

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

Algeria (2002), Syria (2003), Morocco (2000)

Sub-Saharan Africa

Zambia (2002) Tanzania (2003) Kenya (2003)
Ethiopia (2002), Nigeria (2001),
Uganda(2003), Eritrea (2002), Mozambique
(2001)

ICS countries

East Asia and Pacific:

Cambodia (2003), China (2002 and 2003) Indonesia (2003), Philippines (2003)

South Asia:

Bangladesh (2002), Bhutan (2001), India (2000 and 2002), Nepal (2000), Pakistan (2002), Sri Lanka (2004)

Latin America:

Bolivia (2000), Brasil (2003), Ecuador (2003), Guatemala (2003), Honduras (2003), Nicaragua (2003), Peru (2002)

ICS countries

Eastern Europe and Central Asia:

Uzbekistan (2002), Tajikistan (2002), Kyrgyz Republic (2002), Kazakhstan (2002), Georgia (2002), Ukraine (2002),

Slovenia (2002), Slovak Republic (2002), Romania (2002), Poland (2002), Hungary (2002), Serbia and Montenegro (2003), Czech Republic (2002), Croatia (2002), Moldova (2002), Macedonia, FYR (2002)

Turkey (2002), Russian Federation (2002)

Estonia (2002), Lithuania (2004), Latvia (2002)

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

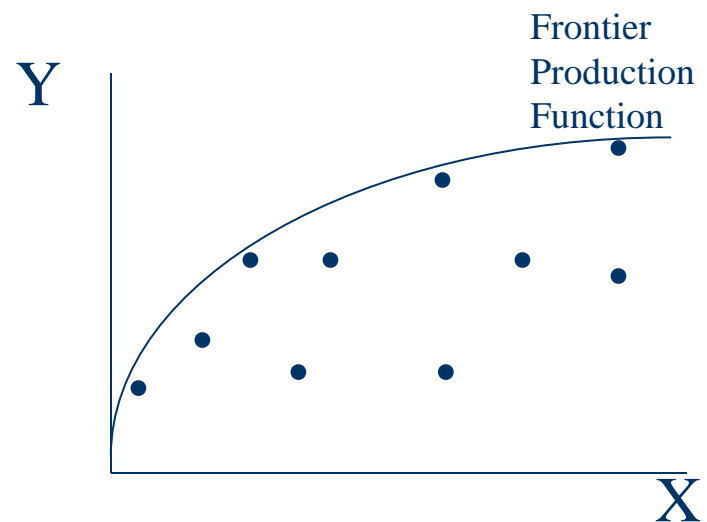
Estimating technical efficiency: methodology

Technical efficiency (TE)
=best practice production

TE score for firm i:

$TE_i = \frac{\text{observed output}}{\text{frontier output}}$

$0 < TE_i < 1$



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

	Informal 54	Formal 121	Age =<5 53	Age>5 122	African 98	Asian 16	European 61
% of firms with...							
In-house R&D	0.0	28.1	9.4	23.77	7.1	18.8	39.3
Licence contract	0.0	20.2	0.0	19.7	6.1	25.0	23.0
Assistance contract	1.9	18.2	1.9	18.0	4.1	25.0	24.6
Expats	1.9	51.2	7.6	48.4	12.2	43.8	72.1
Higher educ. of owner/manager	3.7	48.8	13.2	44.3	17.4	25.0	65.6
Productivity unit	0.0	20.7	9.4	16.4	6.1	18.8	26.2

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 tough, 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

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