An Updated Look at the Recovery of Agricultural Productivity in Sub-Saharan Africa

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ABSTRACT

We analyze the evolution of Sub-Saharan Africa's agricultural total factor productivity (TFP) over the past 40 years, looking for evidence of recent changes in growth patterns using a nonparametric Malmquist index. Our TFP estimates show a remarkable recovery in the performance of Sub-Saharan Africa's agriculture during between 1984 and 2003 after a long period of poor performance and decline. That recovery is the consequence of improved efficiency in production resulting from changes in the output structure and an adjustment in the use of inputs, including an overall net reduction in fertilizer use but increased fertilizer use in most of the best-performing countries. Policy changes implemented by African countries between the mid-1980s and the second half of the 1990s appear to have played an important role in improving agriculture's performance. As TFP growth in Sub-Saharan Africa is mainly a result of catching up to the frontier, we expect growth to slow down in the coming years unless African countries accelerate the incorporation of innovations into the production process and increase agricultural R&D investment and the speed of technical change.

Key words: agriculture, total factor productivity, Sub-Saharan Africa

JEL Codes: D24, Q18

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1. INTRODUCTION

In recent years, "an improvement in economic indicators throughout Africa led some observers to argue that the region had finally solved its economic conundrums and could now expect sustained economic growth" (van de Walle 2001). That optimism was fueled by the end of several civil wars, a wave of democratization in numerous countries, the acceleration of economic growth, and momentous improvements in the performance of the agricultural sector across Africa. During the 1980s and 1990s, a significant increase in the rate of output growth signaled a change in Sub-Saharan Africa's (SSA's) agricultural sector, after its worst performance occurring between 1972 and 1983, when output growth was less than 1 percent. This recovery of agriculture resulted in output growth rates of 3.2 percent per annum from 1984 to 2003. In the first half of this period (1984-1993), agricultural output growth in SSA was below only growth in China, and despite a slowdown, it still compares with growth in other regions in most recent years.

What are the factors behind the dynamism agriculture has shown in recent years? Can this growth be sustained in the coming years? With a growing labor force in agriculture together with land constraints, sustainable agricultural growth can be achieved only through increased total factor productivity (TFP), the amount of output per unit of total factors used in the production process. TFP can make a substantial contribution to economic growth and development by increasing the welfare of agricultural workers and the rural population, allowing workers to move away from agriculture to more productive sectors, and generating surpluses that can be

transferred to other sectors through prices, in particular at early stages of economic development (see, for example, Winters et al. 1998).

Despite evidence of improved performance in the past 10 years, only a few studies have attempted to analyze SSA's agricultural productivity changes and the factors explaining those changes (see for example Block 1995, Lusigi and Thirtle 1997, and Fulginiti et al. 2004). This paper contributes to the understanding of the recent changes in SSA's agriculture by analyzing the evolution of the region's agricultural TFP in the past 40 years using a nonparametric Malmquist index. We make four main contributions. First, we confirm the improved performance of SSA's agriculture since the mid-1980s. Second, we determine the contributions of individual countries to total TFP growth in SSA. Third, we show the contribution of different groups of commodities to total output growth and changes in the use of inputs of best performers. Finally, we analyze TFP time series for structural changes to find relationships between TFP growth and policy changes in the 1980s and 1990s.

The paper is organized as follows. The next section presents the methodology employed and the data used to estimate TFP. Section 3 presents productivity estimates and Section 4 discusses TFP growth and policy changes in SSA. The last section concludes.

2. PRODUCTIVITY MEASURES AND METHODOLOGY

The Malmquist index measures the TFP change between two data points (e.g., those of a country in two different time periods) by calculating the ratio of the distance of each data point relative to a common technological frontier. Following Färe et al. (1994), the Malmquist index between period t and $t + 1$ is given by

$$M_o = \left(M_o^t \times M_o^{t+1}\right)^{1/2} = \left[\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \times \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^t, y^t)}\right]^{1/2} \quad (1)$$

This index is estimated as the geometric mean of two Malmquist indices (M_o^t), one using as a reference the technology frontier in t (M_o^t), and a second index that uses the frontier in $t + 1$ as the reference (M_o^{t+1}).

Färe et al. (1994) showed that the Malmquist index could be decomposed into an efficiency change component and a technical change component, and that these results applied to the different period-based Malmquist indices:

$$M_o = \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \times \left[\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D_o^t(x^t, y^t)}{D_o^{t+1}(x^t, y^t)}\right]^{1/2} \quad (2)$$

The ratio outside the square brackets measures the change in technical efficiency between period t and $t + 1$. The expression inside the brackets measures technical change as the geometric mean of the shift in the technological frontier between t and $t + 1$ evaluated using the frontier at t and at $t + 1$, respectively, as the reference. The distance function $D_o^t(x^t, y^t)$ measures the distance of a vector of inputs (x) and outputs (y) in period t to the technological frontier in the same period t. On the other hand, $D_o^{t+1}(x^t, y^t)$ measures the distance between the same vector of inputs and outputs in period t, but in this case to the frontier in period $t + 1$. The other two distances can be explained in the same fashion. The method has been extensively applied to the international comparison of agricultural productivity. See, Nin-Pratt and Yu (2008) for references of previous studies.

Two different approaches have been used to define the nonparametric distance functions involved in the estimation of the Malmquist index: the envelope form and a dual equivalent approach that can be derived from the envelope or primal form. Kuosmanen et al. (2004) generalize the dual interpretation of the distance function showing that the distance has the following dual formulation:

$$D_0^t(x^t, y^t) = \max\left\{ \frac{\rho y^t}{\omega x^t} : \frac{\rho y^t}{\omega x^t} \leq 1 \forall (y^t, x^t) \in L^t \right\}. \quad (3)$$

They interpret this distance function as "the return to the dollar,[1] at the 'most favorable' prices, subject to a normalizing condition that no feasible input-output vector yields a return to the dollar higher than unity at those prices." The optimal weights ρ_k and ω_j are respectively output *k* and input *j* shadow prices with respect to technology L^t. There exists a vector of shadow prices for any arbitrary input-output vector; however, these prices need not be unique. The dual LP problem to estimate this distance function, including constraints to the shadow input shares is:

$$D^t(y_k^t, x_k^t) = \underset{\rho,\omega}{Max} \sum_{r=1}^{s} \rho_r y_{ro}^t,$$

s.t. (4)

$$\sum_{i=1}^{m} \omega_i^t x_{io}^t = 1,$$

$$\sum_{r=1}^{s} \rho_r^t y_{rj}^t - \sum_{i=1}^{m} \omega_i x_{ij}^t \leq 0,$$

$$a_{io}^t \leq \omega_i^t x_{io}^t \leq b_{io}^t \quad \mathrm{i} = 1,...,\mathrm{m},$$

$$\rho, \omega \geq 0.$$

[1] *Return to the dollar* is an economic criterion to evaluate performance. It measures the ability of producers to attain maximum revenue to cost (introduced by Georgescu-Roegen 1951 and referred to in Kuosmanen et al. 2004). The assumption of allocative efficiency depends on the specified economic objectives of the firms through the shadow price domain (Kuosmanen et al. 2004).

The introduction of bounds on shadow input shares constitutes additional constraints to the original formulation.[2] Restricted and unrestricted models will provide the same results only if all the additional restrictions imposed are nonbinding.

In this study we estimate the distance functions needed to calculate the Malmquist index using the dual approach imposing bounds to the shadow shares to assure that these shares are within the expected range of shares for SSA countries. Information on the likely value of the shares of the different inputs is from Evenson and Dias Avila (2007). These authors estimate crop input cost shares for 32 Sub-Saharan African countries by adjusting carefully measured share calculations for India. A detailed discussion of the methodology can be found in Nin-Pratt and Yu (2008).

Data used is from the Food and Agriculture Organization of the United Nations (FAO) and includes one output (agricultural production measured in international dollars) and five inputs (labor, land, fertilizer, tractors, and animal stock) for 98 countries of which 30 are Sub-Saharan African countries.

[2] $\omega_i^t \times x_{io}^t$ the input shadow prices multiplied by the input quantities) is equal to the implicit input shares as shown in Coelli and Prasada Rao (2001)

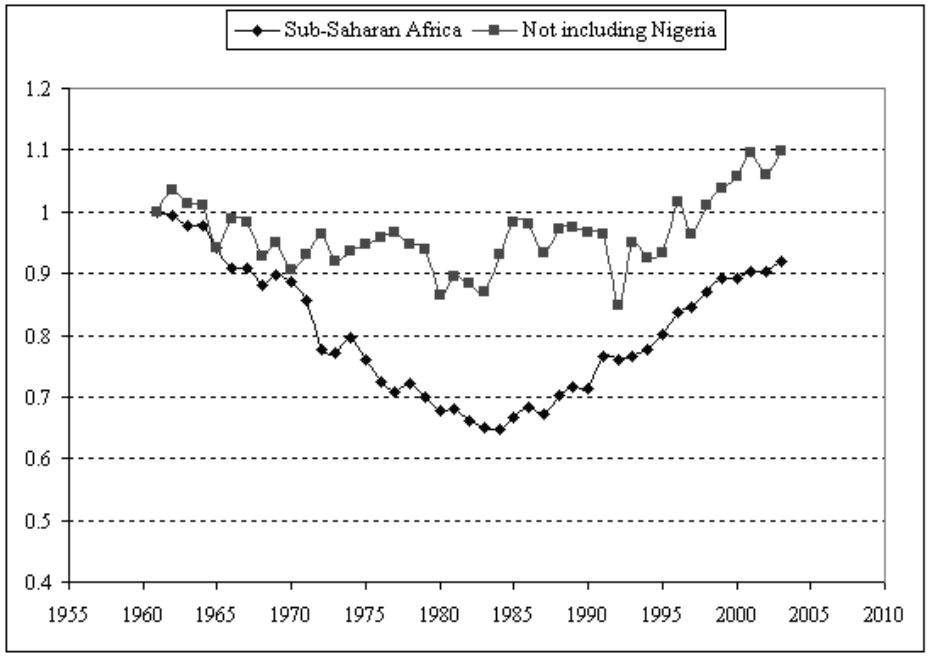
3. TFP GROWTH AND PERFORMANCE OF SUB-SAHARAN AFRICA'S AGRICULTURE, 1964–2003

Aggregated Results Using a Weighted Average of 30 Sub-Saharan African Countries

A weighted average of TFP measures at the country level for a sample of 30 Sub-Saharan African countries shows that annual growth between 1964 and 2003 was –0.15 percent. This average, however, hides significant variations across time, where two periods with contrasting results can be distinguished (Figure 1). A first period of poor performance and decline stretches from the mid-1960s to the mid-1980s, during which productivity growth in SSA was negative: –2.01 and –0.77 percent per annum if average TFP is estimated respectively including or excluding Nigeria.[3] That period is followed by a period of recovery and improved performance that starts in 1984–1985 and extends up to 2003, the last year for which information is available. During this period, TFP grows at an annual rate of 1.73 percent (1.18 percent excluding Nigeria), with 1.65 percent growth in the first half of the period (1984–1993), compared with –1.67 percent between 1974 and 1983. TFP growth accelerates during the 1990s to 1.83 percent as more countries improve their performance and speed up TFP growth.

[3] Because of the size of Nigeria's agricultural sector relative to other countries, some of the aggregated results for SSA could be driven by that country. For that reason, some of the results are presented excluding Nigeria.

Figure 1. Index of cumulative TFP growth in SSA (1961 = 1)



Source: Estimated by authors.

The decomposition of SSA's TFP growth into efficiency and technical change shows that almost all TFP growth of the last 20 years is the result of SSA catching up to the frontier after falling behind during the 1964–1983 period (Table 1).

Table 1. TFP growth rate and decomposition for different periods (percentage)

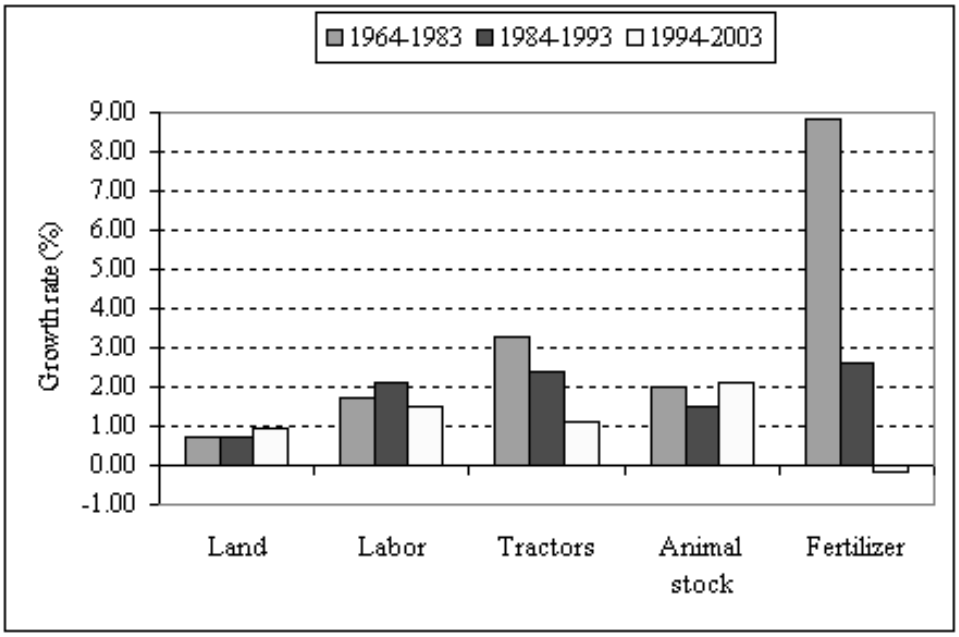
	TFP	Efficiency	Technical change
Sub-Saharan Africa			
1964–1973	-2.35	-2.79	0.46
1974–1983	-1.67	-1.70	0.03
1984–1993	1.65	1.59	0.06
1994–2003	1.83	1.63	0.19
1964–1983	-2.01	-2.25	0.25
1984–2003	1.74	1.61	0.12
Sub-Saharan Africa excluding Nigeria			
1964–1973	-0.99	-1.23	0.24
1974–1983	-0.55	-0.58	0.03
1984–1993	0.89	0.77	0.11
1994–2003	1.48	1.16	0.31
1964–1983	-0.77	-0.90	0.14
1984–2003	1.18	0.97	0.21

Source: Estimated by authors.

During the period of accelerated output growth, oil crops, roots and tubers, other cereals, pulses, and milk increased their share while beef, tropical fruits, and traditional export crops reduced their participation in total output. Maize, which showed growth rates of 3.5 percent from 1984 to 1993, reduced its growth to only 0.9 percent per annum in the 1990s.

Agricultural TFP growth in SSA from 1984 to 2003 can be related from the input side to an adjustment in the relative use of inputs in the production process (Figure 2). The most important change at this level is an absolute reduction in the use of fertilizers. From 1964 to 1983, SSA saw a fast expansion in the use of fertilizers, with growth rates of 8.81 percent on average for 20 years. Growth in fertilizer use falls to 2.62 percent between 1984 and 1993 and becomes negative between 1994 and 2003. Four countries explain most of the reduction in the use of fertilizer, with Nigeria alone explaining 72 percent of this reduction. On the other hand, 21 countries in our sample increased the use of fertilizer during this period. Labor continues to increase faster than other factors, although it appears to be slowing down between 1994 and 2003 compared with previous years.

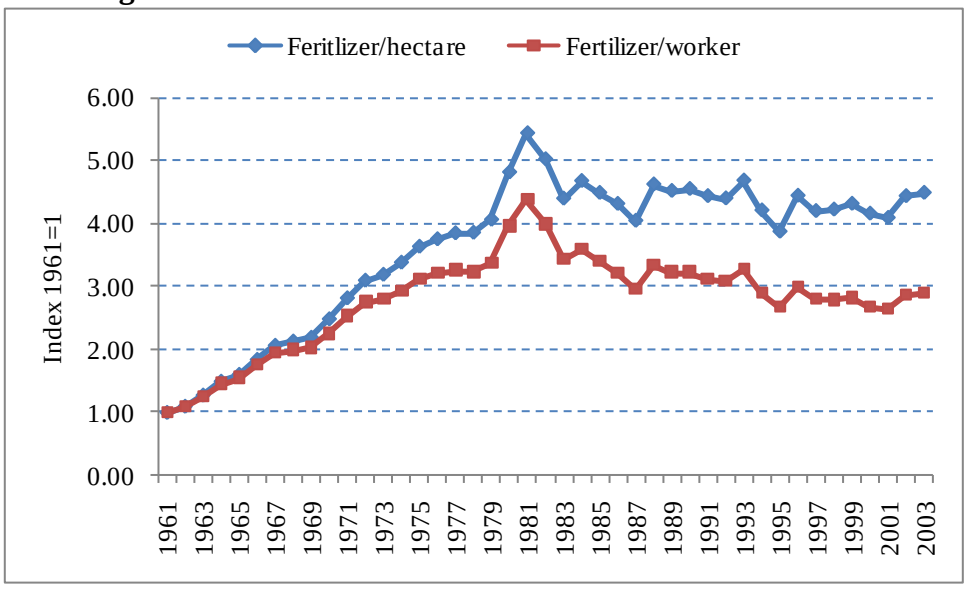
Figure 2. Growth rates in the use of inputs in agriculture production (all Sub-Saharan African countries)



Source: Elaborated by authors

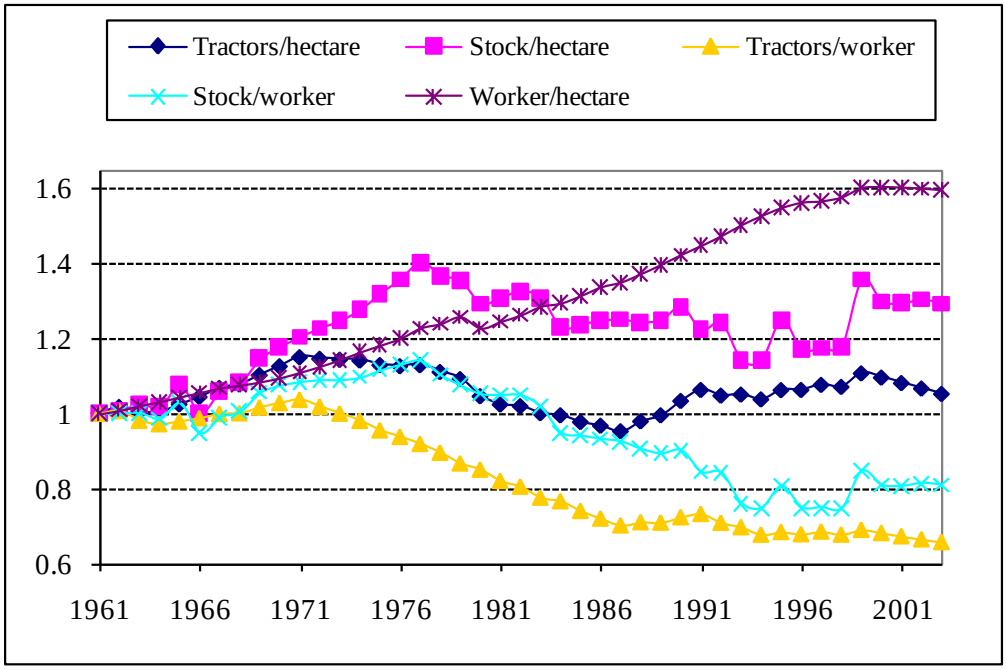
Relative changes in inputs are shown in Figures 3 and 4. The reduction in the use of fertilizer and increased use of labor and land results in the negative growth of fertilizer use per hectare of arable land and per worker during 1994–2003 (Figure 3). The number of workers per hectare of arable land continued to grow, although the growth rate decreased, in the second half of the 1990s. Despite small changes in the number of animals and tractors per hectare, a decrease in animal stock and tractors per worker, and a reduction in the use of fertilizers, output per hectare increased significantly between 1984 and 2003 after several years of little or no growth (Figure 5). Output per worker also grew during that period, but that growth is more pronounced when Nigeria is included in the group of Sub-Saharan African countries.

Figure 3. Indices of fertilizer use per hectare and worker (1961 = 1), weighted average of all SSA countries



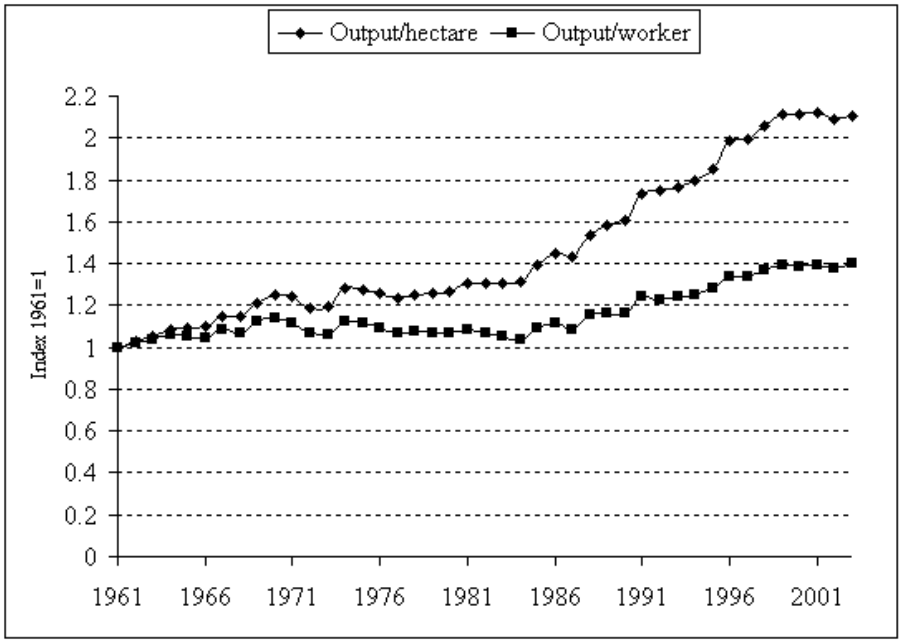
Source: Authors, based on data from FAOSTAT 2007.

Figure 4. SSA: Indices of input use per hectare and worker (1961 = 1), weighted average of all SSA countries



Source: Elaborated by authors

Figure 5. Evolution of output per hectare and worker in SSA (I$) including all countries



Source: Elaborated by authors

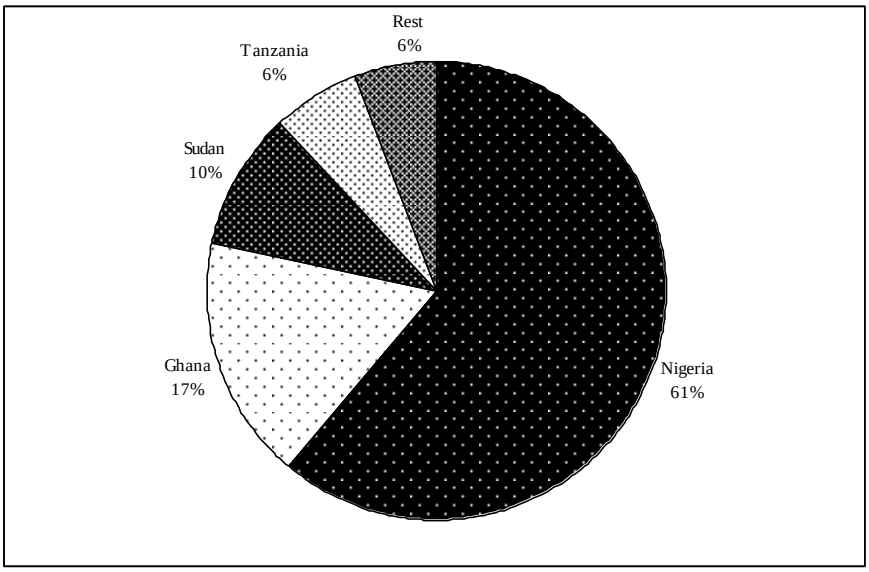
Results at the Country Level[4]

In the first 10 years after the region started implementing new policies, four countries explain most of agricultural TFP growth: Nigeria and Ghana contributed 61 and 17 percent, respectively, of total TFP growth occurring between 1984 and 1993. These two countries together with Sudan and Tanzania (Figure 6) explain 94 percent of total TFP growth in SSA from 1984 to 1993. The number of countries contributing to TFP growth increased significantly between 1994 and 2003, with nine countries explaining 90 percent of TFP growth during that period. Nigeria and Ghana remain as major contributors to TFP growth, but their contribution is down to 42 percent of total growth from 61 percent in 1984–1993. Sudan, Ethiopia, Tanzania, Ivory Coast, Mali, Kenya, and Cameroon together explain almost 40 percent of SSA's TFP growth between 1994 and 2003 (Figure 6b)

[4] Appendix B presents trends in output, inputs, TFP, efficiency, and technical change for the period 1964–2003 for all countries in our sample.

Figure 6. Contribution of different countries to TFP growth in SSA, 1984–1993 and 1994-2003

a) 1984-1993



b) 1994-2003

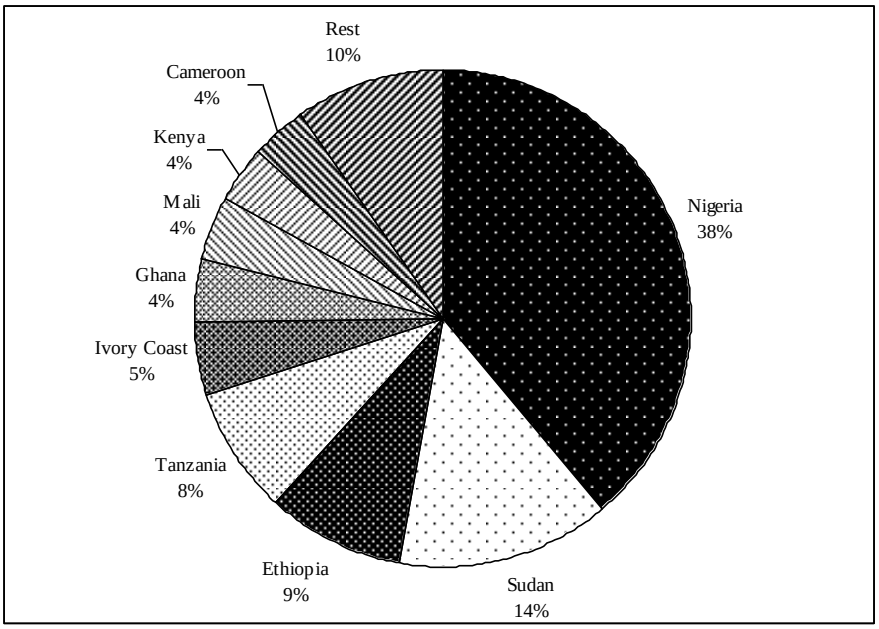


Table 2 focuses on the most recent period (1994–2003), where TFP growth on average is higher than growth in 1984–1993. The first column of this table shows that Coastal West Africa and East Africa are the regions with the best performance (1.89 and 1.90 percent per year, respectively). In Southern Africa, only two countries show a good performance (Malawi and Mozambique), while in the Sahel, results are

mixed, with two countries showing significant TFP growth (Mali and Chad) and two countries with a good performance in historical terms (Mauritania and Burkina Faso).

Table 2. Annual TFP growth rate and TFP growth decomposition, 1994–2003 (percentage)

	TFP	Efficiency	Technical change
Benin	1.67	0.00	1.67
Cameroon	1.84	0.86	0.98
Congo, Rep.	1.39	1.39	0.00
Ivory Coast	1.60	1.37	0.24
Gabon	2.31	2.31	0.00
Ghana	1.79	1.79	0.00
Guinea	0.42	0.42	0.00
Nigeria	2.12	2.10	0.02
Sierra Leone	-0.75	-0.75	0.00
Togo	0.59	-0.19	0.78
Coastal W. Africa	1.89	1.71	0.17
Burkina Faso	1.32	1.24	0.09
Chad	2.48	2.06	0.42
Gambia	-1.38	-1.38	0.00
Guinea-Bissau	0.45	0.34	0.11
Mali	2.85	2.77	0.09
Mauritania	1.44	1.42	0.01
Senegal	-0.70	-0.91	0.21
Sahel	1.11	0.94	0.16
Botswana	-3.99	-3.99	0.00
Lesotho	-1.28	-1.93	0.65
Malawi	3.35	3.22	0.14
Mauritius	0.93	-0.39	1.31
Mozambique	3.32	3.32	0.00
Swaziland	-0.19	-2.34	2.15
Zambia	0.03	0.03	0.00
Zimbabwe	-0.50	-1.64	1.14
Southern Africa	1.48	1.16	0.31
Ethiopia	2.55	2.55	0.00
Kenya	1.05	0.37	0.68
Madagascar	-0.03	-0.03	0.00
Sudan	3.19	3.19	0.00
Tanzania	2.79	2.77	0.02
East Africa	1.90	1.72	0.17

Source: Authors' estimation.

Decomposition of TFP growth into its components (second and third columns in Table 2) shows that in general, most of TFP growth is explained by efficiency gains, which corresponds to the fact that most countries are recovering from periods of negative productivity growth and reduction in efficiency. For

instance, in the case of Coastal West Africa, only 0.17 percentage points in 1.89 percent growth in TFP (9 percent) results from technical change. A similar result is obtained in East Africa. The contribution of technical change to TFP is most important in Southern Africa, with values that are twice those in other regions. Swaziland, Lesotho, Zimbabwe, and Mauritius show a significant share of technical change in TFP growth, but their performance was poor due to growing inefficiency. On the other hand Malawi and Mozambique, two of the countries with better performance in the region, show very little incidence of technical change on productivity growth. In East Africa, only Kenya shows a significant contribution of technical change to total TFP growth.

In terms of the changes in the use of inputs, we are interested in how such changes affect labor and land productivity and through them overall TFP. Increased labor productivity is needed to increase income of agricultural workers, which means that yields need to increase faster than the number of workers per hectare (Block 1995). Changes in the relative use of inputs for the group of best performing countries are shown in Table 3.

The best performing countries show on average similar growth in TFP and increased labor and land productivity, which can be explained by increased used of fertilizer per hectare and worker (Table 3). Some of these countries (Group 1) show a growing rural population (growing number of workers/hectare), but increased yields faster than population (Mali, Congo, Chad, Cameroon, Ethiopia and Mozambique).

Table 3. Annual changes in input relationships, labor and land productivity, and TFP (%), 1994–2003

	Fertilizer per hectare	Tractors per hectare	Animal stock per hectare	Fertilizer per worker	Tractors per worker	Animal stock per worker	Worker per hectare	Output per hectare	Output per worker	TFP
Group 1[a]	4.41	-0.82	1.49	3.88	-1.33	0.98	0.51	2.42	1.90	2.41
Mali	3.97	-0.44	2.04	3.42	-0.96	1.51	0.52	2.25	1.72	2.85
Congo	4.14	-0.54	1.59	3.90	-0.77	1.36	0.23	1.68	1.45	1.39
Chad	10.71	-0.31	2.52	9.73	-1.19	1.62	0.89	2.71	1.80	2.48
Cameroon	1.29	0.00	2.19	0.59	-0.69	1.49	0.69	2.62	1.91	1.84
Ethiopia	1.70	-1.79	1.63	1.01	-2.46	0.94	0.68	2.49	1.79	2.55
Mozambique	4.63	-1.85	-1.01	4.60	-1.88	-1.05	0.04	2.79	2.75	3.32
Group 2[b]	1.81	-1.22	0.18	2.65	-0.42	0.99	-0.81	1.97	2.80	2.23
Malawi	7.34	-2.63	-1.20	8.95	-1.17	0.28	-1.48	3.23	4.78	3.35
Ghana	5.27	-3.96	-1.48	6.66	-2.68	-0.17	-1.31	1.57	2.92	1.79
Ivory Coast	4.75	-0.25	1.01	5.17	0.15	1.42	-0.40	2.09	2.50	1.60
Sudan	0.19	-0.29	1.39	0.33	-0.15	1.53	-0.14	1.64	1.78	3.19
Burkina Faso	-1.26	-1.07	0.52	0.21	0.40	2.01	-1.46	1.25	2.76	1.32
Nigeria	-5.45	0.85	0.82	-5.40	0.90	0.88	-0.06	2.02	2.08	2.12

Note: a) faster growth in yields than in labor productivity; b) labor productivity grows faster than yields.

Countries in Group 2 increase both labor and land productivity, but labor productivity grows faster than yields (Malawi, Ghana, Ivory Coast, Sudan, Burkina Faso and Nigeria). That occurs because these countries are increasing land productivity while the number of workers grows slowly or because countries are still increasing the number of hectares of arable land at a fast pace. In both cases the result is a slow growth of the number of workers per hectare. Countries in this group are more likely to have increased rural living standards through increased labor income in agriculture.

A caveat to these results is that in many of these countries labor per hectare increased slowly because they were still able to incorporate more land into crop production. If the availability of land decreases in the coming years, yields will need to increase faster to compensate for growth in rural population and improve rural income.

4. POLICY CHANGE AND IMPROVED PERFORMANCE OF SUB-SAHARAN AFRICA'S AGRICULTURE

A study by Block (1995) finds that technical change, measured by expenditures for agricultural research, and macroeconomic reform which leads to improved economic incentives for agriculture, might account for up to two-thirds of the recovery of agriculture in SSA. With new evidence after more than a decade since the publication of Block's article, we explore in this section the relationship between our TFP estimates and policy milestones affecting agricultural TFP in SSA. We focus here on the analysis of macro and agricultural policy reform, comparing major milestones in the process of policy reform in different countries with TFP changes in those countries.

We look at the best-performing countries, separately analyzing the evolution of TFP in those countries and relating that evolution to specific milestones in policy reform. Information on policy and TFP relationships for 11 countries that together explain more than 90 percent of total TFP growth in SSA in the period 1994–2003 can be found in the Appendix. We use the information in the Appendix to verify the links between policy milestones and structural change in the TFP series of those countries contributing the most to agricultural TFP growth in SSA. Of the 11 best performing countries, only Kenya shows no correspondence between TFP growth and policy changes, which suggests that for that country, other factors played a more significant role than policy as determinants of TFP performance.

Table 4 presents the results of the analysis of structural change in the estimated TFP series. In most cases the structural change coincides with the period of policy changes. The aggregated TFP series for SSA shows evidence of a break in the 1980s, which reflects the fact that the aggregated series is driven by Nigeria. When Nigeria is excluded, there is evidence of two breaks in the series: the first in 1984 and a second in the early 1990s when the second wave of changes

and the devaluation of the CFA franc occurred. Considering individual countries, tests for Nigeria and Ghana show evidence that structural change occurred in the mid-1980s, when policy changes started. In Ivory Coast and Mali, structural change occurred in 1993–1994, coinciding with the CFA franc devaluation. There is evidence of structural change during the 1990s in East and Southern African countries, also coinciding with major policy changes in those countries: Ethiopia, Sudan, Tanzania, Malawi, and Mozambique.

Table 4. Test for structural change in estimated agricultural TFP series

		Additive outlier	Innovational outlier	Additive outlier	Innovational outlier
	Intercept and trend break	Sudden change in series	Gradual shift in the mean	Sudden change in series	Gradual shift in the mean
	zandrews	clemao1	clemio1	clemao2	clemio2
Nigeria		1985	1986		
Ghana					1968, 1982
Ethiopia					1974, 1995
Sudan				1976, 1990	1977, 1991
Ivory Coast				1973, 1994	1974, 1993
Cameroon	1968		1965		
Mali				1973, 1994	1974, 1995
Mozambique				1982, 1993	
Malawi				1970, 1990	1971, 1991
Kenya				1978, 1994	1966, 1979
Tanzania	1992	1999	2000		
SSA				1970, 1982	
SSA excluding Nigeria					1984, 1991

Source: Authors' estimations.

All values shown are significant at 5% level.

Note: The series were tested for two structural breaks using Clemente, Montañés, and Reyes's test for additive outliers, which captures a sudden change in a series (clemio2), or innovational outliers, allowing for a gradual shift in the mean of the series (clemao2). If these estimates show no evidence of a second break in the series, then zandrews, clemio1, and clemao1 are used assuming one structural break in the series (Baum 2001).

5. CONCLUSIONS

Results of our TFP estimates show a remarkable recovery in the performance of SSA's agriculture during 1984 and 2003, after a long period of poor performance and decline. This accelerated TFP growth occurred simultaneously with rapid growth in output and changes in output composition and in the use of inputs. Considering TFP growth together with balanced growth in land and labor productivity as indicators of good agriculture performance, we find 12 countries (Nigeria, Ghana, Ivory Coast, Burkina Faso, Mali, Mozambique, Malawi, Ethiopia, Sudan, Cameroon, Chad, and Congo) with relatively high TFP growth and sustained growth in labor and land productivity from 1994 to 2003. In most of those countries, growth in land and labor productivity can be explained by increased use of fertilizer per hectare and worker.

The evidence in this study points to policy change conducted by Sub-Saharan African countries between the mid-1980s and the second half of the 1990s as one of the main factors determining the agricultural sector's improved performance. Most countries significantly contributing to TFP growth in SSA show structural breaks in their TFP series in the mid-1980s, the 1990s, or both, coinciding with policy milestones and changes in those countries.

Despite improved agricultural performance between 1985 and 2003, several signs still exist warning that SSA countries need to make more efforts to sustain TFP growth in the coming years. The decomposition of TFP growth into efficiency and technical change shows that most TFP growth in the last 20 years is the result of SSA catching up to the frontier after falling behind during the 1964–1983 period. This structure of TFP growth in SSA differs substantially from that of other regions, where a significant share of TFP growth is explained by technical change. With a small contribution of technical change to TFP, we expect growth to slow down in the coming years as countries catch up with efficiency levels at the production frontier.

According to our estimates, a slowdown in TFP growth is already apparent in the cases of Nigeria and Ghana, who lead the recovery of SSA's agriculture in the mid-1980s.

Sustained growth in labor productivity faces the challenge of population growth and related increases in agricultural labor per hectare. In many countries, expansion of labor productivity was possible because those countries were still able to incorporate more land into crop production. If the availability of land reduces in the coming years, yields will need to increase faster to compensate for growth in rural population and improve rural income. Increased and sustained TFP and labor productivity growth in the future will be possible only if policy improvements are complemented by investments in agricultural R&D that accelerate the expansion of SSA's technical frontier.

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APPENDIX

Table A.1 Summary of policy events and changes in selected Sub-Saharan African countries

	Before structural adjustment			After structural adjustment		
	Period	Policy	% TFP growth	Period	Policy changes	% TFP growth
Nigeria	1964–1984	Overvalued currency; public expenditure concentrated in sectors other than agriculture; price controls and trade restrictions; parastatal marketing boards; subsidized consumption; massive agricultural imports; fertilizer subsidy	-3.45	1985–2003	Structural adjustment program: devaluation of the naira; ban on food imports; Agricultural Development Projects (ADPs)—National Coordinated Research on Cassava Project was set up to coordinate on-farm adaptive research on cassava	3.43
Ghana	1964–1983	Socialist policy targeting food import substitution; promotion of mechanization; grain marketing board	-3.48	1984–2003	Economic recovery program; trade liberalization and foreign exchange controls lifted	4.52
Ethiopia	1974–1993	Command economy; recurrent drought; long and devastating civil war; narrow range of exports; very low technology base	-0.27	1994–2003	Package of economic reform measures implemented by the government that came to power in 1991	2.55
Sudan	1964–1992	Interventionist policy; distorted markets; war and rainfall fluctuations; several million displaced in the southern region	-0.88	1993–2003	Long-term plan with substantial economic reforms: currency devaluation; exchange rate liberalization; abolition of most export and import licenses; liberalization of most domestic markets	1.74
Ivory Coast	1964–1994	Ineffective policies; debt crisis in the 1980s; overvalued currency; little progress in reforms until 1994	-0.45	1995–2003	After adjustment program 1994–1996, Ivory Coast made considerable progress in reducing financial imbalances, controlling inflation, and liberalizing the economy (cocoa and coffee sectors); devaluation of CFA franc in 1994[a]	1.80

Table A.1 Summary of policy events and changes in selected Sub-Saharan African countries (Continued)

	Before structural adjustment			After structural adjustment		
	Period	Policy	% TFP growth	Period	Policy change	% TFP growth
Cameroon	1964–1994	Drop in commodity prices (petroleum, cocoa, coffee, and cotton) in the mid-1980s; overvalued currency; high cost structure induced by oil revenues; economic mismanagement; recession. Real per capita GDP fell by more than 60% from 1986 to 1994	-0.39	1995–2003	Economic reform programs supported by World Bank and IMF began in the late 1980s; CFA franc was devalued by 50% in January 1994; government failed to meet the conditions of the first four IMF programs until the devaluation of the CFA franc	2.11
Mali	1964–1994	Socialist-inspired policies; state intervention; nationalization; state-owned enterprises in several sectors; public monopoly on foreign trade; price controls	-0.66	1995–2003	Reforms implemented in 1992–1995; liberalization of regulatory environment; elimination of price controls; import quotas eliminated in 1988; export taxes dropped in 1991; reform program of the public enterprise sector; devaluation of CFA franc in 1994	2.41
Malawi	1964–1994	Agricultural production and marketing heavily controlled by government; slow progress in agricultural reforms after 1981	-0.23	1995–2003	All input and output prices were set free except for maize; production and marketing of hybrid seed maize liberalized; fertilizer subsidy still used	4.39

Table A.1. Summary of policy events and changes in selected Sub-Saharan African countries (Continued)

	Before structural adjustment			After structural adjustment		
	Period	Policy	% TFP growth	Period	Policy change	% TFP growth
Mozambique	1975-1992	Centrally planned economy after independence; 10-year plan launched in 1981; Economic problems; conflict and civil war; draught and collapse of the economy in 1986	-3.04	1993-2003	Economic and social rehabilitation program introduced reforms in 1989; price liberalization in 1989–1993; trade liberalization and simplified tariff structure since 1996; privatization program implemented (1989); end of civil war, 1993	4.14
Kenya	1964-1993	Structural reforms started in the 1980s but small improvement by 1991; slow pace in changing agricultural policy	2.24	1994-2003	Liberalization of maize market and abolition of maize movement controls, 1994; progress made on fertilizer policy, cereals marketing policy, and output marketing for a variety of enterprises including cotton, dairying, sugar, and coffee	1.05
Tanzania	1975-1985	Heavily state-controlled economy; inadequate policy led to economic stagnation; war with Uganda	-0.43	1986-2003	Economic recovery program began in mid-1986: currency devaluation; international and domestic trade and marketing liberalization; reduction of fiscal deficit; reduction in tariff levels; elimination of price controls; phasing out of petroleum and fertilizer subsidies; a hiring freeze and retrenchment in the civil service	2.79

Source: Elaborated by authors based on several sources: see Nin Pratt and Yu (2008)
[a] International Monetary Fund (1998).