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F. Djoumessi, Yannick

University of Dschang

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GREEN AGRICULTURAL PRODUCTIVITY GROWTH AND CONVERGENCE IN SUBSAHARAN AFRICA

Yannick Fosso Djoumessi
Ph.D. student in Economics, Dschang School of Economics and Management.
T: +237 674 77 07 04. E: yannick.djoumessi@univ-dschang.org

Abstract

This study analyzes the dynamics of green agricultural productivity growth through SSA countries. As subsidiary objectives: (i) to estimate efficiency levels of agricultural production system in SSA countries (ii) to estimate green agricultural productivity index through SSA countries (iii) and then to determine path nature of the green agricultural productivity index trough time and SSA countries. The methodology used to assess the degree of convergence in output per worker is based on the cointégration analysis, which recognizes that labour productivity is generally a non-stationary time series and convergence is a gradual process. First of all, we consider a decomposition of the growth in labour (green) productivity in terms of (1) efficiency change (2) technical change (3) (physical) capital accumulation and (4) growth in human capital. Then, a semi-parametric approach will be used to construct the best production practice frontier for a sample of SSA, and compute Malmquist productivity indexes and their decomposition into the underlying productivity components for each country. Finally, we will assess the individual contribution of the various components to the convergence in labour productivity.

Key words: convergence, green productivity, Malmquist index, Sub-Saharan Africa

1. Context and Justification

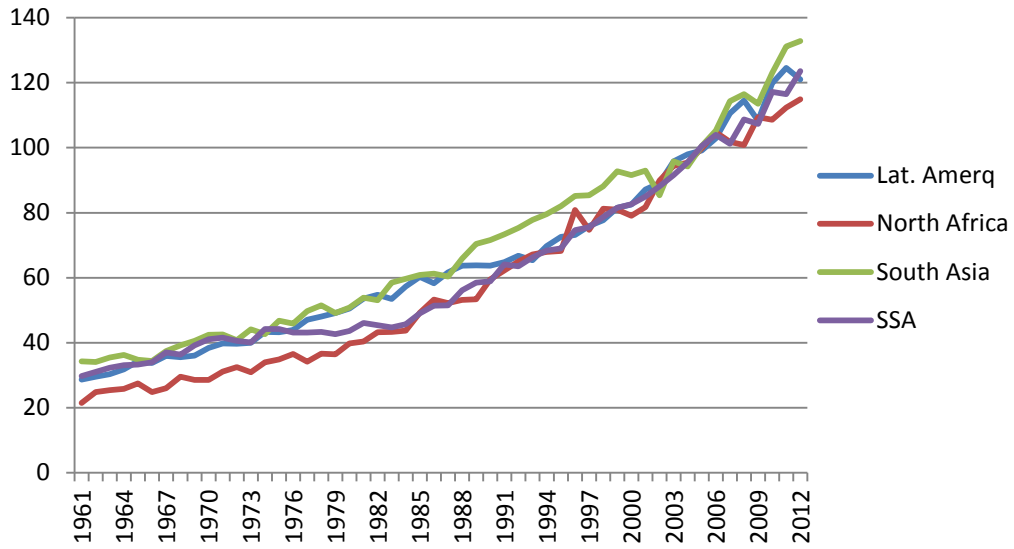
Following Ruttan (2005), for developed countries almost all increases in crops and animal production occurred as a result of increase in the area cultivated at the beginning of the nineteenth century and by the half of the century, almost all increases came from the increase of land productivity in output per hectare: that is the result of the transition from a natural resource-based to a science-based system of agricultural production. According to the same author, one century later the transition had not yet started for most of the poor countries. A significant number of former work denounced a poor performance in the agricultural sector of the African continent compared to the total economic growth; agriculture in Africa is still lagging behind other regions both in terms of production and productivity (Binswanger & Townsend, 2000; Maddison, 1999). A severely under-capitalized agricultural sector led to a low agricultural productivity (Binswanger & Townsend, 2000). According to Delgado and Ranade (1987), historically the marginal product of agricultural labour in Africa is about the same as the average product, whereas in Asia and Latin America the average product of labour is much greater than the marginal product.

Contrary to what is acknowledged in those works, the agricultural production in Africa increased in a supported way, almost as much as in South America and slightly less than in Asia for the same period (see figure 1).

Indeed, most of institutions (NEPAD, FAO)[1] are still claiming that the problem of the agricultural sector in Africa mostly depends on the efficiency to use production factors (labour and land), and African agricultural growth was mainly done by the expansion of cultivated areas and the use of abundant labour, which leads ultimately as a weak improvement or almost non-existent yields. Until now, no scientific study has been conducted in order to understand agricultural productivity growth in Africa. In this work, we will focus our intention in sub-Saharan Africa where almost a third and more of GDP comes from agriculture (World Bank, 2015).

[1] NEPAD (New Partnership for the Development of the Africa) and FAO (Food and Agriculture Organization)

Figure 1: Agricultural production path/area



Source: World Bank, 2015. SSA Sub-Saharan Africa

In Sub-Saharan Africa (SSA), agriculture covers 60% of working population, apart from some countries in Southern Africa, some oil countries of the Golf of Guinea and notable exception as Nigeria, Ivory Coast or Cameroon where agriculture covers half or slightly more of the working population (World Bank, 2015). According to the FAO, population which is living from agriculture represents about 48% of the total population (up to 70% in East Africa). African agriculture of these last thirty years is different from the rest of the World due to his big part capacity's absorption of the working population.

However, beyond a regular progression of African agricultural production these thirty last years, the African model of agricultural growth deviates significantly from dynamic observed in Latin America or Asia. According to Ruttan (2002), countries that are land constrained, such as India, can be expected to follow a productivity growth path that places primary emphasis on biological technology. In contrast Brazil where land is abundant, progress on mechanical technology allowed labour productivity growth (extensive production system). Mechanical technology is labour saving, designed to substitute power and labour for machinery. Whereas Biological and chemical technology is land saving "instead of environmental consequences", designed to substitute labour-intensive production practices and industrial inputs such as fertilizer, plant and animal protection chemicals for land. In SSA where land is very abundant, agricultural growth analysis by labour productivity proves to be indubitable.

2. Problematic

Most of organizations (NEPAD, FAO) are claiming that Agricultural growth in SSA was primarily based on availability of labour (in strong growth) and new cultivated areas. According to FAO, an additional area of more than 700 million hectares would be also cultivable. However, taking in account rural population growth rate annual 2% compared to urban population growth rate annual about 4.12% in SSA (World Bank, 2015). We should not maintain the availability of labour as the first source of agricultural growth in Africa, because of great moving of people from rural to urban area. Research in cross-country growth performance comparisons has intensified in recent years; particular attention has been given to the questions of convergence in per capita (or per worker) output levels and growth rates across groups of countries and the type of variables that serve as empirical determinants of economic growth (Ball, Bureau, Butault, & Nehring, 2001; Fare, Grosskopf, & Margaritis, 2006; Henderson & Russell, 2005).

Convergence particularly implies fast productivity growth for countries (or regions), which had a low initial level of productivity (Ball et al., 2001; Fare et al., 2006; Solow, 1956)

Productivity growth requires at same time efficiency change, technical change, and factors intensity (Kumar & Russell, 2002); further human capital change (Fare et al., 2006; Henderson & Russell, 2005).

A world competition, demographic galloping and above all the impact of climate change are some of the many challenges to take up in order to start durable processes of economic transition. Particularly, SSA is facing problems such as: food safety and very low farmers' income, it would be important to understand SSA agricultural growth while basing on the tendency of productivity growth rate to converge or diverge trough countries (or regions).

Productivity mainly concerns land and labour factors. In this study we will focus our attention on labour factor which requires a mechanical technology, which allows accessing production increase and productivity targets while taking into account environmental impact and natural resources such as land or water. From where the concept of *green agricultural productivity*.

Our main research question is as follow:

What is the dynamics of green agricultural productivity distribution across SSA countries?

Thus we have three subsidiary questions: (i) Is agricultural production system in SSA countries efficient? (ii)Which evaluation of the green agricultural productivity in SSA countries? (iii)How did green agricultural productivity move through time and SSA countries?

3. Objectives

Our main object is to analyze the dynamics of green agricultural productivity growth through SSA countries. As subsidiary objectives:

- ✓ To estimate efficiency levels of agricultural production system in SSA countries
- ✓ To estimate green agricultural productivity index through SSA countries
- ✓ And then to determine path nature of the green agricultural productivity index3 trough time and SSA countries.

4. Literature Review

Several recent works in order to comprehend the economic growth, was based on the tendency of productivity growth rate to converge or diverge across countries (or regions) (Ball et al., 2001; Fare et al., 2006; Henderson & Russell, 2005; Liu, Shumway, Rosenman, & Ball, 2008; Managi & Karemera, 2004; McCunn & Huffman, 2000).

Rahman (2007), applied the sequential Malmquist index to calculate multi-lateral, multi-factor productivity (MFP) indices for agriculture in 16 regions of Bangladesh from 1964-1992 and examined convergence amongst regions. He found that productivity grew at an average rate of 0.9% per annum, led by regions with high level of Green Revolution technology diffusion. The growth mainly occurred due to technological progress estimated at 1.9% per year. Overall technical efficiency declined steadily at 1.0% per year due to falling efficiency in most regions in later years. Both cross-section and times-series tests confirm that divergence among regions disappeared and agricultural productivity reached convergence in the long-run.

Fare and al. (2006), analyzed the determinants of labour productivity in the European Union area and examines the extent to which convergence in output per worker is occurring among Member States (plus Norway) using a recursive common trends analysis and non-parametric kernel density methods. In broad terms, they found that labour and multifactor productivity have improved for most of the countries in their sample. Their cross-section and time series

convergence results are broadly consistent. Non parametric kernel-based estimates of output per worker and efficiency levels suggest that most convergence took place between 1965 and 1990. For time series evidence, they found evidence of convergence clubs; but which failed to support the hypothesis that EU area is a single convergence club.

Ball and al. (2001) decomposed aggregate productivity growth for the US farm sector into its state-specific sources and found that farm sector productivity growth is a function of productivity trends in the individual states. McCunn and Huffman (2000) tested for both beta and sigma convergence in state agricultural total factor productivity (TFP) growth rates and examined the contributions of public and private research and development (R&D) to convergence. The rate of beta convergence was found to be variable and depended on R&D state spillover, private R&D, and famers' education.

5. Method

Study of productivity convergence requires a benchmark country (or region) to set a standard against individual countries will be compared to. Much of the earlier work on the tests of convergence hypothesis used β-convergence approach (Ball et al., 2001; McCunn & Huffman, 2000; Mugera, Langemeier, & Featherstone, 2012; Rahman, 2007). In this approach, the convergence hypothesis involves testing that the coefficient of the output variable is less than zero, normally; countries with lower initial per capita income are expected to grow faster than countries with higher per capita income. Such an approach, aside from the obvious requirement of a large cross-sectional sample size, has been criticized on various grounds including the classical regression fallacy argument (Friedman, 1992; Quah, 1993). An alternative approach, and sufficient condition for β-convergence, known as σ-convergence, examines whether the dispersion of the (log) productivity distribution for a cross section of countries diminishes over time. While decreasing values of σ can be viewed as evidence towards convergence, it is in the case were this type of analysis is not on its own accord sufficient to establish convergence (Fare et al., 2006).

The methodology used in this study to assess the degree of convergence in output per worker seconds Fare and al. (2006), based on the cointégration analysis of Johansen (1988, 1991) and Hansen and Johansen (1999). It recognizes that labour productivity is generally a non-stationary

time series and convergence is a gradual process. Furthermore, cointégration of a group of non-stationary series is a necessary condition for convergence (Bernard & Durlauf, 1995).

First of all, productivity analysis will be done according to the decomposition of Kumar and Russell (2002). Then, a semi-parametric approach will be used to construct the best production practice frontier for a sample of SSA, and compute Malmquist productivity indexes and their decomposition into the underlying productivity components for each country. Finally, we will assess the individual contribution of the various components to the convergence in labour productivity.

Productivity index

For each period $t = 1, 2, \ldots, T$ we have $k = 1, 2, \ldots, K$ countries which use 2 inputs $X^{k,t} = (X_{1k}, X_{2k})$ to produce one output $y^{k,t} = (y_k)$. Following Fare et al. (1989), Malmquist productivity index is define as:

$$M_0(k', t, t+1) = \left[\frac{D_0^t(x^{k',t+1}, y^{k',t+1})}{D_0^t(x^{k',t}, y^{k',t})} \frac{D_0^{t+1}(x^{k',t+1}, y^{k',t+1})}{D_0^{t+1}(x^{k',t}, y^{k',t})}\right]^{1/2} \quad (1)$$

(1) Can be decomposed into two independent components, namely

Efficiency change = ECH = $\frac{D_0^t(x^{k',t+1}, y^{k',t+1})}{D_0^t(x^{k',t}, y^{k',t})}$ (2)

Technological change = TCH = $\left[\frac{D_0^t(x^{k',t+1}, y^{k',t+1}) D_0^t(x^{k',t}, y^{k',t})}{D_0^{t+1}(x^{k',t+1}, y^{k',t+1}) D_0^{t+1}(x^{k',t}, y^{k',t})}\right]^{1/2}$ (3)

Where we can write (1) as follow:

$$M_0(k', t, t+1) = MALM = ECH * TCH$$

Following Kumar et Russell (2002), we can also decompose the relative change in the output to labour ratio(y) between t and t+1, into (i) efficiency change, (ii) technological change, (iii) change in the capital to labor ratio (KCH) given by:

$$\Delta(y) = (y_k^{t+1}/y_k^t) = ECH * TCH * KCH$$

Convergence tests

It is clear that σ-convergence cannot be viewed on its own accord as evidence of convergence. Instead, we will use the recursive approach of Rangvid (2001) to analyze the convergence process. The idea is that an increasing number of cointégration relationships in output per worker for different countries may be regarded as an indicator of a process of closer integration. The recursive estimation method will be based on Hansen and Johansen (1999).

A vector error correction model (VECM) for k log output per worker variables (y), may be written as:

$$\Delta y_t = c + \sum_{i=1}^{l} \Gamma_i \Delta y_{t-l} + \Pi y_{t-l} + \varepsilon_t$$

Where c is a constant, Γ is the short-run dynamics matrix, Π is the long-run impact matrix summarizing all the long-run information in the y process and whose rank (r) determines the number of stationary linear combinations (cointégration vectors) of y_t, the vector ε_t is i.i.d with $N(0, \Sigma)$

Data

The sample will be constituted by 28 countries over the period from 1961-2013 of SSA, divided in 4 areas: West, Central, East and South Africa. In this study, the output (real GDP), labour and most capital series will be drawn from data developed at the World Bank.

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