Agricultural Productivity and Policy Changes in Sub-Saharan Africa

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Causes and Consequences of Global Agricultural Productivity Growth
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1800 M St NW, Washington DC 20036

Introduction & motivation

- **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

1. **Alene, A.D. 2010.** Productivity growth and the effects of R&D in African agriculture. *Agricultural Economics*, 41: 223–238
2. **Block, S. A. 1995**. The recovery of agricultural productivity in Sub-Saharan Africa. *Food Policy* 20: 385–405.
3. **Frisvold, G., Ingram, K., 1995**. Sources of agricultural productivity growth and
4. stagnation in sub-Saharan Africa. Agric. Econ. 13, 51–61.
5. **Fulginiti, L. E., R. K. Perrin, and B. Yu. 200**4. Institutions and agricultural productivity in Sub-Saharan Africa. *Agricultural Economics* 4: 169–80.
6. **Lusigi, A., and C. Thirtle. 1997**. Total factor productivity and the effects of R&D in African agriculture. *Journal of International Development* 9: 529–38.
7. **Nin-Pratt, A. and B.Yu. 20**08. An updated look at the recovery of agricultural productivity in sub-Saharan Africa. IFPRI Discussion Paper 00787, Washington, D.C.
8. **Nkamleu, G., 2004**. Productivity growth, technical progress and efficiency
9. change in African agriculture. Afr. Dev. Rev. 16(1), 203–222.
10. **Suhariyanto, K., A. Lusigi, and C. Thirtle. 2001**. Productivity growth and convergence in Asian and African agriculture. In *Asia and Africa in comparative economic perspective*, edited by P. Lawrence and C. Thirtle, 258–74. London: Palgrave.
11. **Thirtle, C., Hadley, D., and Townsend, R., 1995**. Policy induced innovation in Sub-Saharan African agriculture: A multilateral Malmquist productivity index approach. Dev. Policy Rev. 13(4), 323–342.

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:**
  - **The evolution of agricultural TFP in 26 countries between 1961 and 2006 using a nonparametric Malmquist index.**
  - **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**

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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:

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

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

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

$$\lambda \geq 0$$ r= number of production units

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

Subject to:

$$y_r / \left(w_{A1} * x_{r1} + w_{A2} * x_{r2}\right) \leq 1 \qquad i = 1,\ldots r,$$

$$w_{A1} \geq 0,$$

$$w_{A2} \geq 0,$$

$$j = 1,\ldots n,$$

The same result is obtained from the problems

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

Subject to:

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

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

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

$$\lambda \geq 0$$

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

Subject to:

$$y_r / \left(w_{A1} * x_{r1} + w_{A2} * x_{r2}\right) \leq 1 \qquad i = 1,\ldots,r,$$

$$w_{A1} \geq 0,$$

$$w_{A2} = 0,$$

$$j = 1,\ldots,n,$$

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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:

$$y_r / \left(w_{A1} * x_{r1} + w_{A2} * x_{r2} \right) \leq 1 \qquad \text{i} = 1, \ldots, \text{r}$$

$$b_{1max} \geq w_{A1} * x_{r1} \geq b_{lmin}$$

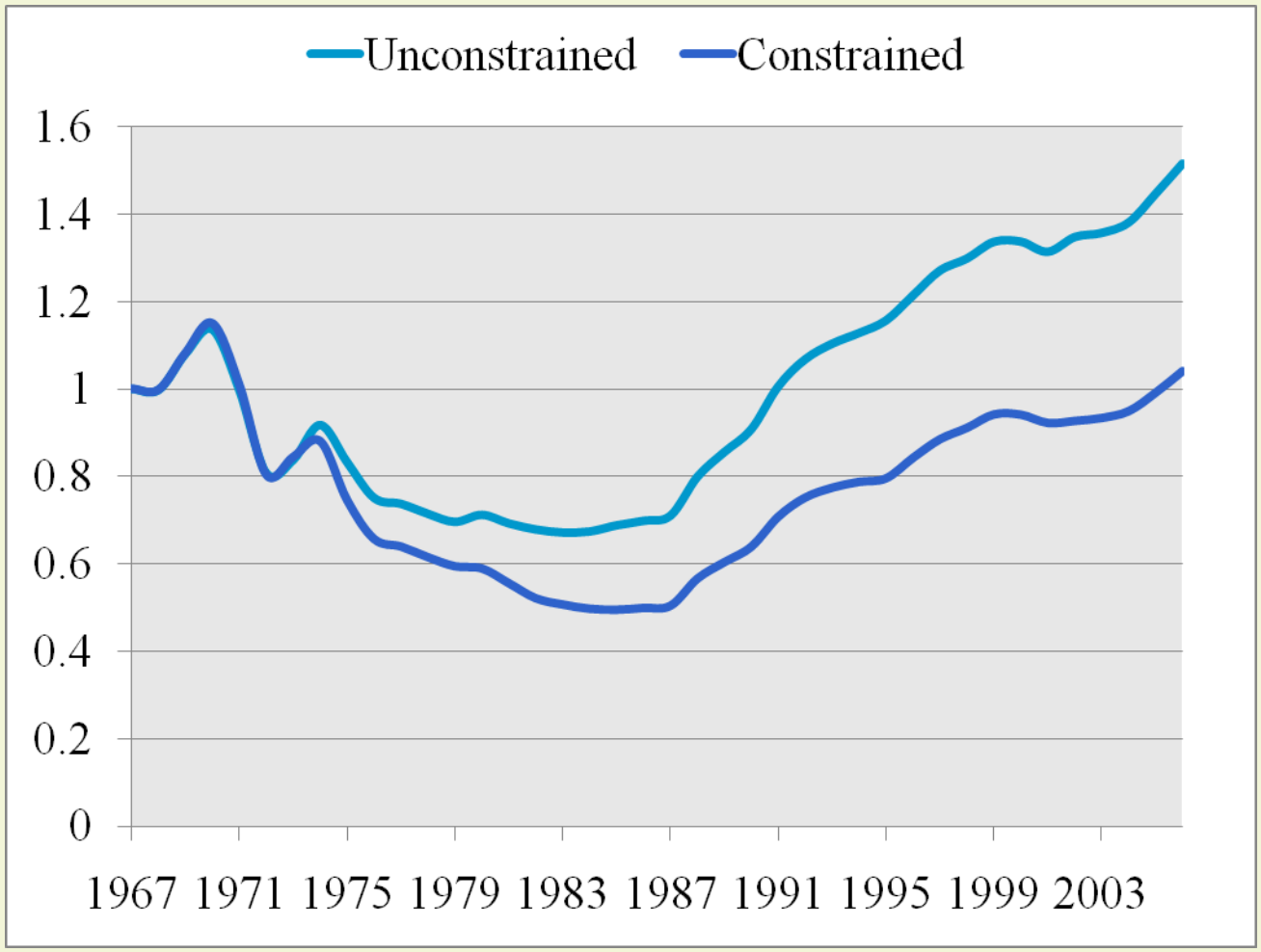
$$b_{2max} \geq w_{A2} * x_{r2} \geq b_{2min}$$

$$w_j \geq 0, \quad \text{j} = 1, \ldots, \text{n}$$

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.**

Cumulative TFP growth for Nigeria estimated using unconstrained and constrained shadow shares, 1967-2006 (Index 1967=1).



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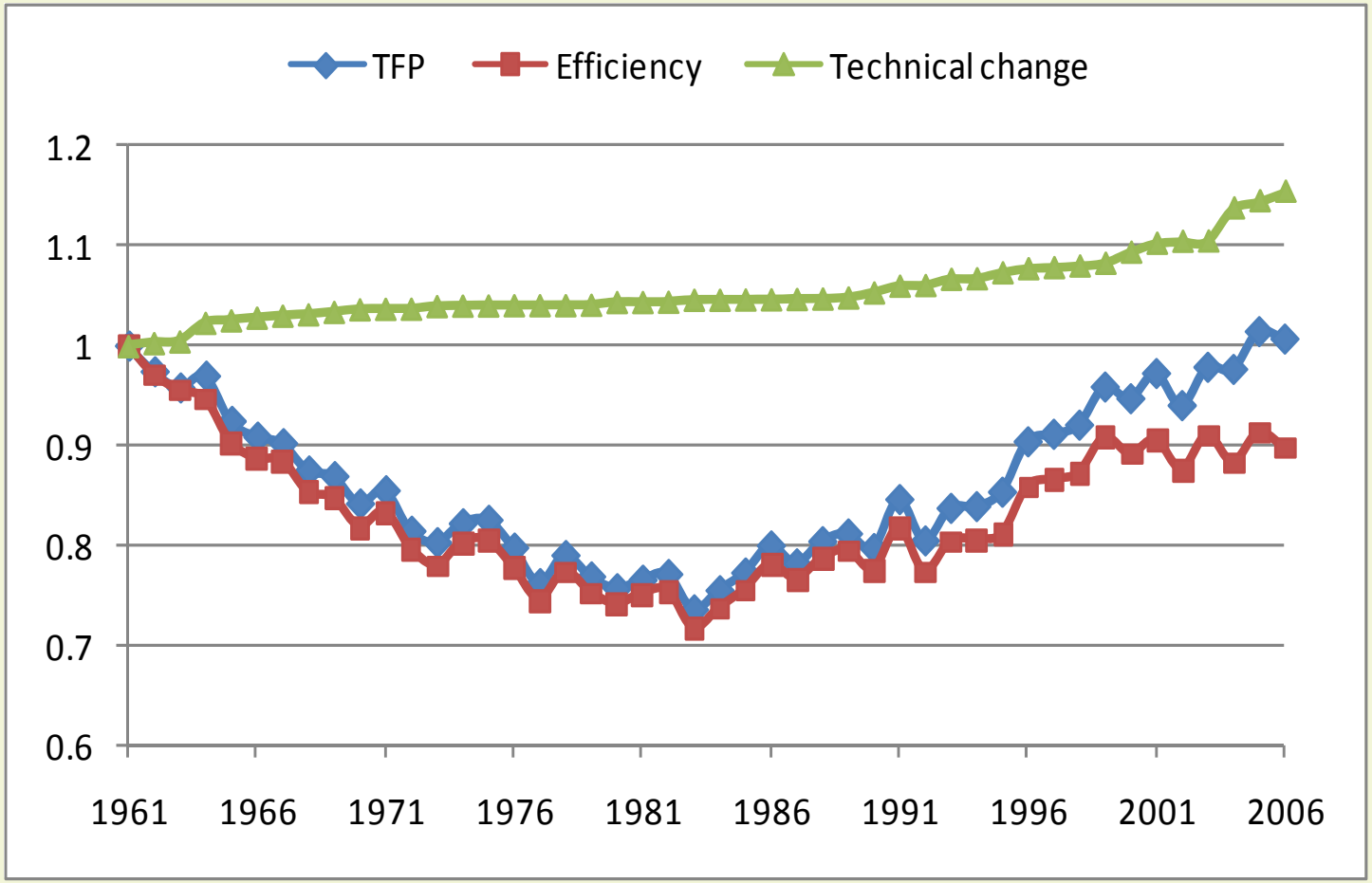
TFP estimates

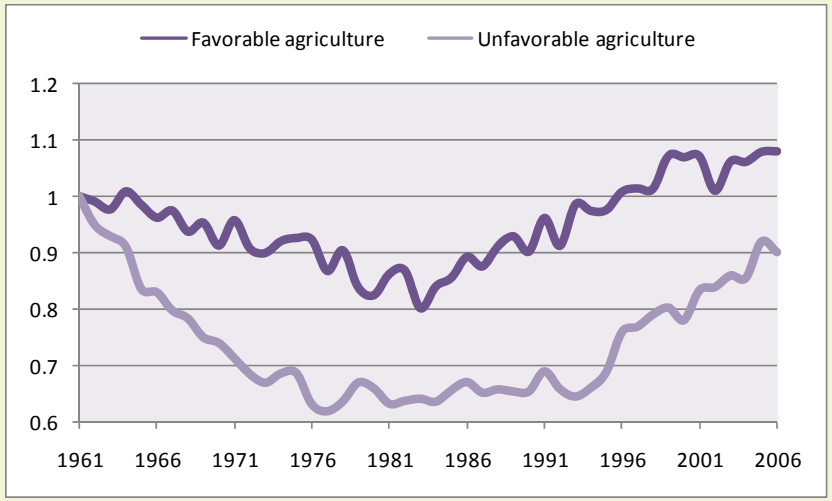
DATA

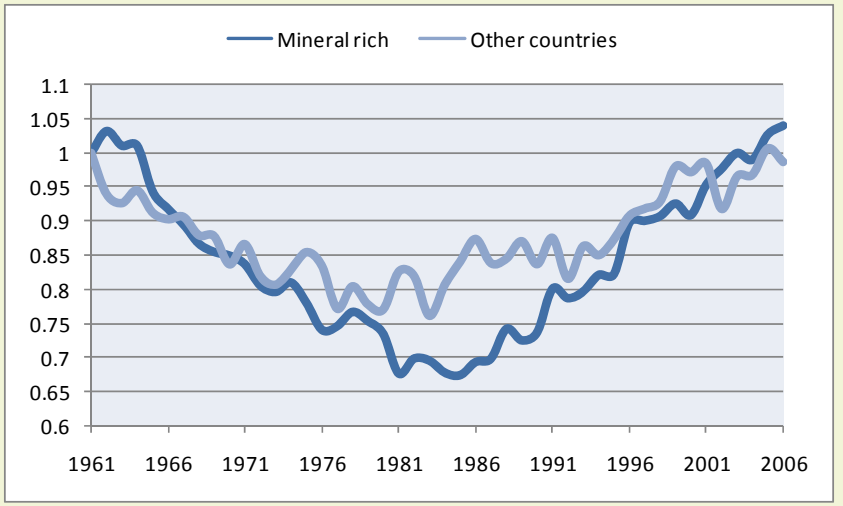
- Data used are from the Food and Agriculture Organization of the United Nations (FAO).
- National time series data from 1961-2006
- One output (agricultural production measured in international dollars)
- Five inputs (labor, land, fertilizer, tractors and animal stock)
- 106 countries including 26 Sub-Saharan African countries

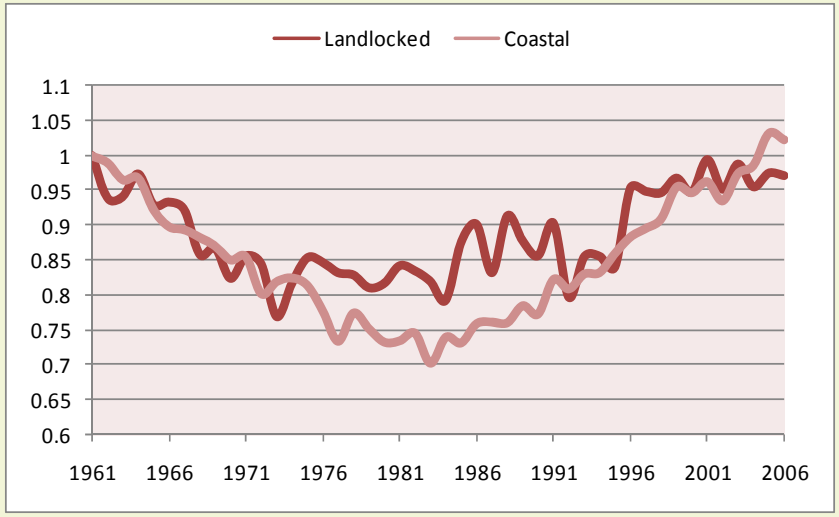
1. Clear recovery of agriculture in SSA after the mid-1980s
2. TFP growth mainly based on increased efficiency

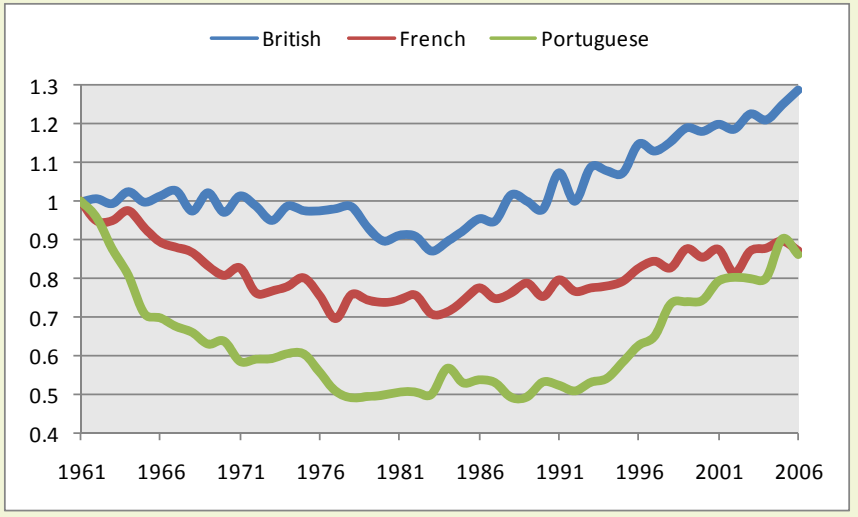


3. Recovery of agriculture is not limited to a particular group of countries









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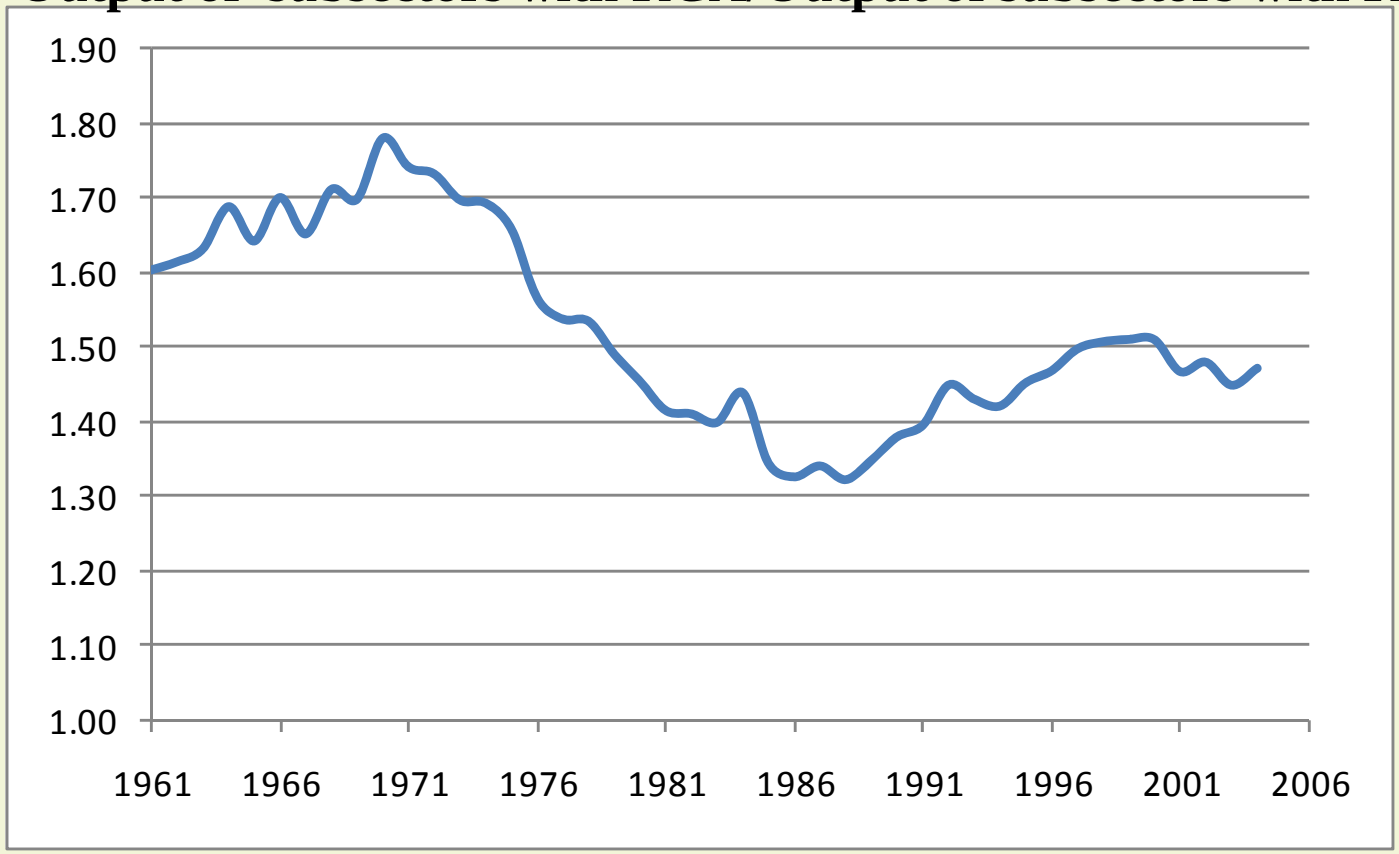
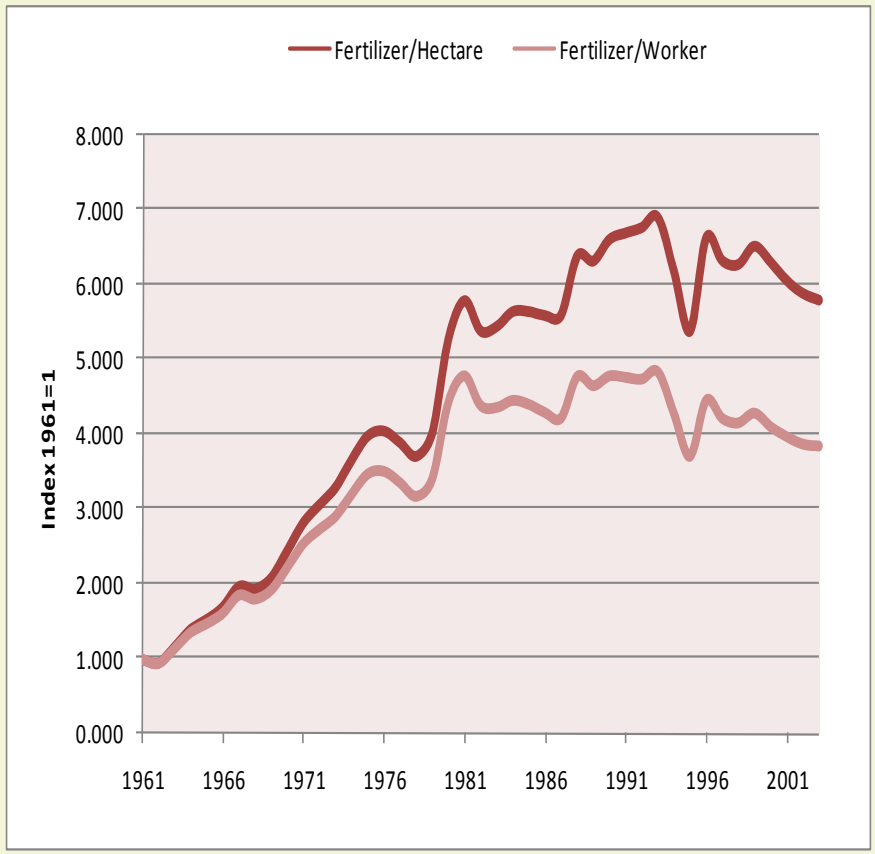
4. Increased efficiency is the result of changes in output structure

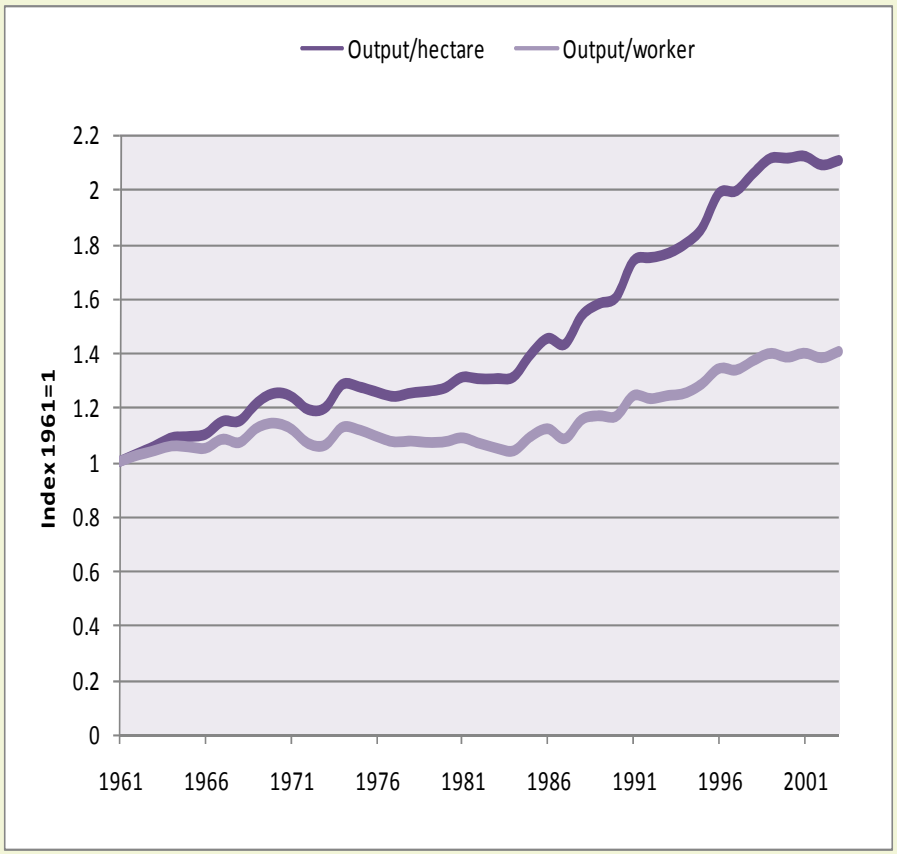
Output of subsectors with RCA/Output of subsectors with RCD



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





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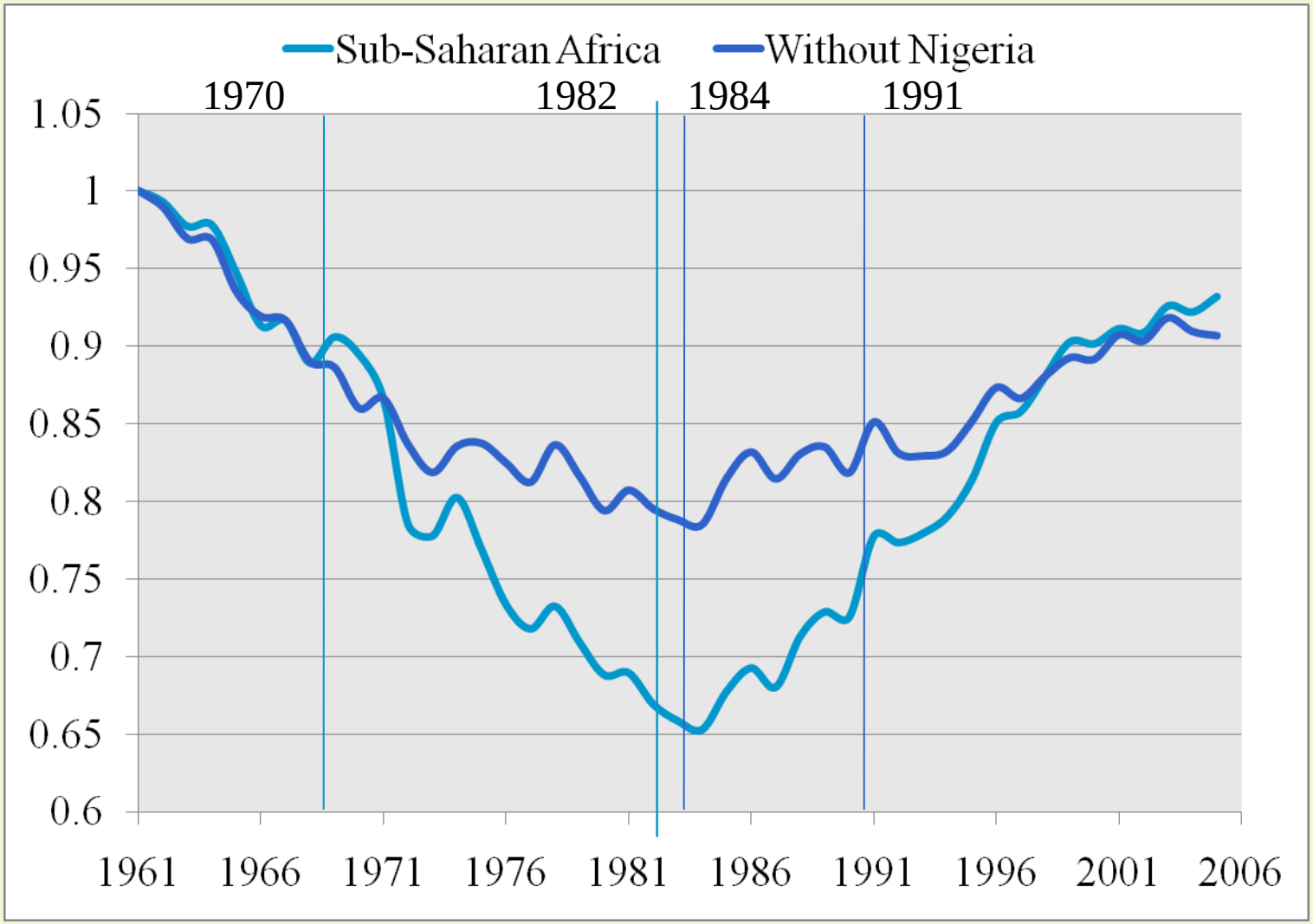
Agricultural performance and policy

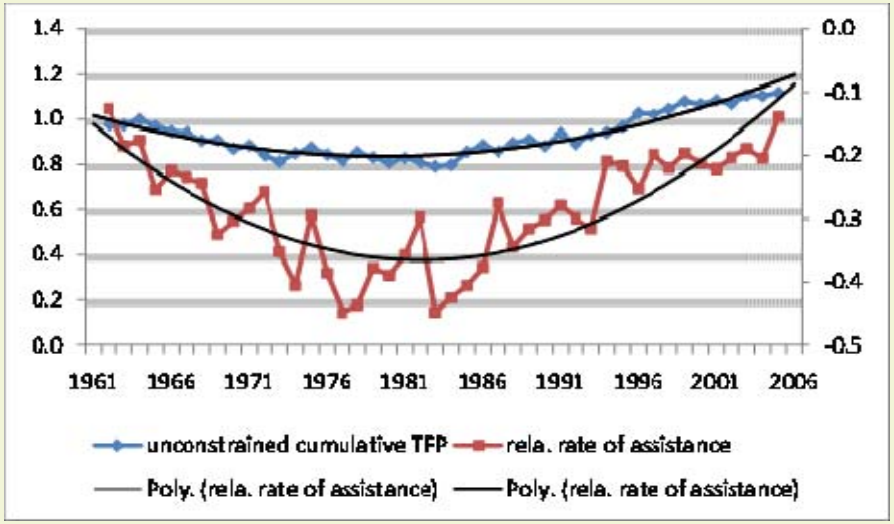
Evidence 1: Policy changes is one of the few factors that can explain observed general pattern between diverse economies

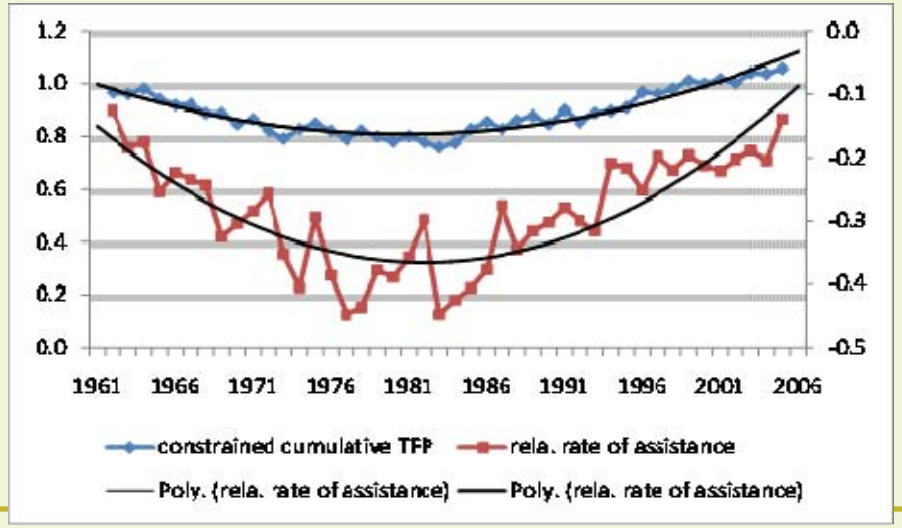
- Africa's larger countries have had relatively interventionist governments (independence to mid-1980s/1990s)
- Followed by reform and a degree of recovery from mid-1980s/1990s to present
- Recovery of traditional export crops (related to improved efficiency)
- Adjustment in the use of inputs (related to improved efficiency)

Evidence 2: Structural change in the series coincide with major policy milestones in the region

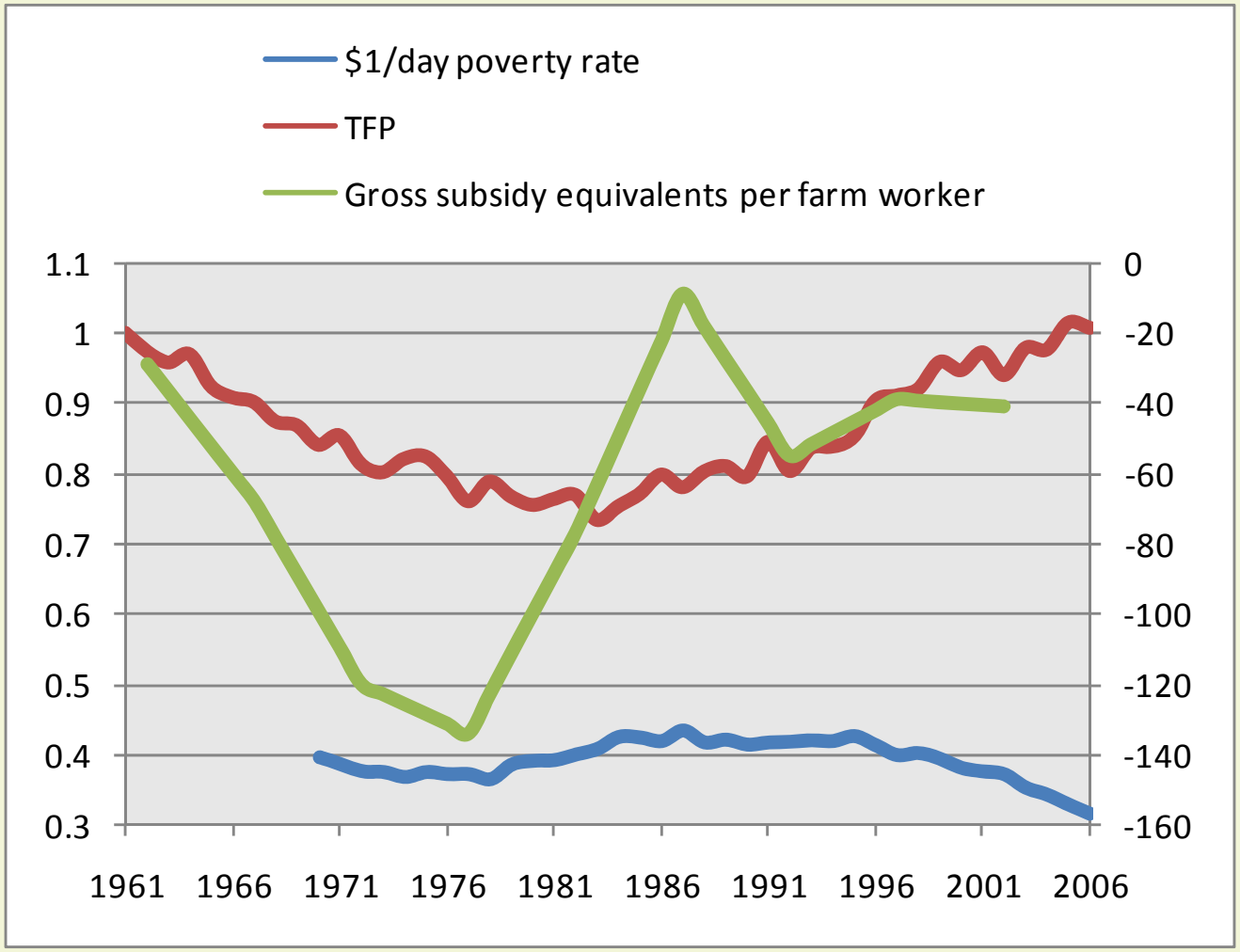


Evidence 4: The evolution of cumulative agricultural TFP growth follows a similar pattern of that of relative rates of assistance (RRA) to agriculture





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

	Unconstrained TFP			Constrained TFP	
	Coef.	Std. Err.		Coef.	Std. Err.
RRA	0.067	(0.014)***		0.086	(0.014)***
Cameroon	-0.139	(0.016)***		-0.146	(0.015)***
Cote d'Ivoire	-0.002	-0.018		-0.152	(0.014)***
Ethiopia	-0.345	(0.018)***		-0.303	(0.014)***
Ghana	-0.18	(0.025)***		-0.262	(0.027)***
Kenya	0.15	(0.046)***		0.06	-0.049
Madagascar	-0.178	(0.014)***		-0.267	(0.014)***
Mozambique	-0.178	(0.017)***		-0.278	(0.016)***
Nigeria	-0.159	(0.051)***		-0.301	(0.040)***
Rsa	0.031	-0.032		0.043	-0.031
Senegal	-0.003	-0.038		-0.072	(0.035)**
Sudan	-0.184	(0.017)***		-0.275	(0.016)***
Tanzania	0.049	(0.018)***		-0.061	(0.017)***
Zambia	-0.076	(0.017)***		-0.056	(0.016)***
Constant	1.136	(0.016)***		1.168	(0.015)***
Observations	557			557	
Number of ccode	14			14	
Chi square	988.8			1387	

Conclusions

1. **Policies applied by several Sub-Saharan African countries after independence imposed a heavy burden on agriculture**
2. **A remarkable recovery in the performance of SSA's agriculture occurred during 1984–2006**
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**