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ARE CROP YIELD GAPS NARROWING ACROSS COUNTRIES? A STUDY BASED ON EXPLORATORY ECONOMETRIC ANALYSIS

Debabrata Mukhopadhyay
West Bengal State University, Department of Economics, India
Email: debu1641975@yahoo.co.in ORCID ID:0000-0002-3159-8928

Abstract:

This study investigates the convergence hypothesis in crop yield of three major kinds of cereal in the world in terms of output production and cereal grain consumption namely rice, wheat and maize during the period 1961 to 2016 across the countries using the conventional analysis of convergence based on modern time series analysis. This has been done first by applying the conventional indicator namely standard deviation. This conventional sigma convergence indicator shows an absence of convergence for all the three crops showing a upward or no trend, thus the paper finds that rice and wheat yield gaps remain on average constant during years, and the maize yield gaps tend to increase. The paper also analyzes the anatomy of those patterns obtained in terms of the evolution of crop yield distribution and club convergence using Markov transition dynamics.
Keywords:*Crop yield, sigma convergence, club convergence, dynamics of distribution, Markov transition dynamics.*
JEL Codes:*Q1, Q18, C23, O47.*

1. Introduction

Raising crop yield (output per unit of land area cropped) has remained a key factor to eliminating food shortages given limited land resources throughout the world, in particular, developing world(Tian & Yu, 2019).This study also noted wide variations in crop yields across regions. Now, the issue on whether the dispersion of crop yield levels are widening or narrowing around the world has important implications for assessing the potential changes in the pattern of trade of specific agricultural products, apart from forecasting yields(Trueblood & Arnade 2001). However, the evidence of convergence of agricultural productivity has been mixed in the world on regional basis. For instance, while investigating the progress and prospect of agricultural productivity convergence, Gong(2020) observed that agricultural convergence has not achieved in China, even after 40 years of reform. While examining the productivity convergence of Brazil, Magalhaes &Diao(2009) observed conditional convergence in three major crops namely maize, rice and wheat based on generalized entropy index.

The global demand for cereal crops is expected to roughly double by 2050, driven by factors such as increases in population, meat and dairy consumption and biofuel (see for instance, Godfray et al. (2010), Tilman et al. (2011), Ray et al(2012)). However, the total global crop production had increased by only 28% from 1985 to 2005, whereas the net expansion of cropped area was 2.5%, increase in frequency of cultivation was 7% , and the major factor for this growth in crop production came from an average 20% growth in crop yields per hectare (Foley et al. (2011). Based on these observations, it may be pointed out that gains in global crop production can be met largely by growth in crop yield.

Again, some authors have suggested that yields for many important crops may be stagnating in some regions around the world (Cassman 1999; Finger(2010)). In this backdrop, it may be worthwhile and interesting to examine whether yield gap across the countries in the world's major cereal crops, including maize, rice and wheat, are declining over time for the period 1961 to 2016.

Christiensen and Yee (1964) in a study on how improvement in agricultural productivity contributed the national economic growth of an imaginary country stated that increase in agricultural productivity comes from two sources: use of additional inputs, and increased productivity resulting from improved technology. They argued that increases in agricultural productivity contribute to national economic development and growth in three major ways: supply of an economic surplus for consumption and production in agriculture or capital formation; the release of labour and other resources for use in non-agricultural sectors; and the resulting increase in purchasing power of rural people, expand markets for industrial products, and structural changes needed for national economic growth. In a similar but more recent study Chang et al. (2006) observed the important role of agriculture in the economic growth of Nigeria. Ruttan (2002) argued that increases in agricultural production, both from crops and animals initially were attributed to increases in the area cultivated but towards the end of the the twentieth century, growth is coming from increases in land productivity – in output per acre or hectare.

Agricultural growth has a pivotal role to play in contributing to an economy's development, especially for developing countries. It is well accepted that agricultural growth is central to development (Gollin et al. (2002)). It is also observed in that work that those countries which are experiencing increases in agricultural productivity will have a shift of workers from the agricultural to the nonagricultural sector. They concluded in their paper that low agricultural productivity can substantially delay industrialization.

This delay might result in low per capita income of the country compared to that of the leader. They further noted that a greater understanding of the determinants of agricultural productivity will improve our understanding of the development process among poor nations. In the context of Asia, researchers have concluded that in most of Asia, agricultural growth has tended to be much pro-poor compared to growth in the modern industrial or service sector (see, for example, Timmer 2005).

The basic objective of this paper is to study the crop yield convergence of three largest commodity crops in the world viz., rice, wheat and maize during 1961 to 2016 by following the conventional analysis of convergence based on standard regression and time series analysis. This study also analyzes the anatomy of those patterns in terms of dynamics of distribution of crop yields across countries to understand whether the distributions are showing clusters and subgroups which have important implications in terms of polarizations or stratification due to Quah(1996).

Agriculture in developing countries is also at a crossroad. Technology-based revolution in agriculture has significantly increased yield in major foodgrains items, especially, rice, wheat and maize, in many parts of the world. However, with time, technology spillover and research and development spillover are expected to have touched the other parts of the world and other items of foodgrains as well. The study of yield convergence in agriculture is very important for not only assessing future yield but also to assess the future pattern of trade of the specific agricultural product. It is also relevant to note, in this context, that the world is focusing on productivity growth to fuel agricultural growth (Barrios and Nalica (1997)). It would, therefore, be worthwhile and interesting to investigate if there is evidence of convergence amongst the major foodgrains producing countries of the world in yields of major crops stated above.

The literature on convergence analysis related to agriculture is vast and comprehensive but those are mostly country specific. For instance, Mukherjee & Kuroda(2003) explored the question of convergence in (total factor productivity)TFP in agriculture across fourteen major agricultural states of lndia using the data covering the period 1973-1993, and found evidence of sigma convergence and conditional beta convergence. Mukhopadhyay & Sarkar(2015) found evidence of beta convergence but not sigma convergence of per capita foodgrains production across Indian states over the period 1991-92 to 2011-12 by following modern panel data analysis. Chatterjee (2016) found that per capita income from agriculture has converged across Indian states and finds evidence in favour of beta convergence. In another important study Somasekharan et al.(2011) observed that during 1971-2007, Indian states have exhibited sigma divergence in per capita agricultural output. Kijek et al(2019) had shown that convergence occurred in agricultural productivity almost in all European Union(EU) member states (except Belgium and the United Kingdom) during 2004-2015. To test the convergence of agricultural land prices across Polish provinces, Tomal & Gumieniak(2020) found that agricultural land prices tend to converge in relative terms.

To address the empirical question of convergence of income, output, crop yield etc. there are two measures of convergence, namely, sigma-convergence and beta-convergence that are commonly used in theoretical and empirical analyses of growth and convergence literature. The simplest testable version may be checking whether a statistic of the distribution that measures dispersion (standard deviation, coefficient of variation, Gini index, Theil index, etc.) diminishes over time. Such an approach had been known long before Barro and Sala-i-Martin, who gave it name “sigma-convergence” in the context of economic growth. For testing the sigma-convergence in line with conventional approach , we have first examined the time trend in the values of each of standard deviation computed for the cross-sectional logarithm (natural) series of productivity, the data for which are obtained in terms of output per unit of cropped area(hectogram per hectare cultivated area) for each major crop namely rice, wheat and maize.

Despite the literature’s stress on beta-convergence, economists have pointed out that it is not a sufficient condition for σ-convergence (Barro & Sala-i-Martin, 1992). Moreover, Quah (1993) and Friedman (1992) both suggest that sigma-convergence is of greater interest because it speaks directly as to whether the distribution of income(output) across economies is becoming more equitable.

We have, thereafter, examined the presence of sigma convergence by using the time series analysis of crop yield series in logarithm for rice, wheat and maize. We also analyze the evolutions of crop yield distribution over the decades and examine the presence of club convergence by Markov transition matrix for each crop.

Based on such analyses, if a conclusive finding on convergence in crop yield is obtained, then apart from inter-country agricultural policy issues concerning cereals, this empirical result should be useful for the solution to the major problem of finding surplus agricultural land required for rapid industrialization in the developing world. This paper has been organized as follows.

The next section deals with the econometric methodology. Data and empirical results are discussed in Section 3. Summary and conclusions are given in Section 4.

2. The Methodology

Methods used in macroeconomic models concerning income growth convergence are applied to the growth of agricultural crop yields worldwide (Trueblood & Arnade 2001). Two concepts of the convergence hypothesis, namely, sigma convergence and beta-convergence, exist in the literature. In the context of crop yield, sigma convergence occurs when cross-sectional dispersion measured by the standard deviation and/or coefficient of variation of the logarithm of crop yield across the countries tends to decline over time. This can be verified by running a regression of either or both of the cross-sectional dispersion measures over time.

The other notion of convergence i.e., beta-convergence, applies when a poor country tends to 'catch up' the richer ones in terms of average yield. Sala-i-Martin (1996) pointed out that beta convergence is necessary but not a sufficient condition for achieving sigma convergence. Beta convergence is necessary but not sufficient condition for sigma convergence (Paas & Schlitte, 2006). According to Monfort (2008), this happens "either because economies can converge towards one another but random shocks push them apart or because, in the case of conditional Beta-convergence, economies can converge towards different steady states." However, the regression based approach of convergence has been criticized by Quah(1993), and many others on several grounds. Most important reason is that the regression parameter of interest is biased towards convergence due to Galton's fallacy.

We first report the specification of test regression towards sigma-convergence. As already stated that sigma convergence implies a declining trend of cross sectional dispersion of the concerned variable, here, crop yield.

Assuming $y_{k,it}$ as the crop yield(in natural logarithm)of the kth crop(k =1,2 and 3, for rice, wheat and maize respectively), we define $\sigma_{k,t} = \sqrt{\frac{1}{n_k}\sum_{i=1}^{n_k}(y_{k,it} - \bar{y}_{k,t})^2}$ as the standard deviation(sd)of the *k*th crop yield, at time point *t*.

We, thereafter, examine the stationarity status of the dispersion, standard deviation for each crop at both level and first difference by applying the augmented Dickey Fuller(ADF) unit root test which assumes difference stationary in the null hypothesis., and then run three separate first order auto-regression(AR(1)) for each crop which takes into account autocorrelation as follows.

$$\sigma_{k,t} = a_0^k + a_1^k t + \theta_1^k \sigma_{k,t-1} + e_{1t}^k,\ k = 1,2,3;\ t = 1,2,....,\ n_k \qquad (1)$$

where, e_1^k 's are assumed to be white noise with zero mean and variances, σ_{1k}^2, respectively for each *k*th model. For the above models, the null hypothesis of 'no sigma-convergence' refers to a_1^k =0 for each *k*th model, while significant negative(positive) values of these coefficients denote sigma-convergence(divergence) under the alternative hypotheses. These models have taken care of the dynamical consideration of the dispersion series by considering autoregressive structure.

We now discuss the distribution dynamics related to the issue of convergence. In this approach, we look at the world crop yield distribution's changing shape instead of econometric models for examining the state of convergence for major world crop. We have used Kernel density estimation assuming Gaussian distribution of crop yield distribution for each crop(in natural logarithm) over the decades namely 1961,1971, 1981, 1991, 2001, 2011 and 2016, and examine whether there is the existence of 'twin peaks' i.e., bimodal distribution to demonstrate the presence of 'club convergence' where there will be two separate groups for ' high crop yield countries' and' low crop yield countries'. This approach also enables us to understand whether the distribution of crop yield across countries have become equitable or not in terms of skewness and kurtosis over the decades.

We also follow the convergence approach that examines the evolution of crop yield distribution over decades using a Markov Switching matrix. The matrix captures how countries moved among five tiers of crop yield relative to the largest yield country. This approach enables us to examine whether distribution dynamics have been steady over the decades.

3. Data and Empirical Results

The data reported under the element yield represents the harvested production per unit of harvested cropped area for each crop. The data on crop yield (also called productivity) (unit: hectogram/hectare) has been defined here as output per unit of cropped area (hg/ha) for each major crop namely rice, wheat, maize for all the countries during the period 1961 to 2016, have been collected from the FAOSTAT of the (http://www.fao.org/faostat/en/#data/QC) of the Food and Agricultural Organization (www.fao.org). Considering the availability of data during this period, we have chosen 99 countries for rice yield, 86 countries for wheat yield and 130 countries for maize yield. The countries belonging to erstwhile Soviet Union along with some other countries could not be included in the analysis due to non-availability of the dataset for the whole period of 1961 to 2016.

Cereals are the most important staple food in the world and the rich sources of protein contributing nearly 45% of our total protein intake. More than 50% of world daily caloric intake is derived directly from cereal grain consumption (Awika 2011). Apart from direct cereal consumption, in affluent regions like the U.S.A., cereals contribute significant additional indirect calories as sweeteners, particularly corn syrup-based sweeteners. Three major kinds of cereals namely, wheat, maize and rice take up the largest areas under cultivation and yield the highest quantities of output which are predominantly used for food and animal feed production. In terms of area under cultivation, total production and trade, it may be pointed out that rice, wheat and maize are the principal crops in major parts of the world. We have presented the list of countries selected for the study of convergence of yield of each of the three major cereal crops namely rice, wheat and maize in the Annex I in the Appendix. As already pointed out that our study covers the period 1961 to 2016 and selected 99 countries for rice yield, 86 countries for wheat and 130 countries for maize.

Table 1. Summary Statistics of the Three Cereals for the Five Major World Producers in 2016

Country Name	Crop Item	Share in World Production(%) in 2016	Annaul average Growth Rate in Production (1961-2016)	Annual average Growth Rate in Yield (1961-2016)	Yield per Hectare in 2016
China	Rice	28.13%	2.78%	4.18%	6856.3 kg
India	Rice	21.65%	2.06%	2.65%	3790.2 kg
Indonesia	Rice	10.49%	5.57%	3.58%	5235.9 kg
Bangladesh	Rice	6.67%	2.50%	3.09%	4586.3 kg
Vietnam	Rice	5.70%	3.79%	3.53%	5573.8 kg
China	Wheat	17.79%	5.41%	15.73%	5396.2 kg
India	Wheat	12.32%	13.44%	4.67%	3033.9 kg
Russian Federation	Wheat	9.80%	-------	--------	2685.4 kg
USA	Wheat	8.39%	1.59%	2.19%	3540.8 kg
Canada	Wheat	4.29%	5.76%	6.56%	3470.2 kg
USA	Maize	34.97%	5.84%	3.27%	10960 kg
China	Maize	23.97%	24.79%	7.34%	5966.7 kg
Brazil	Maize	5.83%	11.09%	4.12%	4288 kg
Argentina	Maize	3.62%	13.1%	5.84%	7442.7 kg
Mexico	Maize	2.57%	6.41%	4.99%	3718 kg

Note: #the data on Russian Federation was not available in 1961 as it was a part of Soviet Union which was disintegrated in December, 1991.

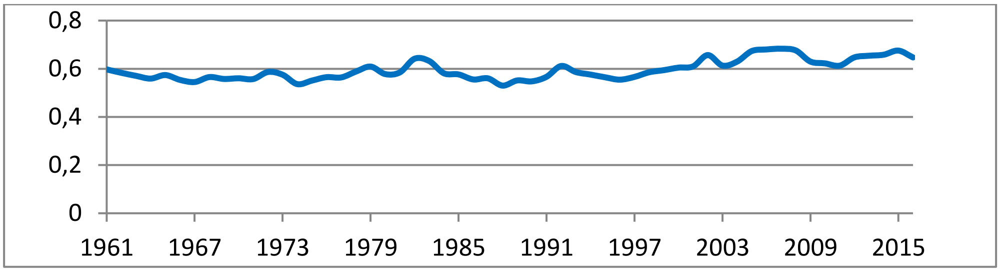

Figure 1. Sigma Convergence based on Standard Deviation of Rice Yield of 99 Countries for the Period 1961-2016

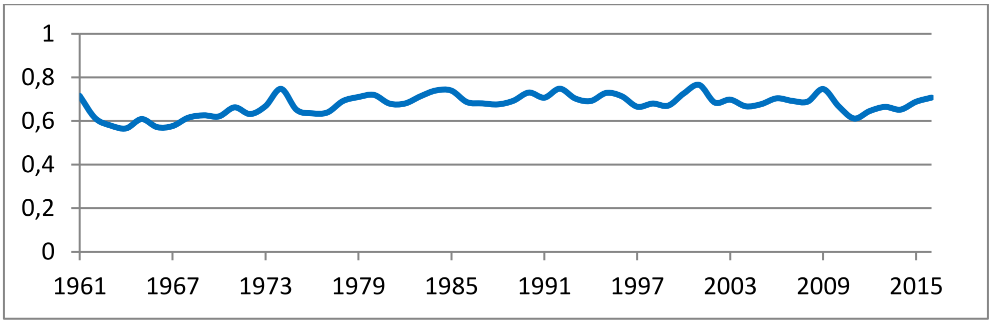

Figure 2. Sigma Convergence based on Standard Deviation of Wheat Yield of 86 Countries for the Period 1961-2016

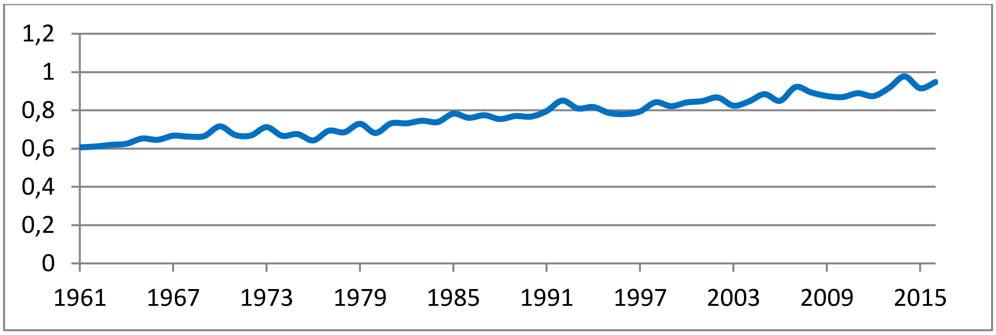

Figure 3. Sigma Convergence based on Standard Deviation of Maize Yield across 130 Countries over 1961-2016

We first present the summary pictures of output growth and growth of yield for the five major producers of the three crop items considered in our study as displayed in table 1 above. For two major kinds of cereal namely rice and wheat, two countries China and India together have 50% and 30% shares in world production, respectively. However, in terms of output growth and yield growth, China has a better performance compared to India during the period 1961 to 2016. But China has been experiencing very slow growth in the cropped area in recent times. Again, in terms of present yield (kg/hectare) for both the crops China is ahead of India. It should be further noted that Indonesia has notable performance in enhancing output growth by increasing both higher land productivity as well as increasing area under crop.

Then we present the results on sigma convergence diagrammatically in Figures 1 through 3 for rice, wheat and maize, respectively. The line diagram of cross-sectional standard deviations of the logarithm of Rice yield for the major 99 countries over the period 1961 to 2016 is presented in Figure 1 above. This shows a somewhat upward trend indicating increasing standard deviations which implies the absence of sigma convergence rather increasing yield gap among the rice- producing countries. The value of the standard deviation has gone up from 0.597 in 1961 to 0.647 in 2016.

Although cross-sectional standard deviation of wheat yield across the globe fluctuate rather than showing a steady decline or rise the same is not true for maize yield. Rather, these values increased over time.

Table 2.Unit Root Test Results of Cross-sectional Standard Deviations for Three Crops

Dispersion Series	**ADF Test Statistic Value**		***p*-value**		**Deterministic Component**	
	Level	First diff.	Level	First diff.	Level	First diff.
Rice yield	-3.347	-7.683	0.069	0.000	*constant, trend*	*constant*
Wheat yield	-4.038	------	0.013	------	*Constant, trend*	------
Maize yield	-6.611	-------	0.000	------	*Constant, trend*	--------

Table 3. Regression Results on Sigma Convergence based on Standard Deviation

Dependent Variable: Standard Deviation of Rice Yield $(\sigma_{1,t})$				
Variable	Coefficient	Standard Error	*t*-statistic	*p*-value
Constant	0.173543	0.052874	3.282196	0.002
$\sigma_{1,t-1}$ σ	0.676170	0.096744	6.989301	0.000
t	0.000680	0.000250	2.721429	0.009
Adj. R^2 =0.737; *Q*(1)*=0.162(0.688) ; Q*(2)=0.746(0.689) ; *Q*(3)*=1.302(0.729) *Q*(4)*=1.718(0.788)				
Dependent Variable: Standard Deviation of Wheat Yield $(\sigma_{2,t})$				
Variable	Coefficient	Standard Error	*t*-statistic	*p*-value
Constant	0.281547	0.071473	3.939196	0.0002
$\sigma_{2,t-1}$	0.553075	0.110690	4.996609	0.0000
t	0.000703	0.000330	2.130258	0.0379
Adj. R^2 = 0.453 ; *Q*(1)*=0.617(0.432) ; Q*(2)=0.781(0.677) ; *Q*(3)*=1.689(0.639) *Q*(4)*=1.701(0.791)				
Dependent Variable: Standard Deviationof maize Yield($(\sigma_{3,t})$				
Variable	Coefficient	Standard Error	*t*-statistic	*p*-value
Constant	0.606653	0.006356	95.43984	0.0000
t	0.005774	0.000194	29.76175	0.0000
Adj. R^2 = 0.941 ; *Q*(1)*=0.386(0.535) ; Q*(2)=1.276(0.528) ; *Q*(3)*=1.884(0.597) *Q*(4)*=3.571(0.467)				

Notes: Q(.) indicates Ljung Q statistic values with values in parentheses indicate p-values.

Before going into the regression analysis of sigma-convergence, we have tested the unit root test of the standard deviation of rice, wheat and maize yield, and reported these results in table 2 above. All the series of dispersions are found to be trend stationary. The regression results of sigma convergence based on standard deviation are reported in Table 4 for all the three crops. We can demonstrate from these results that highly significant positive trend has been found for all the three crops. These results clearly suggest the absence of sigma convergence in three major crop yield across the world during the period 1961 to 2016. Autocorrelations have been taken care of in the regression analysis. The autocorrelation test Q(.) statistics values reported in the table 3 above show that for none of the lag values, the null hypothesis of 'no-autocorrelation' can be rejected.

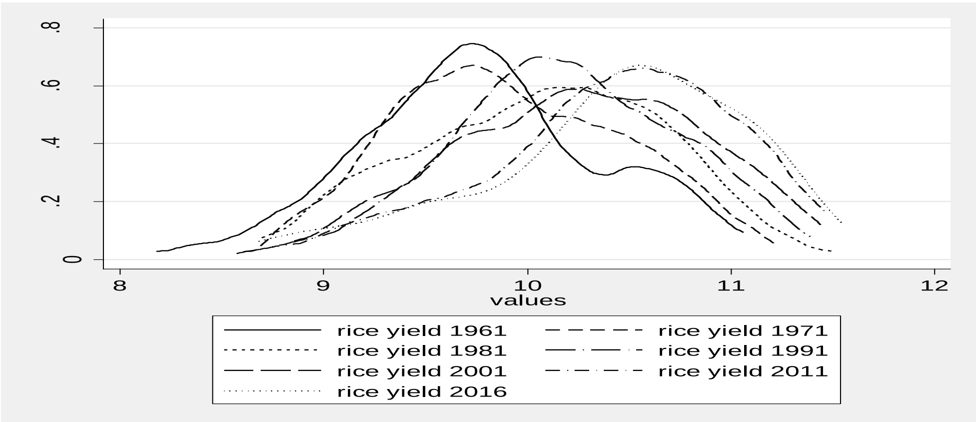

Figure 4. Evolution of Distribution (Kernel Density) of Rice Yield (in Natural Logarithm) over Decades

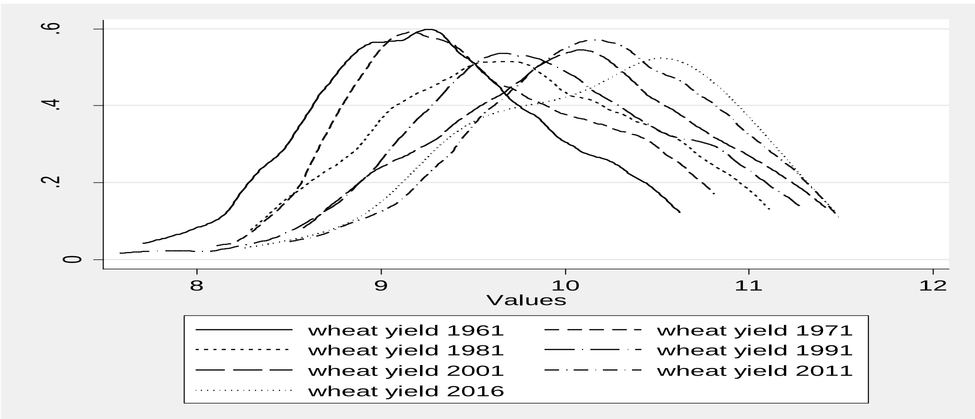

Figure 5. Evolution of Distribution(Kernel Density) of Wheat Yield (in Natural Logarithm) over Decades

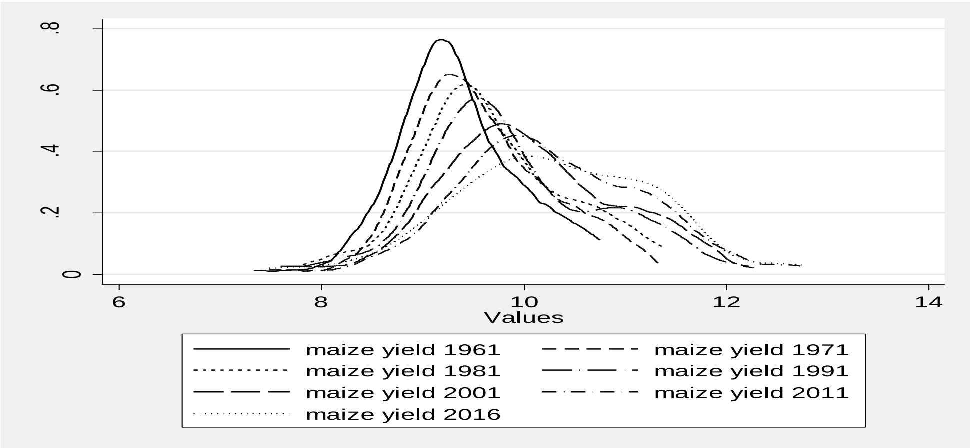

Figure 6. Evolution of Distribution (Kernel Density) of Maize Yield (in Natural Logarithm) over Decades

There are interpretations that if distributions are 'twin-peaked' or bi-modal then there exists club convergence. Our results depicted in figures 4 through 6 demonstrate concerning kernel density under Gaussian assumption over six decades for all the three crop yields that there does not exist any bi-modal distribution for any of the series thereby indicating absence of 'club convergence' except bimodality for rice yield in the year 1961.

In each figure, kernel density is measured along the vertical axis and values of the crop yield(in logarithm) is measured on the horizontal axis. Moreover, the evolution of distributions also shows that distributions are becoming more skewed and fat-tailed indicating higher inequality of crop yield across countries over the decades. Therefore, the absence of sigma-convergence is also being substantiated by the evolution of distributions.

Now to examine whether distribution dynamics have been steady, we have used the Markov switching matrix. The evolution of convergence dynamics for all the three crop yields are presented in figures 7 through 9 with crop yield relative to the highest yield country for that year. Our results include six decades namely, 1961, 1971, 1981, 1991, 2001, 2011 and 2016.

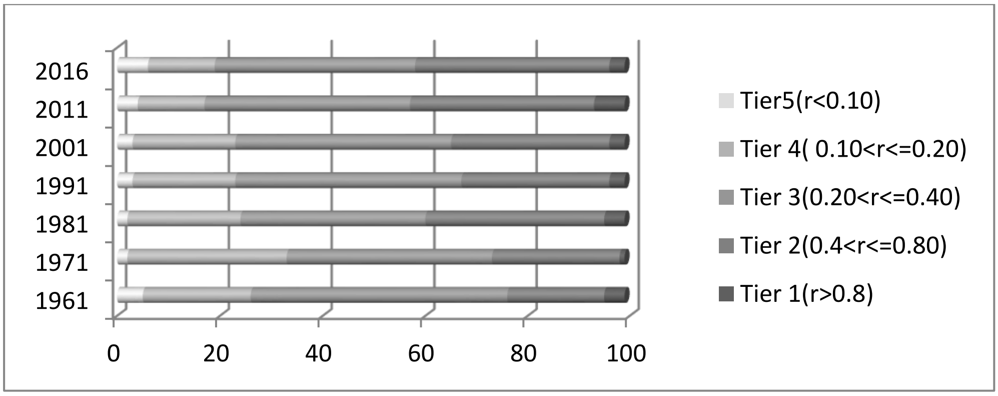

Figure 7. Evolving Convergence Dynamics across 99 Countries of Rice Yield Crop Yield elative to the Highest Yield Country in that Year

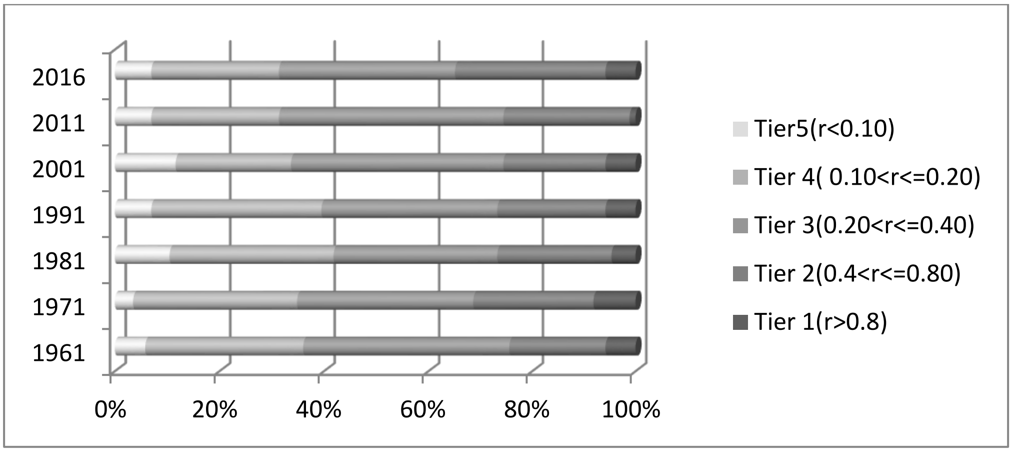

Figure 8.Evolving Convergence Dynamics across 86 Countries of Wheat Yield Crop Yield relative to the Highest Yield Country in that year

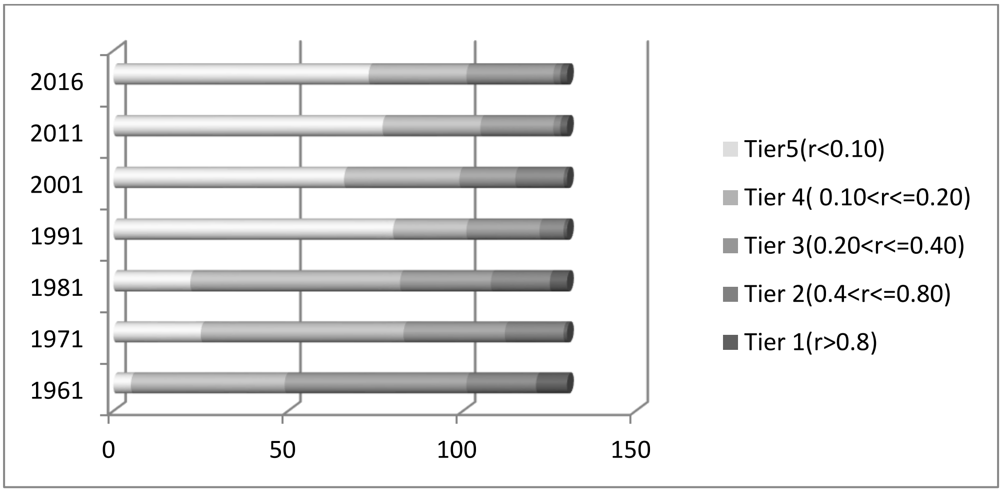

Figure 9.Evolving Convergence Dynamics across 130 Countries of Maize Yield Crop Yield relative to the Highest Yield Country in that year

The Markov transition matrix for six tires are presented where tier 1 refers to countries with relative yield ratio of greater than 0.8 indicating high yield countries, tier II refers to middle yield countries with relative yield ratio between 0.4 to 0.8, tier III refers to relative yield ratio between 0.2 to 0.4. Other two tiers(IV & V) refer to countries with low relative yield ratios of between 0.2 to 0.1, and below 0.1, respectively. The dynamics of distribution for rice and wheat yield are found to be stable over the decades as shown in figure 7 and 8, respectively. Distribution of countries in terms of different tiers remain stable. However, the dynamics distribution concerning maize yield is found to be highly unstable as shown in figure 9.

4. Conclusions

This study investigates the convergence hypothesis in the crop yield (in terms of output per unit of cropped area) of major cereals in the world namely rice, wheat, maize during the period 1961 to 2016 across the globe using sigma-convergence, the evolution of the distribution of crop yield and club convergence. This has been done by applying the modern econometric tools available for time series analysis, kernel density function and Markov transition matrix.

The sigma convergence measures show a positive trend over time implying the absence of convergence in crop yield of major cereals in the world. The kernel density estimation of crop yield distribution over decades shows no 'twin-peak' distribution i.e., single-peaked, skewed and fat-tailed distribution implying an absence of club convergence but higher inequality in yield distribution for all the major crops.

The dynamics of distribution in terms of Markov transition matrix demonstrate that rice and wheat yield distributions across different tiers of relative yield ratios are stable over decades but for maize yield, the dynamics are highly unstable.

Finally, this empirical evidence on convergence in crop yield of major cereals demonstrates that these countries do not converge to their steady-state equilibrium and thus indicate constant yield-gap across the countries for rice and wheat yield, and increasing yield-gap for maize yield for the period 1961 to 2016. This study also observes that there is no club convergence for any of the three crops considered in the analysis. In essence, the paper finds that the rice and wheat yield gaps remain on average constant during 56 years, and the maize yield gaps tend to increase. The study has also analyzed the anatomy of the patterns obtained (e.g., the evolution of the crop yield distribution, the issue of convergence clubs). It is true that achieving yield-gap closure has a multidimensional perspective including social, political and economic factors, but at the global level through proper coordination and adoption of appropriate technology and strategies this issue may be resolved which has important implications for food security in many parts of the world. It may be pointed out that it is possible to reduce rural poverty in the developing world by reducing productivity gaps in major cereal yield.

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Appendix

Annex I. List of Countries selected under different crops

Countries Selected for Rice Yield (99 Countries : Period 1961-2016 (Annual))
Afghanistan, Algeria, Angola, Argentina, Australia, Bangladesh, Belize, Benin, Bhutan, Bolivia, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Central African Republic, Chad, Chile, China, China (mainland), China(Taiwan Province), Colombia, Comoros, Congo, Costa Rica, CÃ´te d'Ivoire, Cuba, Democratic People’s Republic of Korea, Democratic Republic of the Congo, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, France, French Guiana, Gabon, Gambia, Ghana, Greece, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, India, Indonesia, Iran, Iraq, Italy, Jamaica, Japan, Kenya, Lao People's Democratic Republic, Liberia, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mexico, Morocco, Mozambique, Myanmar, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Republic of Korea, Romania, Senegal, Sierra Leone, South Africa, Spain, Sri Lanka, Eswatini, Thailand, Timor-Leste, Togo, Trinidad and Tobago, Turkey, Uganda, Tanzania, USA, Uruguay, Venezuela, Vietnam, Zimbabwe
Countries Selected for Wheat Yield (86 Countries : Period 1961-2016 (Annual))
Afghanistan, Albania, Algeria, Angola, Argentina, Australia, Austria, Bangladesh, Bhutan, Bolivia, Brazil, Bulgaria, Burundi, Canada, Chad, Chile, China, China (mainland), China(Taiwan Province), Colombia, Cyprus, Democratic People’s Republic of Korea, Democratic Republic of the Congo, Denmark, Ecuador, Egypt, Finland, France, Germany, Greece, Guatemala, Honduras, Hungary, India, Iran, Iraq, Ireland, Israel, Italy, Japan, Jordan, Kenya, Lebanon, Lesotho, Libya, Malawi, Mali, Malta, Mauritania, Mexico, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, Netherlands, New Zealand, Niger, Nigeria, Norway, Oman, Pakistan, Paraguay, Peru, Poland, Portugal, Republic of Korea, Romania, Rwanda, Saudi Arabia, South Africa, Spain, Sweden, Switzerland, Syrian Arab Republic, Tunisia, Turkey, United Kingdom, Tanzania, USA, Uruguay, Venezuela, Yemen, Zambia, Zimbabwe
Countries Selected for Maize Yield (130 Countries : Period 1961-2016 (Annual))
Afghanistan, Albania, Algeria, Angola, Argentina, Australia, Austria, Bahamas, Bangladesh, Barbados, Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Canada, Central African Republic, Chad, Chile, China, China (mainland), China(Taiwan Province), Colombia, Comoros, Congo, Costa Rica, CÃ´te d'Ivoire, Cuba, Democratic People’s Republic of Korea, Democratic Republic of the Congo, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, France, Gabon, Gambia, Germany, Ghana, Greece, Grenada, Guam, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, India, Indonesia, Iran, Iraq, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Lao People's Democratic Republic, Lebanon, Lesotho, Libya, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Myanmar, Namibia, Nepal, Netherlands, New Caledonia, New Zealand, Nicaragua, Niger, Nigeria, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Puerto Rico, Republic of Korea, RÃ©union, Romania, Rwanda, Saint Vincent and the Grenadines, Sao Tome and Principe, Saudi Arabia, Senegal, Sierra Leone, Somalia, South Africa, Spain, Sri Lanka, Suriname, Eswatini, Switzerland, Syrian Arab Republic, Timor-Leste, Togo, Trinidad and Tobago, Turkey, Uganda, Tanzania, USA, Uruguay, Vanuatu, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe