries

<table>
<thead>
<tr>
<th></th>
<th>GDP pc Gap (US rel. to country)</th>
<th>Agr. Empl. Share (in %)</th>
<th>Prod. Gap (non-ag. rel. to ag)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>4.5</td>
<td>17</td>
<td>2.6</td>
</tr>
<tr>
<td>90th Percentile</td>
<td>11</td>
<td>44</td>
<td>4.3</td>
</tr>
<tr>
<td>Maximum</td>
<td>22</td>
<td>62</td>
<td>4.4</td>
</tr>
</tbody>
</table>
2) Comparing Gaps in Productivity and Wages

Cross–country evidence on labor share in agriculture

- US labor share is 0.44 during 1990–2009

- To what extent is value this representative for our sample of countries?
  - Fichelson (RES,1974): 0.44 in Israel at the end of the 1960s
  - Echevarria (IER,1998): 0.41 in Canada 1971–93
  - Mundlak (JEL,2005): less than 1/2 in sharecropping arrangements

\[ L S_a < L S_n \implies \text{Gap}(Y/L) < \text{Gap}(W) \]
Gaps in Productivity and in Wages

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Summary statistics for wage gaps and productivity gaps in selected countries

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<td>4.3</td>
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<td>4.4</td>
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- Productivity and wage gaps are not in the ballpark
- This suggests measurement problem
3) Locating the Measurement Problem

A second identity

\[ LS = \left( \frac{Y_a}{Y} \right) LS_a + \left( \frac{Y_n}{Y} \right) LS_n \]

\[ \Rightarrow \quad LS_a = \frac{LS}{\left( \frac{Y_a}{Y} \right) + \left( \frac{Y_n}{Y} \right) \left( \frac{LS_n}{LS_a} \right)} \]

\[ LS_n = \frac{LS}{\left( \frac{Y_a}{Y} \right) \left( \frac{LS_a}{LS_n} \right) + \left( \frac{Y_n}{Y} \right)} \]
Summary statistics implied labor shares for the selected countries

<table>
<thead>
<tr>
<th></th>
<th>Non-ag.</th>
<th>Ag.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>0.67</td>
<td>0.75</td>
</tr>
<tr>
<td>90th Percentile</td>
<td>0.67</td>
<td>1.08</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.70</td>
<td>1.25</td>
</tr>
</tbody>
</table>
5) Gaps in wages and human capital

<table>
<thead>
<tr>
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<th>Gap(W)</th>
<th>Gap(H)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>2.0</td>
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<td>Maximum</td>
<td>4.1</td>
<td>4.3</td>
</tr>
</tbody>
</table>

- Large gaps also in human capital
- The sizes of the gaps in wages and human capital are surprisingly close
Conclusion

Our work establishes that

- **In US states**
  1) There are large productivity gaps and large wage gaps
  2) The productivity gaps are inconsistent with the wage gaps
  3) There is a measurement problem in agriculture
  4) After correcting for it, productivity gaps are roughly consistent with wage gaps
  5) Wage gaps are mostly accounted for by sectoral differences in human capital

- **In selected countries**
  1)–3) and 5) hold
Our work also establishes that

- The US economy behaves like the benchmark in standard models
- Sectoral differences in human capital lead to quantitatively large wage gaps
- There is a measurement problem in agriculture