Productivity in Sub Saharan Africa

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Outline

• Agricultural productivity overview
  – Trends in spatial patterns in Labor and Land
  – Trends in Total Factor Productivity

• Key constraints
  – R&D
  – Input markets
  – Infrastructure

• Results and implications
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Measures of Productivity

• Partial factor productivity (land and labor)

• Total factor productivity and decomposition
  
  – *efficiency* arising from reallocation of productive factors

  – *technical change* arising from things that do not directly relate to the factors of production or the productivity of the factors
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Drivers of trends at Africa-wide level (top 9)

- Nigeria
- Egypt
- Morocco
- Algeria
- Sudan*
- Kenya
- South Africa
- Ethiopia
- Tanzania

Land and labor productivity in SSA and sub-regions (1961-2009)

Land and labor productivity in selected countries (1961-2009)

Summary of Trends

• Labor productivity has risen much faster than land productivity in Africa as a whole
  – particularly in the northern region a trend that is driven by Egypt

• In SSA and many other countries, land productivity has risen much faster than labor productivity

• In the southern Africa and in Morocco both measures have risen at about the same rate

• General slowdown in the increase in both land and labor productivity in the 1990s than in preceding or subsequent sub-periods.
Spatial Patterns (annual avg. 2005-07)

- **Land productivity**
  - Closer for ECA ($690/ha) and SA ($756/ha); significantly higher in WA ($1300/ha)
  - In WA, rising from semi-arid Agro-Pastoral systems of the Sahel ($700/ha), through the higher rainfall Cereal-Root Crop system ($1293/ha) and Root Crop system ($2129/ha), to the sub-humid and humid Coastal Artisanal Fishing system ($2143/ha)

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• Slight improvement in 1960s followed by a rapid deterioration in TFP and efficiency till mid-1980s and then recovery starting in 1984-1985

• Very little technical change

Major Drivers of the trends in SSA: Nigeria and South Africa

- Nigeria exerts downward pressure
- South Africa exerts upward pressure

Annual Average Growth Rate in TFP by Region (%, 1985-2005)

- High TFP growth in western, but little technical change
- Southern Africa outperforms in technical change
- Technical change in the central region was also high

Annual Average Growth Rate in TFP by country (% , 1985-2005)

- Except South Africa, average or below average performance for Big 9 agricultural economies

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• Results and implications
• AgR&D infrastructure and capacities have eroded over time through years of neglect, primarily from lack of public funding for agR&D.
• Growth in spending on agR&D and number of researchers have only recently picked up; reflects the trends in agricultural productivity growth

Source: Beintema and Stads (2011)
Meeting the Maputo 10% target


Annual Average (2003-2010)

Except Ethiopia, none of Big 9 has achieved target
How much is spent on agR&D?

- Only 8 of the 31 countries studied met the NEPAD 1% target.
- Except Kenya and South Africa, the other big agricultural economies spent less than 0.5 percent.
- The other high performers (Botswana, Burundi, Mauritania, Mauritius, Namibia, and Uganda) together account for only 3.2 percent of Africa’s total agGDP; little impact on the performance for Africa/SSA as a whole.
How has the increase in agR&D expenditure been allocated?

- **Ghana**: mostly salaries
- **Tanzania**: capital investments in 2002-2004 and operating costs in following years
- **Uganda**: operating costs

Source: Beintema and Stads (2011)
What types of investment are needed?

- Those that deliver location-specific technologies and account for diversity of potentials in and constraints faced by farmers
  - But many small economies and limited capacities and resources for developing effective agR&D systems
  - Regional agricultural R&D strategy can help fill these gaps and facilitate scale economies.
  - African centers of excellence initiatives are laudable
  - Need complementary polices and extension systems that enhances and maximizes the technology spillovers from centers to all places
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Missing input markets: fertilizers

**Fertilizer application rates by region**

- **World**: 101 kg
- **Low & middle income**: 94 kg
- **High income: OECD**: 120 kg
- **Sub-Saharan Africa**: 14 kg (8.7 if we exclude South Africa)
- **South Asia**: 104 kg
- **Middle East & North Africa**: 84 kg
- **Latin America & Caribbean**: 92 kg
- **European Union**: 198 kg
- **East Asia & Pacific**: 230 kg

(kg of nutrients/ha of arable land)

Missing input markets: fertilizers

Maize Yield Response to Fertilizer

Yield Response to 1 kg N fertilizer

Distribution of Maize Yield Response to N application

Increased fertilizer use can significantly raise productivity growth in smallholder agriculture

Source: Harvest Choice, IFPRI.
Input markets – Fertilizers: Global patterns
high dependence of SSA on imported fertilizer

Imports of fertilizer as a percentage of consumption in sub-Saharan Africa, Latin America and South Asia, 2002-2007

Note: Data on fertilizer nutrient consumption and imports obtained from the FAOSTAT Online database.
Fertilizer prices

- During the food price crisis of 2007-2008, fertilizer prices exhibited higher spikes than oil and agricultural prices.

- Industry reports indicate that leading fertilizer producers achieved record profits in recent years (e.g., Potash Corp reported a gross margin of US$ 4.86 billion in 2008 versus US$ 474 million in 2000).
Global patterns
Top-5 countries control more than 50% of the global production capacity

- Canada & Russia alone explain more than half of potash global capacity.
- Basically the same countries (China, US, India & Russia) control most of the production capacity of urea and DAP/MAP.

Distribution of world fertilizer production capacity by country, 2008-09

Note: Based on capacity of operative plants in 2008-09 according to IFDC Worldwide Fertilizer Capacity Listings by Plant.
Global patterns

Top-4 FIRMS generally control more than half of EACH Major COUNTRY production capacity

- In some cases, only one company operates in the country (e.g., in Belarus and Germany for potash and in Morocco for DAP/MAP).

- Figures do not include associations/partnerships between firms.

Concentration of fertilizer production capacity in main producing countries, 2008-09

Note: Based on capacity of operative plants in 2008-09 according to IFDC Worldwide Fertilizer Capacity Listings by Plant.
Empirical model

• We estimate the following dynamic price model.

\[ \ln p_{ijt} = \alpha \ln p_{ijt-1} + \beta mktstructure_{ijt} + X_{ijt} \delta + \varepsilon_{ijt} \]

\[ \varepsilon_{ijt} = c_i + u_{ijt} \]

where \( p_{ijt} \) is the price of urea in country \( i \) from region \( j \) at year \( t \); \( mktstructure_{ijt} \) is a measure of market concentration; \( X_{ijt} \) is a vector of controls; \( c_i \) is a country specific effect and \( u_{ijt} \) is an idiosyncratic shock.

• We use annual data on urea for 38 countries during 1970-2002.
  - The panel nature of our data permits us to exploit differences in market structure across countries and time.

• Estimate model following Arellano & Bond (1991) GMM procedure to account for the potential correlation of \( c_i \) with some of the \( X_{ijt} \), and the potential endogeneity of market structure and the lag of price.
RESULTS

**effect of market concentration on urea prices**

- Positive correlation between concentration and prices (when significant).
- Elasticities range between 0.82 and 1.65.

<table>
<thead>
<tr>
<th>Concentration measure</th>
<th>Arellano-Bond difference GMM</th>
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<tbody>
<tr>
<td></td>
<td>Model 1</td>
</tr>
<tr>
<td>Top-4 ratio on production capacity</td>
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</tr>
<tr>
<td>Measure 1</td>
<td>0.032</td>
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<tr>
<td>Measure 2</td>
<td>0.718</td>
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<tr>
<td>Top-4 ratio on number of plants</td>
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<tr>
<td>Measure 1</td>
<td>-1.013</td>
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<tr>
<td>Measure 2</td>
<td>0.976**</td>
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<td>HHI on production capacity</td>
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<td>HHI on number of plants</td>
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<td>Measure 1</td>
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<tr>
<td>Measure 2</td>
<td>0.998**</td>
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<td>Main producer &amp; share imports/consumption</td>
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<tr>
<td>Among top-4 producers &amp; share imports/consumption</td>
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<tr>
<td>Regional fixed effects</td>
<td>Yes</td>
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<td>Year fixed effects</td>
<td>Yes</td>
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Note: * significant at 10%; ** significant at 5%; *** significant at 1%. Measure 1 corresponds to the weighted average of the measure of market concentration at the country and regional levels; Measure 2 is the measure of market concentration at either the country or regional level, depending on whether most of the urea consumed is from local production or imports.
It is worth further evaluating the potential impact that increased competition in the industry could have on low-income countries.

We conduct a basic simulation analysis.

- First simulate the general impact of increased competition on prices, fertilizer intake, crop production and rural income.
  (use elasticities derived above and from other related studies)

- Then perform a cost-benefit analysis for selected countries.
  (Ghana, Kenya, Senegal and Tanzania in SSA; Bangladesh and India in SA)

Based on the top-4 concentration ratio results, a 10% increase in competition leads to:

- Conservative scenario: 8.2% decrease in prices.
- Optimistic scenario: 11.6% decrease in prices.
• NPV in 4 countries in SSA: US$1 billion (3% discount rate); US$561 million (5% discount rate).
• NPV in 2 countries in SA: US$21.4 billion (3% discount rate); US$15.6 billion (5% discount rate).
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Africa’s infrastructure services several times more expensive than elsewhere
Infrastructure will require an additional US$31 billion a year and huge efficiency gains.

All figures in US$ billion a year

Source: World Bank
Infrastructure will require an additional US$31 billion a year and huge efficiency gains.

- Funding gap: $31 billion
- Efficiency gap: $17 billion
- Existing spending: $45 billion
- Spent budgeted resources: $1.9 billion
- Improving operational efficiency: $7.5 billion
- Increasing cost recovery: $4.7 billion
- Prioritizing public spending: $3.3 billion
- Spending needs: $93 billion

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Results and Implications

• Agricultural productivity growth in Africa, and particularly in SSA, has been impressive since the mid-1980s.

• But the performance represents a mere catching up with the levels achieved in the early 1960s, and there has been very little technical change.

• Sustaining growth in labor productivity faces challenge of population growth and slowdown in land availability.

• To allow this growth to continue there is a need for:
  – Policy improvements and significant investments in agricultural R&D
  – Reduction of the infrastructure gap
  – Increase competition and dependability on access to fertilizers and seeds.