Agricultural Productivity and Policy Changes in Sub-Saharan Africa

Alejandro Nin-Pratt and Bingxin Yu

Causes and Consequences of Global Agricultural Productivity Growth
Tuesday and Wednesday, May 11-12, 2010
USDA Economic Research Service,
1800 M St NW, Washington DC 20036
Is agriculture in SSA growing?
If so, which factors explain this growth?
What are the policy implications of past performance?

Problems to answer these questions
  » Small number of studies
  » Data availability
  » Methodology
Small number of studies, data and methodology


What do we know so far?

- **Evidence of accelerated TFP growth in agriculture**
  - Stochastic frontier methods show higher productivity growth than those using nonparametric Malmquist indexes

- **Factors behind recovery**
  - Policy reforms
  - Population pressure
  - Institutions
  - Agricultural R&D investment
  - Rain
GOAL

» Contribute to the understanding of changes in SSA’s agriculture and the factors behind them through the analysis of:

- Evidence linking policy changes to agricultural TFP growth
- Implications for future growth
Outline

- Methodological issues and problems with the nonparametric Malmquist index
- TFP estimates and decomposition into efficiency and technical change
- Evidence on the links between policy changes and performance of agriculture
METHODOLOGY
The Malmquist Index

\[ M_o = \frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \]

- Extensively used after Färe et al. (1994) showed that the index can be estimated using data envelopment analysis (DEA).
- Popular in international comparisons of productivity because:
  - No need to assume profit maximization or cost minimization
  - Does not require prices for its estimation which are normally not available.
  - Can be decomposed into efficiency and technical change components
  - No need to impose a functional form
The DEA approach to estimate Distances

\[ D^t = \min_{\theta, \lambda} \theta_A \]

Subject to:

\[ y_A - \sum_{i=1}^{r} y_i \lambda_i \leq 0 \]

\[ x_{A1} \theta - \sum_{i=1}^{r} x_{i1} \lambda_i \geq 0 \]

\[ x_{A2} \theta - \sum_{i=1}^{r} x_{i2} \lambda_i \geq 0 \]

\[ \lambda \geq 0 \quad \text{r= number of production units} \]

\[ D^t = \max y_A / (w_{A1} x_{A1} + w_{A2} x_{A2}) \]

Subject to:

\[ y_r / (w_{A1} * x_{r1} + w_{A2} * x_{r2}) \leq 1 \quad i=1, \ldots r \]

\[ w_{A1} \geq 0, \]

\[ w_{A2} \geq 0, \]

\[ j=1, \ldots n \]
The same result is obtained from the problems

\[
D^t = \min_{\theta, \lambda} \theta_A
\]

Subject to:

\[
y_A - \sum_{i=1}^{r} y_i \lambda_i \leq 0
\]

\[
x_{A1} \theta - \sum_{i=1}^{r} x_{i1} \lambda_i \geq 0
\]

\[
x_{A2} \theta - \sum_{i=1}^{r} x_{i2} \lambda_i > 0
\]

\[
\lambda \geq 0
\]

\[
D^t = \max_{w_{A1}, w_{A2}} y_A/(w_{A1} x_{A1} + w_{A2} x_{A2})
\]

Subject to:

\[
y_r/(w_{A1} * x_{r1} + w_{A2} * x_{r2}) \leq 1 \quad i = 1, \ldots, r
\]

\[
w_{A1} \geq 0,
\]

\[
w_{A2} = 0,
\]

\[
j = 1, \ldots, n
\]
Problems with the Malmquist Index

- The DEA approach still uses implicit price information
- With data noise, shadow prices can be inconsistent with prior knowledge or accepted views on relative prices or cost shares (e.g. zero shadow prices)
- Except for Coelli and Prasada Rao (2005), to our knowledge, previous studies did not discuss the implications of zero shadow prices in their results
Imposing bounds to shadow shares

\[ D^t = \max_{w_{A1}, w_{A2}} y_A / \left( w_{A1} x_{A1} + w_{A2} x_{A2} \right) \]

Subject to:

\[ y_r / \left( w_{A1} x_{r1} + w_{A2} x_{r2} \right) \leq 1 \quad i = 1, \ldots, r \]

\[ b_{1\text{max}} \geq w_{A1} x_{r1} \geq b_{1\text{min}} \]

\[ b_{2\text{max}} \geq w_{A2} x_{r2} \geq b_{2\text{min}} \]

\[ w_j \geq 0, \quad j = 1, \ldots, n \]
Introducing information on prices

- Information to set the bounds for input shares are from Evenson and Dias Avila (2007).
- They use carefully measured share calculations for India and Brazil to estimate input cost shares for 78 developing countries
  - Based in FAO data
  - Used similar inputs.
TFP estimates
DATA

» Data used are from the Food and Agriculture Organization of the United Nations (FAO).

» National time series data from 1961-2006

» One output (agricultural production measured in international dollars)

» Five inputs (labor, land, fertilizer, tractors and animal stock)

» 106 countries including 26 Sub-Saharan African countries
1. Clear recovery of agriculture in SSA after the mid-1980s
2. TFP growth mainly based on increased efficiency
3. Recovery of agriculture is not limited to a particular group of countries
4. Increased efficiency is the result of changes in output structure

Output of subsectors with RCA/Output of subsectors with RCD

RCA: Output of coffee, cocoa, cotton, tobacco, beef & sheep meat
RCD: cereals, roots and tubers, milk and chicken meat
5. Increased efficiency is also related to an adjustment in the use of inputs
Agricultural performance and policy
Evidence 1: Policy changes is one of the few factors that can explain observed general pattern between diverse economies

» Africa’s larger countries have had relatively interventionist governments (independence to mid-1980s/1990s)

» Followed by reform and a degree of recovery from mid-1980s/1990s to present

» Recovery of traditional export crops (related to improved efficiency)

» Adjustment in the use of inputs (related to improved efficiency)
Evidence 2: Structural change in the series coincide with major policy milestones in the region
Evidence 4: The evolution of cumulative agricultural TFP growth follows a similar pattern of that of relative rates of assistance (RRA) to agriculture.
Evidence 5: Policy changes and increased agricultural TFP are related to poverty reduction in the region
Evidence 6: If it looks like a duck...

### Agricultural TFP and the RRA

<table>
<thead>
<tr>
<th>Country</th>
<th>Unconstrained TFP</th>
<th>Constrained TFP</th>
</tr>
</thead>
<tbody>
<tr>
<td>RRA</td>
<td>0.067</td>
<td>(0.014)***</td>
</tr>
<tr>
<td>Cameroon</td>
<td>-0.139</td>
<td>(0.016)***</td>
</tr>
<tr>
<td>Cote d'Ivoire</td>
<td>-0.002</td>
<td>-0.018</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>-0.345</td>
<td>(0.018)***</td>
</tr>
<tr>
<td>Ghana</td>
<td>-0.18</td>
<td>(0.025)***</td>
</tr>
<tr>
<td>Kenya</td>
<td>0.15</td>
<td>(0.046)***</td>
</tr>
<tr>
<td>Madagascar</td>
<td>-0.178</td>
<td>(0.014)***</td>
</tr>
<tr>
<td>Mozambique</td>
<td>-0.178</td>
<td>(0.017)***</td>
</tr>
<tr>
<td>Nigeria</td>
<td>-0.159</td>
<td>(0.051)***</td>
</tr>
<tr>
<td>Rsa</td>
<td>0.031</td>
<td>-0.032</td>
</tr>
<tr>
<td>Senegal</td>
<td>-0.003</td>
<td>-0.038</td>
</tr>
<tr>
<td>Sudan</td>
<td>-0.184</td>
<td>(0.017)***</td>
</tr>
<tr>
<td>Tanzania</td>
<td>0.049</td>
<td>(0.018)***</td>
</tr>
<tr>
<td>Zambia</td>
<td>-0.076</td>
<td>(0.017)***</td>
</tr>
<tr>
<td>Constant</td>
<td>1.136</td>
<td>(0.016)***</td>
</tr>
</tbody>
</table>

Observations: 557
Number of ccode: 14
Chi square: 988.8
Conclusions

1. Policies applied by several Sub-Saharan African countries after independence imposed a heavy burden on agriculture


3. Evidence points to policy changes during 1984-1994 as one of explanations of this improvement
Warning signs

- Most TFP growth is catching up after falling behind in the 1970s
- Poor performance in technical change and no much evidence of increased R&D
- Substantial distortions remain that still impose a large tax burden on agriculture
- Sustained growth in labor productivity faces the challenge of population growth