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Agricultural Convergence Clubs in Africa Countries: A Note

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Research

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Abstract

The study investigates productivity club convergence to assess whether countries follow different African agriculture convergence trajectories. We employ cross country panel covering 1961-2012 across 48 countries with total factor productivity (TFP) as an indicator of agricultural productivity in the study. Empirical results show evidence of population divergence in agricultural TFP. Further analysis shows evidence of club convergence as countries follow different convergence trajectories. Specifically, the result identifies three different transition groups in the region's agricultural productivity convergence. Countries in the first and two groups show a convergence path, while countries in the third group exhibit a divergence path. A total of 16 and 28 countries in the sample converge into the first and second clubs. The implication of this is that efforts to intensify agricultural productivity might require club-specific attention. For instance, new agricultural technology diffusion might focus on countries within a specific club or group.

Keywords: Agricultural Productivity, Club Convergence, Panel data, Africa

Introduction

The importance of agriculture cannot be overemphasized as the cornerstone of Africa's economy. This is because agriculture employs over 60% of the African population and contributes around 20% to gross domestic product (GDP) in the region (CTA, 2012; Awokuse and Xie 2015). The contribution of agriculture to poverty reduction and food security in Africa has also been stressed in the literature (Liagoneta et al., 2018; Christianesen et al., 2011). Thus, making agriculture a critical component of programs that seek to reduce poverty and attain food security in the continent (Ogundari 2014). Given the significance of agricultural development in Africa, policymakers and academicians have always used agricultural productivity to gauge the region's performance. For instance, Alene (2010) reported an annual agricultural total factor productivity (TFP) growth rate of 0.2 percent based on 1970-2004 data in Africa. Based on the 1960-2006 data, Yu Nin-Pratt (2011) reported an agricultural yearly TFP growth rate of 1.6 percent in the region. Lusigi and Thirtle (1997) also estimated an agricultural TFP growth for Africa at a rate of 1.2 percent per year over 1961-1991. The consensus from these studies is that agricultural productivity in Africa has been increasing over the years, albeit at a slow rate.

The convergence hypothesis is widely used to show whether the equalization of economic indicators across countries over time exists. Evidence of convergence implies a reduction in dispersion or differences in economic variables across the countries over a certain period. The concept has been applied to indicators such as income per capita, total factor productivity, research and development, poverty, carbon emission, and nutrition (Ogundari and Ito, 2015; Bai et al., 2019; Churchill et al., 2019; Kindberg-Halon and Okou 2020; Ravallion 2012; Sala-i-Martin 1996; Regmi et al., 2008). Four different tests are used to investigate the convergence hypothesis in the literature. This includes beta convergence, sigma convergence, cointegration - unit root test, and club convergence tests. Beta convergence refers to when countries with low initial conditions grow faster than those with high initial conditions (Sala-i-Martin, 1996).[1] Sigma convergence refers to reducing the dispersion of an economic variable across countries (Philips and Sul 2007).[2]

[1] Beta-convergence tests are usually implemented by the regressing growth rate of an economic variable such as income per capita on an economic variable's initial value with or without other conditioning variables. A negative coefficient indicates evidence of convergence.
[2] Sigma convergence is implemented by regressing the coefficient of variation or standard deviation of an economic variable on the data's trend time. A negative coefficient indicates evidence of convergence.

Cointegration and unit root tests identify convergence when countries are close to their steady states (Pesaran 2007).[3] Club convergence test allows for a wide range of possible transition toward a long-run growth path (Philips and Sul 2007). The methodology does not support the hypothesis that all countries converge to a single equilibria state but rather follow different convergent tractories.

According to Philips and Sul (2007), there are methodological problems in testing convergence hypotheses using the first three tests highlighted above. Lichtenger (1999) noted that beta convergence might be misleading, especially when countries with low initial conditions grow so fast that they surpass regions with high initial conditions with a greater gap. Because time series data are used in convergence analysis, non-stationary data may increase variance, making it difficult to distinguish from divergence in sigma convergence (Philips and Sul (2007). Aspergis et al. (2012) argued that transitional dynamics could bias cointegration and unit root tests, thus misleading results if individuals converge to multiple steady-state equilibria. Club convergence test accommodates heterogeneity or unique transitional patterns across different countries to identify groups of the countries converging towards a common club trend (Philips and Sul (2007). The methodology has the advantage of identifying convergence that cannot be detected by beta and sigma convergence and cointegration tests (Churchil et al., 2019).

A few literatures have investigated the convergence hypothesis in African agriculture (Ogundari and Onyeaghala, 2021; Lusigi et al., 1998; Tian and Yu, 2019). And the results have been mixed. While Lusigi et al. (1998) found no evidence of convergence in African agricultural TFP, Ogundari and Onyeaghala (2021) found evidence of conditional beta-convergence. Their results also find no evidence of unconditional convergence of agricultural TFP in the study. Tian and Yu (2019) found no evidence of population convergence of crop yield in Africa. The authors also find the existence of convergence unto several clubs in the study. Since evidence of population convergence is not sufficient to assume the existence of club convergence,[4] the present study investigates club convergence in African agricultural total factor productivity.

[3] Convergence test based on cointegration and unit root approach is based on the data's evidence of stationary process.

[4] Philips and Sul (2007) argue that if a panel of economies fails to converge, this does not preclude convergence subgroups (clubs) within a panel.

The rest of the papers is structured as follows. Section 2 describes the data source and description. Section 3 focuses on the empirical model, while section 4 presents the results and discussion. Concluding remarks are provided in section 5.

2. Data source and description

The study employs a balanced panel of 48 countries covering 1961-2012 in Africa. The agricultural total factor productivity (TFP) index used as an indicator of agricultural productivity were obtained from the United States Department of Agriculture Economic Research Services website (USDA-ERS, 2018). We transformed the agricultural TFP levels to the logarithm. Figure 1 shows the distribution of the agricultural TFP (in logarithm) across each country included in the analysis. Specifically, the left-hand side figure shows evidence of variation in agricultural TFP levels over time across the countries. However, the right figure shows an increasing trend in Africa's average aggregate agricultural TFP level.

3. Empirical Model

The study employs Philips and Sul (2007) methodology to test whether agricultural productivity convergence exists across countries in Africa. Subsequently, we test the null and alternative hypothesis of convergence using the following regression:

$$log(H_1/H_t) = 2log[log(t)] = \delta + \beta log(t) + \mu_t \qquad 1$$

$$t = [rT], [rT] + 1, \ldots\ldots, T \ \ with\, r > 0$$

$$H_t = \frac{1}{N} \sum_{i=1}^{N} (h_{it} - 1)^2, \ h = \frac{X_{it}}{N \sum_{i=1}^{N} X_{it}}, \text{ and } \beta = 2\hat{\alpha}$$

$$H_0: \alpha \geq 0 \quad \text{and} \quad H_A: \alpha < 0$$

Where X_{it} represents the annual total factor productivity index for each country; β is the coefficient of $log(t)$; T is the number of years in the data; h_{it} represents the transmission parameters; r represents the fraction of time series; $\hat{\alpha}$ represents the least square estimate of α; the rejection of the null hypothesis of convergence at a 5% level of significance occurs when $t_\beta < -1.65$.

To identify club convergence in the panel, we employ the robust clustering algorithm proposed by Philips and Sul (2007).

4. Results and Discussion

Table 1 shows evidence of population divergence. For instance, the estimated t-statistic $t_\beta = -53.1695 < -1.651$ indicates that the null hypothesis of convergence is rejected, showing evidence that agricultural TFP does not converge across the full sample. Because evidence of population divergence might be that countries converge to multiple steady states, we carried out the club convergence test presented in Table 2. Given the estimated t-statistics of $t_\beta = 0.3299 >$ -1.651 and $t_\beta = 1.1209 > -1.651$ for the first and second clubs, respectively, the results show that the null hypothesis of convergence cannot be rejected. Thus, indicating evidence of convergence in agricultural TFP across countries in the first and second clubs. Specifically, the analysis shows that 16 and 28 countries in the first two groups follow a club convergence trajectory. The first club countries converge into one group with the highest agricultural TFP, while countries in the second club converge with moderate agricultural TFP levels. For instance, the average agricultural TFP for countries in the first and second clubs is about 1.17% and 0.96%, respectively. The convergence of countries in the first and second clubs to a common steady-state implies that differences in agricultural TFP levels among member clubs are removed in the long run. Also, with an estimated t-statistic of $t_\beta = -9.0570 < -1.651$, the results show that the null hypothesis of convergence is rejected across the countries in the third club. Specifically, 4 countries in the third group could not converge with other countries in the study. The average agricultural TFP for countries in the third club is 0.766%. These countries are assumed to have similar structural characteristics and exhibit divergence in productivity levels.

The results provide a mix of convergence and divergence clubs as countries with common characteristics follow the same trajectories. While club membership might be determined by climate, natural, economic, and even culture, we may not fully know why countries share the same club (Tian and Yu 2019). Hence, a literature review shows that this finding is consistent with the works of Lusigi et al. (1998) and Tian and Yu (2019).). While Lusigi et al. (1998) found evidence of divergence in African agricultural TFP growth using sigma convergence, Tian and Yu (2019) found evidence of population convergence in crop yield in Africa using sigma, beta, and club convergence analyses based on data covering 2000-2014. In contrast, Ogundari and Onyeaghala

(2021) found evidence of conditional beta convergence in African agricultural TFP using 1981-2010 data. Tian and Yu (2019) also found that crop yield converges into several countries' clubs, consistent with the study's finding.

These findings have enormous policy implications. The evidence of convergence into two different clubs in African agricultural TFP indicates that the agricultural productivity gap between countries in these groups has lessened over time in the region. It also suggests that countries further outside the two converging groups' technological frontier will likely have high rapid agricultural productivity growth. Also, the existence of a mix of convergence and divergence clubs of countries in African agricultural TFP shows that intensifying agricultural productivity might require club-specific attention. For instance, new technology and diffusion might focus on countries within a specific club or group, as countries in the same club share a common trend in agricultural productivity change. The finding could serve as an important input for policymakers aiming to improve agricultural production and food security in the region.

5. Concluding remarks

The study investigates productivity club convergence to determine whether countries follow different African agriculture convergence trajectories. The analysis employs cross country panel covering 1961-2012 across 48 countries. Using Phillips and Sul (2007) method to test agricultural productivity convergence, we reject the null hypothesis of population convergence but found evidence of club convergence in the study. In other words, African agricultural productivity converges to multiple steady-state equilibria in the study. Specifically, our result shows three different transition clubs in agricultural productivity convergence in the region. Countries in the first two groups follow a convergence trajectory, while countries in the last group exhibit a divergence path. The implication of this is that countries converge into different clubs with different agricultural TFP levels even with the rejection of population convergence in the study.

However, the measures that may offer explanatory power in determining convergence club can be linked-to functioning institutions such as availability of functioning credit markets, research and development (R&D), and effective extension services in the region. Hence efforts to intensify agricultural productivity might require club-specific attention. For example, efforts to boost agricultural production among countries in the first and second clubs might differ from those of the third club. Therefore, the agricultural productivity gap between countries in the first and second clubs has lessened, while the agricultural productivity gap between countries in the third club has increased. Hence, countries outside the club's technological frontier converging groups (i.e., first and second clubs) will likely have high rapid agricultural productivity growth.

Availability of data and materials

The data and the code used for the analysis will be made available upon request

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References

Alene, A. D. (2010). Productivity Growth and the effects of R&D in African Agriculture. *Agricultural Economics*, Vol. 41: 223-238.

Aspergis, N., C. Christou, and S. Miller (2012). Convergence patterns in financial development: evidence from club convergence. Empirical Economics, Vol. 43(3): 1011-1040.

Awokuse, T.O, and R. Xie (2015). Does agriculture matter for economic growth in developing countries? Canadian Journal of Agricultural Economics, Vol. 63: 77-99.

Bai. C., Y. Mao, Y. Gong, and C. Feng (2019). Club convergence and factors of per capita transportation Carbon Emissions in China, Sustainability Vol 11(2): 539.

Christiaensen, L., L. Demery, and J. Kuhl (2011). The (evolving) role of agriculture in poverty reduction? An empirical perspective. Journal of Development Economics, 96(2), 239–254.

Churchill. S. A, J. Inekwe, and K. Ivanovski (2019). Convergence of R&D intensity in OECD countries: evidence since 1870. Empirical Economics, Vol. 59, 295-306.

CTA (2012). Technical Centre for Agriculture (CTA) 's Policy Brief. Number 4 February 2012. Wageningen, The Netherlands

Kindberg-Halon. G and C. Okou (2020). Productivity Convergence: Is anyone catching up? Policy Research Working Paper 9378 World Bank Group, Washington DC.

Lichtenber, F. R (1994). Testing the convergence hypothesis. The Review of Economics and Statistics, Vol. 761(3): 576-579.

Ligon, E, and E. Sadoulet, E. (2018). Estimating the relative benefits of agricultural growth on the distribution of expenditures. World Development, 109, 417–428.

Lusigi, A., J. Piesse, and C. Thirtle (1998). Convergence of per capita income and agricultural productivity in Africa. Journal of International Development, Vol. 10(1): 105-115.

Lusigi, A, and C. Thirtle (1997). Total factor productivity and the effects of R&D in African Agriculture. *Journal of International Development* Vol. 9(4): 529-538.

Ogundari, K, and R. Onyeaghala (2021). The Effects of Climate Change on African Agricultural Productivity Growth Revisited, Environmental Science and Pollution Research, Vol.

Ogundari. K and S. Ito (2015). Convergence and determinants of change in nutrient supply: Evidence from sub-Saharan African countries. *British Food Journal,* Vol.117 (12): 2880-2898.

Ogundari. K (2014). The Paradigm of Agricultural Efficiency and its implication on food security in Africa: What does meta-analysis reveal? *World Development*, Vol. 64: 690-702., vol. 22(2): 265-312.

Pesearn, M. H (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, Vo. 22(2): 265-312.

Phillips, P.C.B, and D. Sul (2009). Economic transition and growth. J. Appl. Econom. Vol. 24, 1153–1185

Ravallion, M. (2012), "Why don't we see poverty convergence?", American Economic Review, Vol. 102 (1): 504-523.

Regmi, A., H. Takeshima, and L. Unnevehr (2008). Convergence in global food demand and delivery. Economic Research Report No. 56, USDA, Washington, DC.

Sala-i-Martin, X. (1996). The classical approach to convergence analysis. The Economic Journal, Vol. 106 No. 437, pp. 1019-1036.

Tian. X and X. Yu (2019). Crop yield gap and yield convergence in African countries. Food Security, Vol. 11: 1305-1319.

USDA-ERS (2018). International Agricultural Productivity. https://www.ers.usda.gov/data-products/international-agricultural-productivity/

Yu, B, and A. Nin-Pratt (2011). Agricultural Productivity and Policies in sub-Saharan Africa. IFPRI Discussion paper No. 01150 Washington DC.

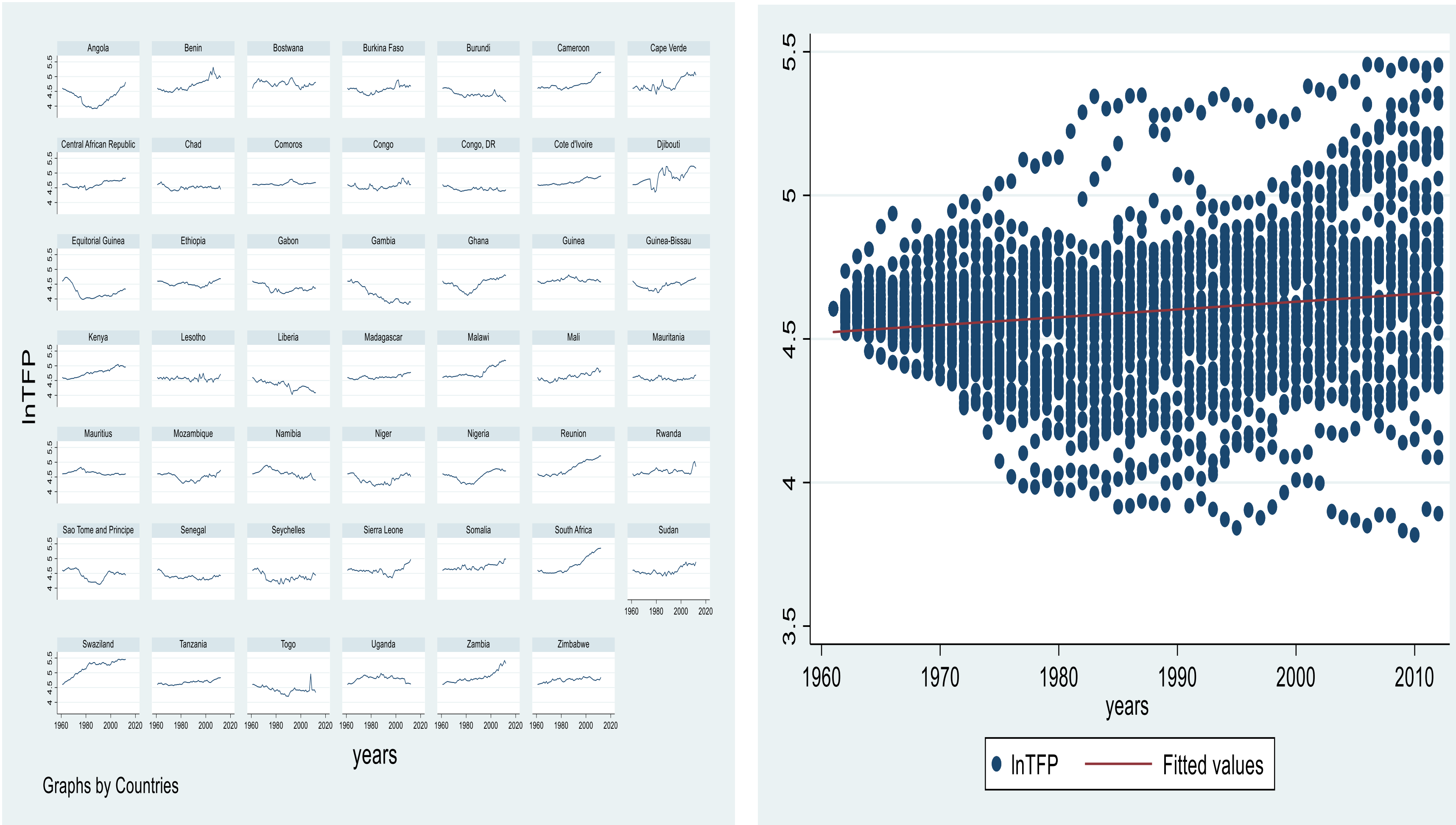

Figure 1: Distribution of the agricultural TFP levels across the countries

Table 1: productivity Convergence test in Agricultural Total Factor for all countries

Variable	b-coefficient	Std. Error	t-statistics
Full sample (48)	-1.1922	0.0224	-53.1695

With one-sided null hypothesis, $\beta \geq 0$ and $\beta < 0$, we employ the critical value: $t_{0.05} < -1.651$ in all cases.

Table 2: Club convergence test for Agricultural Total Factor productivity

Clubs	Transition (#)	Country	b-coefficient	t-statistics
1	Convergence (16)	Angola, Benin, Cameroon, Cape Verde, Cote d' Ivore, Djibouti, Ghana, Kenya, Malawi, Nigeria, Reunion, Somalia, South Africa, Sudan, Swaziland, Zambia	0.0605 [0.1833]	0.3299
2	Convergence (28)	Botswana, Burkina Faso, Central African Republic, Chad, Comoros, Congo DR, Equatorial Guinea, Ethiopia, Gabon, Guinea, Guinea-Bissau, Lesotho, Madagascar, Mali, Mauritania, Mauritius, Mozambique, Nambia, Niger, Rwanda, Sao tome and Principe, Seychelles, Sierra Leone, Tanzania, Togo, Uganda, Zimbabwe	0.1412 [0.1259]	1.1209
3	Divergence (4)	Burundi, Gambia, Liberia, Senegal	-2.7388 [0.3024]	-9.0570

With one-sided null hypothesis, $\beta \geq 0$ and $\beta < 0$, we employ the critical value: $t_{0.05} < -1.651$ in all cases; Standard error in parenthesis

Figures

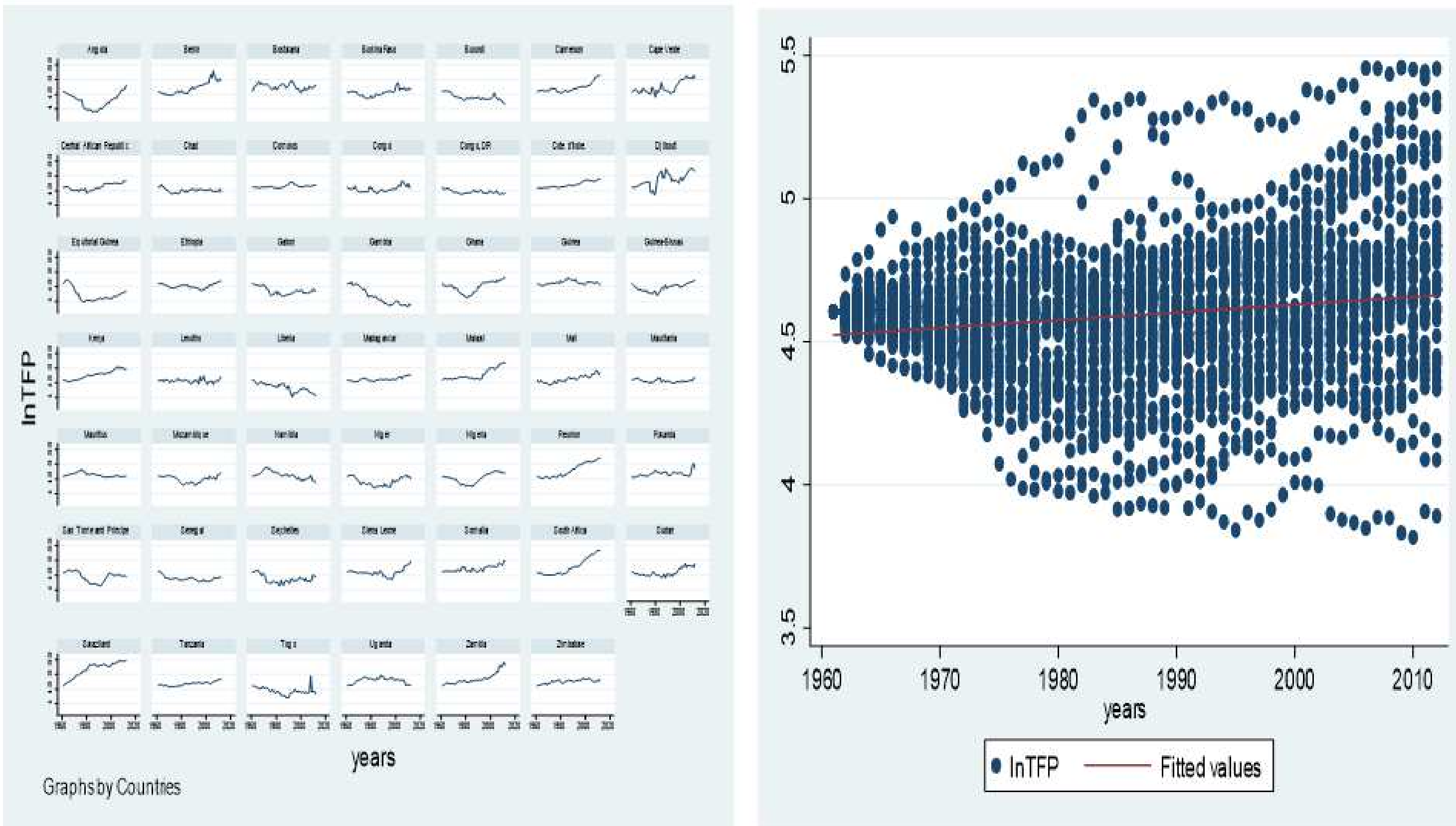

Figure 1

Distribution of the agricultural TFP levels across the countries