Technology development and firm growth in Africa

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Investment climate surveys

http://iresearch.worldbank.org/ics/jsp/index.jsp

Online data analysis tool, 65 countries

- **IC survey instruments**: a written questionnaire of 12-15 sections of questions, that can be categorized into three distinct groups:
  - a) information for the profiling of businesses
  - b) the profiling the investment climate in which the businesses operate
  - c) indicators of firm performance
ICS-Core Questionnaire

1. General information
2. Sales and supplies, incl. exports
3. Investment climate constraints to the establishment
4. Infrastructure and services
5. Finance
6. Business-government relations
7. Conflict resolution/legal environment
8. Crime
9. Capacity, innovation, learning
10. Labor relations, incl. skills level, training
11. Productivity, incl. 3 year production, sales, expenses; r&d
Capacity, innovation : questions

- What was this establishment's average capacity utilization over the last year?
- How many new products (i.e. those that involve a significant change in the production process) has your establishment introduced in the last three years?
- Does your establishment use technology licensed from a foreign-owned company?
- Has your firm received ISO (e.g. 9000, 9002 or 14,000) certification?
Capacity, innovation : questions

Has your company undertaken any of the following initiatives in the last three years?

1. Developed a major new product line
2. Upgraded an existing product line
3. Introduced new technology that has substantially changed the way that the main product is produced
4. Discontinued at least one product line
5. Opened of new plant
6. Closed at least one existing plant or outlet
7. Agreed a new joint venture with foreign partner
8. Obtained a new licensing agreement
9. Outsourced a major production activity that was previously conducted in-house
10. Brought in-house of a major production activity that was previously outsourced
Capacity, innovation: questions

Over the last two years, what were the leading ways in which your establishment acquired technological innovations?

1) Embodied in new machinery or equipment
2) By hiring key personnel
3) Licensing or turnkey operations from international sources
4) Licensing or turnkey operations from domestic sources
5) Developed or adapted within the establishment locally
6) Transferred from parent company
7) Developed in cooperation with client firms
8) Developed with equipment or machinery supplier
9) From a business or industry association
10) Trade Fairs and/or Study Tours
11) Consultants
12) From universities, public institutions
Capacity, innovation: questions

Which of the following is the most important influence on your establishment to:
reduce the production costs of existing products or services? Pressure from:
1. domestic competitors
2. foreign competitors
3. customers
4. shareholders
5. creditors
6. government or gov't agencies
develop new products or services and markets?
ICS countries

North African and Middle East

Sub-Saharan Africa
ICS countries

**East Asia and Pacific:**

**South Asia:**

**Latin America:**
ICS countries

Eastern Europe and Central Asia:
Technology development and firm performance

- Observation: persisting ‘missing middle’ in the size distribution of firms in many African countries, little interaction

- Resulted in two related empirical research subject:
  - Technical efficiency and its impact on profitability
    - Methodology
    - Technology development and determinants of technical efficiency
    - Technical efficiency and profitability
  - Determinants of firm growth
  - Market imperfections and the existence of a technology trap
Technology development and firm performance

Empirical setup:

- Cross section firm-level data from Côte d’Ivoire (240 firms), Tanzania (200), Burundi (120)
- In agro-industries, textiles, wood working, metal working;
- formal and informal firms, foreign and local firms
Technical efficiency (TE) = best practice production

TE score for firm i:

$$\text{TE}_i = \frac{\text{observed output}}{\text{frontier output}}$$

$$0 < \text{TE}_i < 1$$
Estimating the frontier

- Assume a functional form for the production function: Cobb-Douglas
  \[ Y_i = AK_i^a L_i^b e^{v_i-u_i} \]

- In log-linear form
  \[ \ln Y_i = \ln A + a \ln K_i + b \ln L_i + v_i - u_i \]

- Estimation at sub-sectoral level
Technical efficiency and firm heterogeneity

- 'Technological capabilities'
  The information and skills-technical, managerial and institutional- that allow productive enterprises to utilise equipment and technology efficiently

- 'Technology development'
  Efforts and activities that enterprises undertake to absorb knowledge and build upon existing knowledge necessary for efficient production and higher quality output – LEARNING
Technology development and firm characteristics

- Technology development activities:
  - In-house R&D
  - Licence contract
  - Assistance contract
  - Expats
  - Education
  - Productivity unit
  - Exporting/importing
  - Access to inputs

- Firm characteristics:
  - Foreign ownership
  - Firm Age
  - Formal status
<table>
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<th></th>
<th>Informal</th>
<th>Formal</th>
<th>Age &lt;5</th>
<th>Age &gt;5</th>
<th>African</th>
<th>Asian</th>
<th>European</th>
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<td>% of firms with…</td>
<td></td>
<td></td>
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<td>In-house R&amp;D</td>
<td>0.0</td>
<td>28.1</td>
<td>9.4</td>
<td>23.77</td>
<td>7.1</td>
<td>18.8</td>
<td>39.3</td>
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<tr>
<td>Licence contract</td>
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<td>20.2</td>
<td>0.0</td>
<td>19.7</td>
<td>6.1</td>
<td>25.0</td>
<td>23.0</td>
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<tr>
<td>Assistance contract</td>
<td>1.9</td>
<td>18.2</td>
<td>1.9</td>
<td>18.0</td>
<td>4.1</td>
<td>25.0</td>
<td>24.6</td>
</tr>
<tr>
<td>Expats</td>
<td>1.9</td>
<td>51.2</td>
<td>7.6</td>
<td>48.4</td>
<td>12.2</td>
<td>43.8</td>
<td>72.1</td>
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<tr>
<td>Higher educ. of owner/manager</td>
<td>3.7</td>
<td>48.8</td>
<td>13.2</td>
<td>44.3</td>
<td>17.4</td>
<td>25.0</td>
<td>65.6</td>
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<tr>
<td>Productivity unit</td>
<td>0.0</td>
<td>20.7</td>
<td>9.4</td>
<td>16.4</td>
<td>6.1</td>
<td>18.8</td>
<td>26.2</td>
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</table>
Results (1)

- Average technical inefficiency = 0.41 (0.47)

- Technology active foreign and formal firms exhibit higher levels of technical efficiency
  - Non-parametric test based on ranking of firms according to deviation from frontier
  - Inclusion of binary variables FORMAL and EUROPEAN and ASIAN shift frontier upward
Results (2)

- $a+b>1$
- Increasing returns to scale in agro-industries, wood working and metal working (1.40-1.60)
  - scale inefficiencies: suboptimal small firms produce at a severe cost disadvantage
Impact on profitability

Market share determined by:
- Technical efficiency (+)
- Scale efficiency (+)
- Advertising intensity (+)
- Firm age (+)
- Foreign (European) ownership (+)

Profitability determined by:
- Market share (+)
- Capital intensity (+)
- Product differentiation
Impact on profitability

- Importance of technical efficiency and scale in improving a firm’s competitive position and profitability
  - Formal and foreign owned firms are more active in technology development activities and exhibit superior efficiency.
  - This, and reputation effects result in a higher profitability via its impact on the market share.
  - Sub-optimal local firms exhibit low profit margins, thereby facing self-finance constraints.
Firm growth: literature

- Empirical literature finds robust negative size-growth relationship
- Empirical literature finds robust negative age-growth relationship; Growth is result of passive and active learning (Lucas, Pakes, Ericsons, Jovanovic, Oi):
- Institutional factors affect growth opportunities of firms in developing countries
Firm growth determinants: results

- Younger firms grow faster
  Active and passive learning processes
- Small firms grow faster
  Efficiency seeking through scale enlargements in the existence of scale economies

But...
Firm growth determinants: results

- Non-linear initial size-growth relationship, path dependence
- Controlling for efficiency, size and age, reputation and legitimation effects (formal status and ownership structure) facilitate growth
- Owners of firms report restricted access to inputs as strongly hampering growth
- Competition for inputs (credit, skilled labour, infrastructure, raw materials...) is though, especially for SMEs
Uncovering a technology trap

- Importance of technical efficiency and scale in improving a firm’s competitive position and profitability

- Formal and foreign owned firms show superior efficiency, profitability and growth, also due to better access to inputs

- Sub-optimal informal local firms exhibit low profit margins, thereby facing self-finance constraints and restricted access to inputs
References

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