The Agricultural Productivity Gap in Developing Countries

Douglas Gollin
Williams College

David Lagakos
Arizona State University

Michael Waugh
New York University

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In most sub-Saharan countries, agriculture is a large sector in terms of employment and output.

But typically agriculture’s share of employment is much higher than its share of GDP.

Is this evidence of allocative inefficiency?

McMillan and Rodrik (2011): report potential gains from moving workers out of agriculture and into other sectors.

Potentially important policy implications.
Some Questions about Productivity Gaps

- This paper asks what we actually know about these productivity gaps.
  - Are the gaps measured accurately?
  - How could large gaps persist?
  - Can labor market rigidities possibly explain gaps of the magnitude found in the data?
  - What other explanations might be relevant?
Productivity gaps are widely noted in the literature as far back as Kuznets and, of course, Lewis.

- Caselli (2005) argued that cross-country income differences must be closely related to differences in agricultural productivity.

- Micro data systematically finds evidence of lower living standards in rural areas.
A First Look at the Data

- What do the data show?
  - Agriculture’s share of employment high.
  - Share of value added lower than share of employment.
Agriculture Shares of GDP and Workforce

Figure: Agriculture shares in developing countries

Gollin, Lagakos & Waugh (2011)
Implications of the Raw Data

- Taken at face value, these data imply that value added per worker ($\frac{VA}{L}$) is lower in agriculture than in the non-agricultural sector.
- The implied productivity gaps are large.
Agricultural Productivity Gap

- We define the Agricultural Productivity Gap (APG) to be
  \[ APG \equiv \frac{VA_n/L_n}{VA_a/L_a} \]
- Simple two-sector model says APG should be 1.
- Typical developing country has APG of 4.
- Some (particularly in sub-Saharan Africa) have APGs of 8 or more!
Simple Two-Sector Model

- Technologies

\[ Y_a = A_a L_a^\theta K_a^{1-\theta} \quad \text{and} \quad Y_n = A_n L_n^\theta K_n^{1-\theta} \]

- Competitive labor markets

- Households can supply labor to either sector

- Then, in equilibrium:

\[ APG \equiv \frac{VA_n/L_n}{VA_a/L_a} = \frac{Y_n/L_n}{p_a Y_a/L_a} = 1. \]
"Raw" Agricultural Productivity Gaps

<table>
<thead>
<tr>
<th>Measure</th>
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<th>Unweighted</th>
</tr>
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<tr>
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</table>
Sub-Saharan Productivity Gaps

- In general, the APGs are largest for the poorest countries.
- They are even larger, however, for sub-Saharan countries.
- A number of African countries have APGs greater than 10.
"Raw" Agricultural Productivity Gaps

Africa

Asia

Americas

Europe

Number of Countries

APG

Number of Countries

APG

Number of Countries

APG

Number of Countries

APG
Possible Implications of Large APGs

- APGs appear to “explain” much of cross-country disparities in GDP per worker.
- Appear to suggest massive misallocation.
- Policy debate: encourage movement out of agriculture?
- Our view: gaps may reflect measurement issues; need to ask more questions.
What Do Agricultural Productivity Gaps Reflect?

Sector differences in hours worked per worker?
- Construct measures of hours worked by sector for 56 countries

Sector differences in human capital per worker?
- Construct measures of human capital by sector for 127 countries

Urban-rural differences in cost of living?
- Use cost-of-living data for 87 countries from World Bank

Measurement error in national accounts data?
- Use household income/expenditure surveys from 20+ countries
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Preview of Results

- After adjustments, APG in average developing country reduced from 4 to 2.
- Household survey data also suggest big sector income gaps.
- Puzzling that gaps are still so large.
"Simple" Measurement Questions

- National accounts exclude production of agriculture for own consumption?

- Rural people counted as agricultural workers?
"Simple" Measurement Questions

- National accounts exclude production of agriculture for own consumption?
  
  No, it is included.

- Rural people counted as agricultural workers?
“Simple” Measurement Questions

- National accounts exclude production of agriculture for own consumption?

- Rural people counted as agricultural workers?

  No, only "economically active" persons should be included.
"Simple" Measurement Questions

- National accounts exclude production of agriculture for own consumption?

- Rural people counted as agricultural workers?

  In practice, official estimates similar to our surveys.
Sector Differences in Hours Worked

- Average hours worked per worker might differ across sectors

- We construct average hours worked per worker by sector for 56 countries
  - Population census micro data or labor force surveys
  - All employed or unemployed persons 15+ years old
  - Industry of primary employment (employed); industry of previous employment or rural/urban status (unemployed)
  - Hours worked in reference period (usually one week)
Sector Differences in Hours Worked

![Sector Differences in Hours Worked](image)
Sector Differences in Hours Worked: Summary

- Explains on average a factor 1.2
- Only a few countries above 1.5
- Unlikely to be the main cause of APGs in developing countries
Sector Differences in Human Capital

Relevant for U.S. development experience (Caselli & Coleman, 2001); developing countries today (Vollrath, 2009)

We construct human capital per worker by sector for 127 countries

- Same sources, sample selection as for hours
- Years of schooling measured directly when available
- Impute years of schooling using educational attainment otherwise
- Baseline: assume 10% rate of return on year of schooling (Psacharoplos & Patrinos 2002; Banerjee & Duflo, 2005)
Sector Differences in Human Capital

Human Capital in Agriculture vs. Human Capital in Non-Agriculture

Countries represented on the graph include:
- ALB
- ARG
- ARM
- AZE
- BGD
- BLR
- BLZ
- BTN
- BOL
- BWABRA
- BFA
- BDIMK
- CMR
- CAF
- TCD
- CHL
- CHNCOL
- CRI
- CIV
- CUB
- DOM
- ECU
- EGYSLV
- ETH
- FJI
- GAB
- GMB
- GEO
- GHA
- GTM
- GIN
- GUY
- HND
- IND
- IDN
- IRN
- IRQ
- JAM
- JOR
- KAZ
- KEN
- KGZ
- LAO
- LSO
- LBR
- LTUMKD
- MDG
- MWIMYS
- MDV
- MLI
- MHL
- MEX
- MDA
- MNG
- MAR
- NAM
- NPL
- NIC
- NGA
- PAK
- PAN
- PNGPRY
- PER
- PHL
- ROM
- MDA
- MNG
- UZB
- SRB
- TJK
- TZA
- THA
- TON
- TUR
- UGA
- UKR
- UZB
- VEN
- VNM
- YEM
- ZAF
- ZMB
- ZWE
Quality Differences in Schooling

- Rural schools often of lower quality than urban schools (Williams, 2005; Zhang, 2006)

- Potentially *overestimate* human capital among agriculture workers

- We use literacy data to adjust for schooling quality
Uganda: Literacy by Years of Schooling Completed

![Graph showing literacy rate by years of schooling completed for non-agricultural and agricultural workers.](image-url)
Measuring Quality Differences in Schooling

- Given literacy rates by years of schooling: $\ell^n_i(s)$ and $\ell^a_i(s)$ for $s = 1, 2, ...$

- Assume that one year in rural school is worth $\gamma$ years in urban school

- For each country $i$, solve for $\gamma_i$ that solves

$$\min_{\gamma} \sum_{s=1}^{\bar{s}} \left( \tilde{\ell}^n_i(\gamma s) - \tilde{\ell}^a_i(s) \right)^2$$

where $\tilde{\ell}^n_i(\cdot)$, $\tilde{\ell}^a_i(\cdot)$ are polynomial interpolations of $\ell^n_i(\cdot)$, $\ell^a_i(\cdot)$ for $s \in [0, \bar{s}]$. 
### Table 3: Rural-Urban Education Quality Differences

<table>
<thead>
<tr>
<th>Country</th>
<th>$\tilde{\gamma}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>0.87</td>
</tr>
<tr>
<td>Bolivia</td>
<td>0.95</td>
</tr>
<tr>
<td>Brazil</td>
<td>0.89</td>
</tr>
<tr>
<td>Chile</td>
<td>0.92</td>
</tr>
<tr>
<td>Ghana</td>
<td>0.90</td>
</tr>
<tr>
<td>Guinea</td>
<td>0.62</td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.93</td>
</tr>
<tr>
<td>Mali</td>
<td>0.89</td>
</tr>
<tr>
<td>Mexico</td>
<td>0.77</td>
</tr>
<tr>
<td>Panama</td>
<td>0.87</td>
</tr>
<tr>
<td>Philippines</td>
<td>0.80</td>
</tr>
<tr>
<td>Rwanda</td>
<td>0.88</td>
</tr>
<tr>
<td>Tanzania</td>
<td>1.25</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.90</td>
</tr>
<tr>
<td>Uganda</td>
<td>0.82</td>
</tr>
<tr>
<td>Venezuela</td>
<td>0.78</td>
</tr>
<tr>
<td>Vietnam</td>
<td>0.74</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>0.87</strong></td>
</tr>
</tbody>
</table>
Sector Differences in Human Capital: Summary

- Explains on average a factor 1.4

- Range (10th-90th percentile) from 1.2 to 1.6

- Quality adjustments using literacy data don’t change results much

- Even assuming rural years of schooling are worth 1/2 as much as urban, still get only a factor 1.6 on average, maximum of 2.1
"Adjusted" Agricultural Productivity Gaps

<table>
<thead>
<tr>
<th>Measure</th>
<th>Countries w/ Complete Data</th>
<th>All Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>5th Percentile</td>
<td>1.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Median</td>
<td>2.3</td>
<td>1.8</td>
</tr>
<tr>
<td>Mean</td>
<td>2.0</td>
<td>1.9</td>
</tr>
<tr>
<td>95th Percentile</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Number of Countries</td>
<td>34</td>
<td>112</td>
</tr>
</tbody>
</table>
Raw vs Adjusted Gaps

The graph compares raw APG (Adjusted APG) against adjusted APG, showing how the data points align along the 45-degree line, indicating a strong linear relationship. The countries listed include JAM, IDN, TUR, DOM, MEX, NGA, CHL, UGA, and ZMB, among others.
Raw vs Adjusted Gaps

Adjusted APG vs Raw APG for various countries.

Countries: ARM, BGD, Bol, BRA, CHL, CHN, CRI, DOM, ECU, GHA, IDN, JAM, JOR, KHM, LSO, MEX, NPL, NGA, PAN, PAK, PHL, ROM, ZAF, SWZ, TUR, UGA, VEN.
Raw vs Adjusted Gaps

Complete Data, Raw

All Countries, Raw

Complete Data, Adjusted

All Countries, Adjusted
Comparing National Accounts & Household Surveys

- National accounts might underestimate agriculture value added/income.

- Can compare with household income/expenditure survey evidence.

- Use World Bank’s Living Standards Measurement Surveys (LSMS).

- Explicit goal of LSMS: household income and expenditure measures.
Comparing Macro to Micro Sector Income Measures

- **Agricultural value added, household $i$**

  \[ VA_{a,i} = y_{a,i} - INT_{a,i} \]

- **"Agricultural revenue"**

  \[ y_{a,i} = \sum_{j=1}^{J} p_j \left( x_{i,j}^{\text{home}} + x_{i,j}^{\text{market}} + x_{i,j}^{\text{invest}} \right) \]

- **Non-agriculture value added**

  \[ VA_{n,i} = y_{n,i} - INT_{n,i} \]
## Comparison of Macro and Micro APG

<table>
<thead>
<tr>
<th>Country</th>
<th>Agriculture Share (%) of Employment</th>
<th></th>
<th>Agriculture Share (%) of Value Added</th>
<th></th>
<th>APG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Micro</td>
<td>Macro</td>
<td>Micro</td>
<td>Macro</td>
<td>Micro</td>
</tr>
<tr>
<td>Cote d’Ivoire (1988)</td>
<td>71.0</td>
<td>32.0</td>
<td>37.7</td>
<td>4.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Guatemala (2000)</td>
<td>40.2</td>
<td>15.1</td>
<td>16.9</td>
<td>3.4</td>
<td>3.3</td>
</tr>
<tr>
<td>Pakistan (2001)</td>
<td>57.8</td>
<td>25.8</td>
<td>20.5</td>
<td>4.2</td>
<td>4.3</td>
</tr>
<tr>
<td>South Africa (1993)</td>
<td>11.8</td>
<td>4.3</td>
<td>8.2</td>
<td>1.6</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Computing Income, Expenditure

- Deaton (1997), others: consumption expenditures more reliable than income

- Robustness: compare VA/worker to Income/Worker and Consumption/Worker
## Sector Differences in VA, Income, and Expenditure from Micro Data

<table>
<thead>
<tr>
<th>Country</th>
<th>VA/Worker</th>
<th>Income/Worker</th>
<th>Consumption/Worker</th>
</tr>
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<tr>
<td>Cote d’Ivoire (1988)</td>
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Different Labor Shares Across Sectors?

- Production functions with different labor shares

\[ Y_a = A_a L_a^{\theta_a} K_a^{1-\theta_a} \quad \text{and} \quad Y_n = A_n L_n^{\theta_n} K_n^{1-\theta_n} \]

- In equilibrium

\[ APG = \frac{Y_n/L_n}{p_a Y_a/L_a} = \frac{\theta_a}{\theta_n} \]
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- Macro evidence on \( \theta_a, \theta_n \)
  - Employment share of agriculture varies a lot across countries;
  - Aggregate labor share of GDP doesn’t (Gollin, 2002)
  - Suggests \( \theta_a \) isn’t much higher than \( \theta_n \)
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- Micro evidence on \( \theta_a, \theta_n \)
  - Sharecropping arrangements suggest \( \theta_a \sim 0.5 \)
  - Econometric estimates: \( \theta_a \sim 0.5 - 0.7 \)
Conclusions

- Measurement problems seem to play a large role in explaining the APGs.
- Adjusting for simple and obvious observables reduces the APGs substantially.
- But large productivity gaps remain even after all our adjustments.
- If these numbers are accurate, they suggest a major puzzle:
  - Why are people not moving out of rural areas as fast as they possibly can?
  - What barriers or labor market rigidities could possibly keep urban populations so small?
Possible Explanations?

- Harris-Todaro models suggest that riskier income in urban areas might keep people from moving; but only at entirely implausible levels of risk aversion.
  
    ▶ (And do we really think that rural livelihoods are less risky than urban livelihoods?)

- Are there some unmeasured amenities to rural life?
  
    ▶ Should we be trying to measure the value of leisure in rural areas?
    ▶ Is there a value to food security and self-reliance?
Directions for Further Research

- Continue pursuing measurement issues.
- Look for evidence of *measurable* rigidities in labor markets and migration costs.
- Consider plausibility of alternative models and explanations.