THE INTERNATIONAL JOURNAL OF HUMANITIES & SOCIAL STUDIES

Growth Dynamics of Cereal Cultivation in Asian Agriculture: A Non-Parametric Approach

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Abstract:
This paper attempts to analysed pattern of Agricultural growth by using Kakwani's (1997) growth parameters. Based on the aggregated country wise data on area production and yield of cereal grains in Asia, the study reveals considerable variations in country wise growth rates. It is observed that there is a diminishing return to scale in operation which slows down the growth rates of the leading countries. However, the less-developed countries have not been able to catch up adequately over time. The result is also supported by the periodization analysis as suggested by Kakwani (1997). The study concludes that the growth of agriculture over 53 years has been highly unequal. The study also analysed what different mechanical procedures imply about the welfare weights attached to growth in different years.
JEL: Q10, Q12, Q15, Q19

Keywords: *Agricultural Growth, Welfare, Underdeveloped Economy, Growth Diversity, Kakwani's Growth Parameters*

1. Introduction

A very important question in growth theory is the question of convergence. Convergence literally means that, the cross sectional unit which is growing, have a focal point to which they are tending. If the focal point is a common point (Baumol, 1986), then we can speak of absolute convergence. However, if the focal point varies then we have condition of convergence. The entire convergence debate is built on a parametric framework. A limitation of the parametric framework is that it blankets all differences in observation at a more macro level. The parametric specification has inherent tendency towards a 'representative' unit framework. How far the actual is different to the observed is not clear in a parametric specification. However, in a non parametric framework, it is possible to capture such non representative behaviour. This study shows the pace of a dynamic change in agriculture using non parametric framework. The fence is crossed here to encompass different methods of growth calculation as developed by Kakwani (1991, 1997). There may be several aspect of measuring growth. One purpose may be to see how the structure of agrarian economy has been changing over time. Although we deal with this issue in the paper, our main focus is on the welfare aspect of agrarian growth rates.

A sustainable agriculture is the fundamental to ensure food security, poverty alleviation and the overall growth and development of a nation. Strong forward and backward linkages between agricultural and non agricultural sector stimulate growth and development of a country. The role of agriculture in development is often dismissed in the face of the stylized fact of structural change (Briones 2013). There exist a one-to-one relationship between agrarian growth rates and economic welfare. In a path breaking paper, Kakwani (1997) was the first to explore the relationship between growth rates and welfare using alternative growth procedure.

The role of agriculture varies from one stage of economic development to another and from one country to another. According to Kuznets (1961), agriculture makes product, market and factor contributions to economic development. This sector increases food supplies, enlarges agricultural exports, transfers manpower, forms capital, and stimulates industrialization through increased rural net cash income (Johnston and Mellor, 1961). Agricultural transition has not been uniform across region. Various studies have indicated this and tried to identify the possible factors behind this phenomenon (Bhalla and Alagh 1979, Huang et. al. 1993, Rao 1998, Mundlak, Larson, and Butzer 2002, Galati, et. al. 2005, Joshi et.al. 2007, Wik et. al. 2008, Bhalla and Singh 2011, Viswanathan et. al. 2012,). Most of the authors, in this context, argued that the uneven economic differences in agricultural development came to arise due to the uneven resource endowment with considerable country-wide variations in rural investment, infrastructural development as well as technological innovations that could adversely affect its sustainability. Since economic growth is associated with some notion of welfare concept, comparisons of growth performance over time and across country seem to be oblivious of the inherent welfare indicators. Such comparisons are necessary particularly in studying an economy where the destiny of millions is closely involved with the success or failure of agricultural growth (Sengupta et. al., 2004).

In this article an attempt has been made to examine the agrarian growth process across 31 countries in Asian continent using the alternative growth measures suggested by Kakwani (1991 and 1997). This article first presents a conceptual and methodological framework and the description of data used in this analysis in the next section. The findings of the application of this methodology

on the acreage, production and yield of cereals in the Asian countries are discussed in section III. The article ends with some concluding remarks in section IV.

2. Conceptual Framework and Methodology

The rate of growth can be defined as a discrete and a continuous variable with reference to time. However, in reality, a continuous time series data for a particular variable happens to be available only after a certain interval of time. An econometrician's task is then to identify the pattern of growth along a given stretch of time.

2.1. Growth Dynamics

Let $x = (x_1, x_2, ..., x_n)$ be the vector of values of an economic indicator for n periods. Then the long run growth rate, R, is estimated by the logarithmic transformation of the compound growth rate equation

$$x_t = x_1(1+R)^{t-1} \quad (1)$$

Another very popular measure of growth is the period-to-period growth rate defined as:

$$r_t = \frac{x_t - x_{t-1}}{x_{t-1}} \quad (2)$$

Kakwani (1997) deciphered the following functional relation between the growth rates derives in (1) and (2) as:

$$\log(1+R) = \sum_{t=2}^{n} w_t \log(1+r_t) \quad (3)$$

Where

$$w_t = \frac{6(t-1)(n+1-t)}{n(n+1)(n-1)}$$

w_t is the weight attached to the period-wise growth rate r_t. However w_t behaves in a particular fashion. This type of growth rate gives maximum weight to the growth rates at the middle of the time period. The lower weights are given to the growth rates at the beginning and at the end of the time period. There is not a priori reason why the weights should take this specific functional form. Kakwani (1997) provided alternative specifications of such weight structures. He defined a more general structure:

However, if one defines w_t in this way, the estimated growth rate (R) becomes:

$$\hat{R}_1 = \left(\frac{x_n}{x_t}\right)^{1/n-1} - 1 \quad (4)$$

This is referred to as the Geometric Mean Growth Rate (GMGR). Similarly, growth rate that gives more weight to the initial period and decreases over time can be constructed by defining as:

$$w_t = \frac{3[n(n-1)-(t-1)(t-2)]}{n(n-1)(2n-1)} \quad (5)$$

This growth rate is called the Restricted Least Square Growth Rate (RLSGR). It tries to estimate the trend equation by restricting it to passing through

An increasing weight growth rate (IWGR) is derived by defining

$$w_t = \frac{2t}{n^2+n-2} \quad (6)$$

This w_t gives more weight to the end period. It increases with t.

All these above growth rates fall within the class of growth rate defined by (2).

However, in order to estimate these growth rates, it is necessary to specify the parameter x. in Kakwani's exercise it was per capita income. In our exercise, these are the relevant agrarian parameters.

These measures may be compared with one another to test the relative stagnancy of growth rates among the countries. Since different weight are used to measure different growth rates, their ranking should obviously be different, except in the case of relative stagnancy. Kakwani (1997) also suggested a test to verify the alternative rankings for arriving at a meaningful conclusion. For example, if there were differences between IWGR and RLSGR, it would signify that the particular country has experienced either acceleration or deceleration in the growth rates for the time period under consideration.

In order to compare the welfare implications of different growth rates, Kakwani's (1997) put forward an overall growth index that would incorporate certain axiomatic foundations which have welfare theoretic implications. Thus he derived at the following growth rate which is known as Kakwani Welfare Growth rate (KWGR) and has some welfare implication on the growth of the parameters. In deriving welfare implications of the growth rate, Kakwani (1997) closely follows the Bergson-Samuelson tradition[1]. Following them, he first devised an arbitrary social welfare function as:

$$W(x) = W(x_1, x_2, \ldots\ldots, x_n) \quad (7)$$

Where x,s includes the relevant parameters on which welfare depends.

[1] The social Welfare Function as introduced by Bergson in 1938 and subsequently developed by Samuelson in 1947.

Given the social welfare function, the concept of equivalent uniform growth rate (R) is introduced. This is the constant growth rate that would result in the same level of welfare as per the observed values of x in n years. In other words R would give the same welfare as can be obtained from the observed values of x.

Thus he arrived at the following growth rate which is known as the Kakwani Welfare Growth Rate (KWGR) which is defined as follows.

$$\log[1 + KWGR(s)] = \sum_{t=2}^{n} w_t(s)\log(1 + r_t) \quad (8)$$

Where s is the focal point lying between 1 and n. KWGR is calculated with reference to s. Kakwani(1997) has derived the following conditions

$$w_t(s) = \frac{-2(t-1)}{n(n+1-2s)} \qquad 2 \leq t \leq s$$

$$= \frac{2(n-t+1}{n(n+1-2s)} \qquad t > s \quad (9)$$

When s=1

$$w(1) = \frac{2(n-t+1)}{n(n-1)} \quad (10)$$

The corresponding KWGR is the KWGR at the initial period. This is comparable with RLSGR.

Similarly when s=n

$$w_t(n) = \frac{2(t-1)}{n(n-1)} \quad (11)$$

This gives KWGR at the end period. It is comparable with IWGR. This equation was denoted by Kakwani (1997) as a welfare improving growth rate. It was also proved that among all the alternative procedures discussed earlier, the KWGR is mostly desirable for two reasons:

Firstly, it was derived from a welfare function and therefore, it provides a positive relationship between the aggregate growth rate and the aggregate welfare. If a higher growth rate is prefer to the lower growth rate, and then an increase in growth rate should imply a higher level of welfare.

Secondly, it is simple to compute; it is equal to weighted average of the logarithmic function of yearly growth rates. This is perfectly compatible with the abstract social welfare function developed by Kakwani (1991 and 1997)). This function is applicable to deferent specifications of x. However, it can be argued that per capita income is more often used as a welfare parameter. It is not our purpose to contest this view. The chip aim of the paper is to view agrarian growth from a welfare point of view. In a country, the role of agriculture in enhancing aggregate welfare is clearly evident. Several welfare issues such as poverty reduction, improvement of food availability and food security, and the reduction of unemployment are closely linked with agrarian growth. Thus it is possible to use KWGR in order to assess welfare implications of agrarian changes.

2.2. Sub Period Analysis

In the periodisation analysis, the standard technique of calculating growth rates for different sub periods of a given length of time often suffers from the problem of discontinuity. To overcome this problem, he assumed a two period set up such that the growth equations for the two periods would be:

$$x_t = x_t(1 + R_t) \quad \text{If } t \leq n_1 - 1$$

And $$= x_1(1 + R_1)^{n-1}(1 + R_2)^{t-n_1} \quad \text{if } t > n_1 \quad (12)$$

Where, R_1 and R_2 are the growth rates in two periods each having a length of n_1 and $(n - n_1)$ respectively. The economy has moved into a higher (lower) growth path if $R_2 > R_1$ ($R_1 > R_2$). It can be shows that if the aggregate growth rates in the two sub periods are equal, i.e., $R_1 = R_2 = R$ then equation 12 reduces to

$$x_t = x_1(1 + R)^{t-1} \quad (13)$$

Where R is the aggregate growth rate of entire period

Kakwani (1997) provided a system of equations to estimate R_1, R2, and R. And finally arrives the following relation between

$$\log(1 + R) = \frac{(2n-n_1)(n_1-1)}{n(n-1)}\log(1 + R_1) + \frac{(n-n_1)(n-n_1+1)}{n(n-1)}\log(1 + R) \quad (14)$$

R can be computed from equation 3 and R_1 can be obtained by substituting $n=n_1$ in equation 3. And, therefore, given R_1 and R we can calculate R_2 from equation (14).

Equation (14) shows that log (1+R) is a weighted average of log ($1+R_1$) and log ($1+R_2$). This implies that R lies between R_1 and R_2. Boyce (1986) has argued that the LSGR for the whole period may lie outside the range of sub period growth rates. It means that the total growth rate may be negative (or positive) when the sub period growth rates are both positive (and negative). However Kakwani's (1991) experience told that the total growth rate computed by the LSGR procedure was outside the range of the sub period growth rates. The main cause of anomalies (explained by Kakwani) in the LSGR procedure as pointed out by

Boyce is that the exponential trend lines used are likely to be discontinuous. Boyce (1986) proposed a restricted dummy variable procedure to eliminate such discontinuities. But Kakwani's procedure of computing sub period growth rates implies a continuous trend line and therefore it does not give rise to any anomalies.

2.3. Sub Period Growth Rate and Welfare Change

The relationship between Welfare change and sub period growth rates can be derived as :

$$\omega = \frac{x_2^* - x_1^*}{x_1^*} = (1+R_1)^{\frac{n_1-1}{2}}(1+R_2)^{\frac{n-n_1+1}{2}} - 1 \qquad (15)$$

Where x_1^*, x_2^* be the welfare levels which are equivalent to the value of agrarian parameter in this exercise in the two sub periods (1 to n_1) and (n_1+1, to n), respectively. For the symmetric welfare function x_1^*, x_2^* are given by

$$\log x_1^* = \frac{1}{n_1}\sum_{t=1}^{n} \log x_t$$

and

$$\log x_2^* = \frac{1}{n-n_1}\sum_{t=n_1+1}^{n} \log x_t$$

respectively. And is an index which measures the percentage change in welfare from period 1 to period 2. This index is invariant with respect to any linear positive transformation of welfare function. A positive (negative) value of would imply an improvement (deterioration) in the welfare in period 2 over period 1. We would apply the index to see how the welfare level in respect of area expansion, production and yield level of Asian agriculture has changed during the last Fifty years of agricultural development.

3. Growth Analysis

Since growth is a multifaceted concept, we wish to study the pattern of growth from two perspectives. We first concentrate on the dynamics of growth as illustrated by the major types of growth rates envisaged by Kakwani (1991 and1997). We then move on to the sub-period growth analysis. Data on area (in Hector) and output (in Tonnes) of cereals production for 31 major countries can be obtained from FAOSTAT (http://faostat.fao.org). Panel data from 1961 to 2013 has been used. I have selected only cereals because these crops are more or less widely cultivated in all the regions of Asian Continents. It is true that commercial crops (such as jute, sugarcane and cotton) are important ingredients of modern agriculture. However, these crops are very area specific.

3.1. Dynamics of Growth

The alternative procedures for computing growth (discussed in the previous section) will now be applied to the data from thirty – one countries in Asia. The data on area harvested (in Hector), production quantities (in Tonnes) and yield rate (per hector) of total cereals was used to compare the performance of agricultural sector of the countries over the period 1961 to 2013. The absolute value of the major growth rates are presented in Table A1 in appendix section. The first column in the table provides growth rates computed by the least squares procedure which gives maximum weight to the growth rates around the middle of the time span. The remaining five columns in the table present growth rates computed by five alternative procedures proposed in the paper.

A number of features of the growth pattern are noticeable from the table. First of all one finds that although the growth in area harvested of total cereals are positive for a number of countries, some of the country like Taiwan Province of China, Cyprus, Israel, Japan, Jordon, Republic of Korea and Yemen recorded negative growth rates in terms of all the alternative procedures. Such a widespread decline in growth rates of area expansion may have serious implications for the living conditions of the majority of people in these countries. So far as the growth rates of cereals production is concerned, there are only two countries, i.e. Taiwan province of China, and Japan which recorded negative growth rates in terms of all the alternative procedures. However, the performance of these countries for yield up-gradation is positive. Brunei Darussalam is only the country which shows negative growth rates of yield up-gradation in terms of all the alternative procedures. We summarise the results in table 1.

Parameters	**Number of Countries with Negative Growth Rates**					
	LSGR	GMGR	RLSGR	IWGR	KWGRI	KWGRE
Area	14	13	10	13	9	14
Production	8	7	6	5	5	5
Yield	1	1	1	1	1	1

Table1: Countries with Negative Growth Rates of Area, Production and Yield of Cereals measured by the Alternative Procedures (1961-2013)

From the table 1 it can be seen that the number of countries that experienced negative growth rates are larger for area expansion and it varies from 9 to 14. For production of cereals this varies from 5 to 8 and for yield up- gradation the number is only one.

The numerical results in the table A1 in appendix section also show that growth rates computed by alternative procedures vary substantially for a large number of countries. These differences occur because of the differences in weighting schemes implied by each method. Any procedure which gives higher weight to the growth rates in the beginning of the period would show higher

values of the total growth rate in these countries. Therefore, the analysis clearly demonstrates that the growth performance of countries can vary substantially with respect to the procedure employed.

In order to bring out the nature of growth performance more clearly, we provide the ranking of the countries according to the growth rates in Table A2 in appendix section. the ranking of countries also differ according to the alternative procedure due to the weighting schemes applied by each method. For RLSGR the weight given to growth rates decreases monotonically and for IWGR, it increases. Therefore, it is possible to identify different patterns of growth dynamics according to the ranking of countries. The analysis suggests a wide variation in growth patterns across countries as well as agrarian parameters. This also helps to distinguish between convergence and the catching up effect. The former represents an overall tendency of narrowing up of gaps in terms of growth rates among different countries. The latter, however, is a feature of individual states moving to a dominant position from a backward one. The opposite is falling behind where a leading state may move down in its performance. While the findings presented in table A2 reflect the catching up of some countries, some others are falling behind. Thus, we-cannot speak of any general convergence. However, in order to test the above conjecture statistically, we have used the rank correlation test as suggested by Kakwani (1997). If the test statistic is found to be significant, it is argued that the ranking according to the rival growth rates differ. Since IWGR gives greater weight age to the end period while RLSGR to the beginning period, any significant difference between these two indicates that the growth pattern has shifted. Similar comparisons can be made with respect to KWGR (beginning) and KWGR (end). In Table 2, we present the results of our analysis.

	IWGR-RLSGR	**KWGRI-KWGRE**
AREA	0.487**	0.413**
PRODUCTION	0.478*	0.356*
YIELD	0.497*	0.329

Table 2: Rank Correlation Test Showing Relative Stagnancy of the Variables during 1990-91 to 2009-10

Df = n-2
*Significant at 5%. ** Significant at 1%.
IWGR: Increasing welfare Growth Rate
RLSGR: Restricted Least Square Growth Rate.
KWGRI: Kakwani Welfare Growth Rate (Initial Period)
KWGRE: Kakwani Welfare Growth Rate (End Period)

Table 2 shows the results of rank correlation indicating the relative position of different states with respect to the growth of acreage, production and yield of cereals in Asian continent. It is seen that the ranking does not satisfies the stagnancy hypothesis in respect to acreage, production and yield of cereals according to IWGR-RLSGR criterion. In fact, there appears to be major shifts among the countries in terms of the ranking based on IWGR and RLSGR criterion. Incorporating welfare criterion advanced by Kakwani (1997), the same conclusion can be drawn for area and production. However, for yield up-gradation, there are no major shifts among the countries in terms of welfare criterion (as the rank correlation is insignificant in that case). Since these various growth rates indicate different weight structures, their inclusion indicates that the special variations of cereal cultivation either in respect of area or production or yield have offer much of a change during the span of 53 years. On the other side welfare enhancing growth as envisaged by kakwani (1997) is observed only for area expansion and production of cereals. No such change is observed in case of yield of cereals as a whole.

Next, the study considered the temporal fluctuations of growth rates from which acceleration/deceleration of the crop in different countries can be visualised. The results are summarised in table 3.

Acceleration (IWGR>RLSGR)			**Deceleration (IWGR<RLSGR)**		
Area	**Production**	**Yield**	**Area**	**Production**	**Yield**
Afghanistan, Brunei-Darussalam, China, (mainland), Cyprus, Israel, Japan, Jordan, Lao, Myanmar, Sri Lanka, Vietnam, Yemen	Afghanistan, Bangladesh, Brunei Darussalam, Iraq, Japan, Jordan, Lao, Nepal, Sri Lanka, Viet Nam, Yemen,	Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, India, Iraq, Jordan, Malaysia, Nepal, Thailand, Timor-Leste, Viet Nam, Yemen	Bangladesh, Bhutan, China (Taiwan Province of), Democratic Korea, India, Indonesia, Iran, Iraq Malaysia, Mongolia Nepal, Pakistan Philippines, Republic of	Bhutan, China (mainland), China (Taiwan Province of), Cyprus, Democratic Korea India Indonesia Iran (Islamic Republic of), Israel, Malaysia, Mongolia, Myanmar, Pakistan, Philippines,	China (mainland) China (Taiwan Province of) Cyprus, Democratic Korea, Indonesia, Iran (Islamic Republic of) Israel, Japan, Lao, Mongolia, Myanmar, Pakistan, Philippines,

			Korea Saudi Arabia, Syrian Arab Republic, Thailand, Timor-Leste, Turkey	Republic of Korea Saudi Arabia, Syrian Arab Republic, Thailand, Timor-Leste, Turkey	Republic of Korea, Saudi Arabia, Sri Lanka, Syrian Arab Republic, Turkey

Table 3: Showing the Position of the Countries According to the Acceleration/Deceleration of Growth Rates of Cereals during 1961-2013

Table 3 reports that there are 12 out of 31 countries which recorded acceleration for area expansion. For production and yield up gradation the numbers are 11 and 13 respectively. In fact many countries have evidenced upward movement with respect to yield growth due to the growth of production, but not acreage at all. Again more the fifty percent countries have evidenced deceleration of growth rates with respect to the parameters considered. In some cases, improvement seems to indicate a movement from a larger negative sign to a lower one. The above analysis clearly demonstrates that the growth performance of the countries is highly unequal with respect to the procedure employed. Among all the procedure the KWGR comparison is most desirable one as these are derived from a welfare function and hence it provides a positive relationship between the aggregate growth rate and aggregate welfare. If a higher growth rate is preferred to the lower growth rate, then an increase in growth rate should imply a higher level of welfare.

3.2. Sub Period Growth Rates and Change in Welfare

In this section, we study the period-wise variations of growth rates. Table A3 in Appendix section presents the growth rates for 31 Asian Countries. To examine whether any kind of break is statistically valid or not, the entire time period has been sub-divided into two sub periods, viz. 1961 to 1986 (i.e., Period I) and 1987 to 2013 (i.e., Period II).

This periodization is rough and not exact. Like other break-point analysis, our choice of break year is arbitrary. However, it represents a realistic turning point in government policy and the emergence of new concepts of development and growth. The countries were ranked according to their growth performance in each period; the lower (higher) the rank, the better (worse) the countries growth performance. These ranks are also presented in the table.

Since the growth rates between the two sub periods differ, it is of interest to know whether welfare levels of countries were lower or higher in the period II compared to period I. the index ω in equation (15) measures the percentage change in welfare from period I to period II. Kakwani (1991) was computed for each country on the basis of welfare function. A positive (negative) value of the index ω indicates an improvement (deterioration) in the welfare enjoyed by the countries in period II than period I. the numerical values of the index are presented in the last column of Table A3 along with its rank.

The results presented in Table A3 provide some interesting features. There has been a marked difference between the two sub periods in the growth rates of the countries. The results depicts that the leading countries in period I, mostly loss their position in period II. While some of the laggard countries in period I improved their positions in period II. It implies that there seems to be a catching –up effect in operation, with regard to the relative status of these laggard countries in terms of agricultural performance. In fact these relatively less developed countries eventually are gaining access to the new technologies, particularly irrigation, Chemical fertilizers, therefore improving their performance in agriculture. It is interesting to know that a drop in the aggregate growth rate does not necessarily imply a drop in welfare. Summary results of Table A3 are presented in Table 4.

	Acceleration	Deceleration	Welfare level improved	Welfare level Deteriorated
Area	Afghanistan Brunei Darussalam Cyprus Indonesia Iraq Japan Jordan Lao Myanmar Viet Nam Yemen	Bangladesh Bhutan China, mainland China, Taiwan Province of Democratic Korea India Iran (Islamic Republic of) Israel Malaysia Mongolia Nepal Pakistan Philippines Republic of Korea Saudi Arabia Sri Lanka Syrian Arab Republic Thailand Timor-Leste Turkey	Afghanistan Bangladesh Cyprus Indonesia Iraq Lao Myanmar Nepal Pakistan Saudi Arabia Syrian Arab Republic Timor-Leste Viet Nam	Bhutan Brunei Darussalam China, mainland China, Taiwan Province of Democratic Korea India Iran (Islamic Republic of) Israel Japan Jordan Malaysia Mongolia Philippines Republic of Korea Sri Lanka Thailand Turkey Yemen
Production	Afghanistan Bangladesh Cyprus India Iraq Japan Jordan Lao Nepal Saudi Arabia Syrian Arab Republic Thailand Viet Nam Yemen	Bhutan Brunei Darussalam China, mainland China, Taiwan Province of Democratic Korea Indonesia Iran (Islamic Republic of) Israel Malaysia Mongolia Myanmar Pakistan Philippines Republic of Korea Sri Lanka Timor-Leste Turkey	Afghanistan Bangladesh China, mainland India Indonesia Iran (Islamic Republic of) Iraq Jordan Lao Malaysia Myanmar Nepal Pakistan Philippines Saudi Arabia Sri Lanka Syrian Arab Republic Thailand Timor-Leste Turkey Viet Nam Yemen	Bhutan Brunei Darussalam China, Taiwan Province of Cyprus Democratic Korea Israel Japan Mongolia Republic of Korea
Yield	Bangladesh Bhutan India Iran (Islamic Republic of) Iraq Jordan Nepal Saudi Arabia Syrian Arab Republic Thailand Timor-Leste Viet Nam Yemen	Afghanistan Brunei Darussalam China, mainland China, Taiwan Province of Cyprus Democratic Korea Indonesia Israel Japan Lao Malaysia Mongolia Myanmar Pakistan	Afghanistan Bangladesh Bhutan China, mainland China, Taiwan Province of India Indonesia Iran (Islamic Republic of) Iraq Israel Jordan Lao Malaysia	Brunei Darussalam Cyprus Democratic Korea Japan Mongolia

		Philippines Republic of Korea Sri Lanka Turkey	Myanmar Nepal Pakistan Philippines Republic of Korea Saudi Arabia Sri Lanka Syrian Arab Republic Thailand Timor-Leste Turkey Viet Nam Yemen	

Table 4: Summary of Table A3 in Appendix Section

It is observed that among the 31 countries under the study, growth rate of area expansion of cereal production decelerated for 20 numbers of countries from 1961 – 1986 to 1987-2013. For production and yield growth the numbers of countries were 17 and 18 respectively between the two sub periods. The countries which recorded a deceleration in respect of all the agrarian parameters (i.e., area production and yield) are China (Mainland), China (Taiwan Province of), Democratic Korea, Israel, Malaysia, Mongolia, Pakistan, Philippines, Republic of Korea, Sri Lanka, and Turkey.

So far as the percentage change in welfare is concerned, there are 18 countries for area expansion, 9 countries for production and 5 countries for yield up gradation which recorded deterioration from period I to Period II. Democratic Korea and Mongolia are the two Asian countries which recorded deterioration of welfare level in respect of all the agrarian parameters. Interestingly, a drop in the aggregate growth rate does not necessarily imply a drop in welfare. Viz., Bangladesh, Nepal, Pakistan, Saudi Arabia, Syrian Arab Republic, Timor-Leste were recorded declining in growth rates of area expansion, however, the welfare level of these countries improved during the two sub periods. One of the most populated countries in the world, China (mainland) has shown deceleration in respect of area production and yield growth rates. However, the welfare level in respect of production and yield growth has recorded an improvement.

The theoretical basis of the IWGR-RLSGR comparison and Sub period growth rate comparison for analysing growth performance are different. The sub period comparison is rather arbitrary. It depends on the choice of the break point that is rather arbitrary depending only on some indirect empirical realities. Kakwani (1997) has utilized this criterion to test the relative convergence of various countries. This article, however, puts forward the viewpoint that the IWGR-RLSGR comparison may be better, considering that it is free of any arbitrary break point. Rather, it depends only on the nature of the annual growth rates (r,). Another interesting trend seems to be the increase in the number of negative growth rates in Period II as compared to Period I (see Table 6), for all the variables under consideration. The trend once again supports the view that the effects of new technology on the growth of agricultural output of different varieties of crops vary from one region to another, and it will be misleading to treat specific effects as if they are the same everywhere.

Variables	**Number of countries with negative growth rates**			**Welfare level deteriorated**
	1961 to 1986	1987to 2013	1961 to 2013	1961 to 2013
AREA	11	21	14	18
PRODUCTION	7	12	8	9
YIELD	5	11	1	5

Table 5: Number of countries with negative growth rates

From the above analysis, it is clear that the increase in the growth of foodgrains production over time has not been possible to many Countries in Asia, mainly because of the sharp diminishing rate of growth of the cropped area. However, the growth of the yield which has been the striking feature in agricultural development has been helpful in raising the growth of production. Interestingly, it is observed that the acceleration in the growth of production has taken place in those regions and in those sub periods where the growth of yield rate is positive.

4. Conclusion

The international organisations such as World Bank routinely employ mechanical procedures on computing aggregate growth rates of a wide range of socio Economic variables. These procedures can give rise to unreasonable economic implications. Although this methodology focused on measuring growth rates of agrarian parameters, it can be modified to measure a country's performance in other indicators of individual well-being. All the methods commonly used to calculate the average growth rate (least-squares, geometric mean, etc.) are shown to imply unreasonable or bizarre welfare weights.

In this paper, we have discussed the imperatives of growth rates. Traditionally, there are two types of growth rates-long-run trend growth rates and period-to-period instantaneous growth rates. Kakwani (1991 and 1997) in his paper tried to find out a link between the two. In the process, he was able to derive a weight structure linking these two types of Growth Rates. However this

particular weight structure is rather arbitrary. Following Kakwani (1991 and 1997), an alternative weight structure has been devised to deriving different types of growth parameters. These alternative growth rates gave varying emphasis to the differing time points thereby giving a clue to the improvement, stagnancy or enhancement of growth over time. Thus they could be profitably used as alternative measures of convergence or divergence. The present paper uses them. The picture is a mixed one. Some areas show an acceleration, others deceleration or stagnancy. However, agrarian growth is not a descriptive entity. Lives of millions are linked with it. Hence it should have a welfare dimension. I have discussed the normative aspect of growth delving deeply into the relationship between long run and short run growth. Kakwani (1991 and 1997) was able to sort out a weighting structure appropriate for a social welfare function. The structure was adopted by us in the context of Asian agriculture. This would help us to unravel the welfare complexity behind the agrarian dynamics.

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Appendix

AREA						
Country	LSGR	GMGR	RLSGR	IWGR	KWGR(I)	KWGR(E)
Afganistan	-0.471	-0.077	-0.516	0.362	-0.531	0.379
Bangladesh	0.481	0.720	0.742	0.612	0.832	0.608
Bhutan	-0.373	0.111	0.634	-0.724	0.984	-0.755
Brunei Darussalam	-3.168	-0.870	-3.034	1.214	-2.988	1.293
China, mainland	-0.172	0.065	-0.023	0.099	0.029	0.100
China, Taiwan Province of	-2.587	-2.052	-1.883	-2.448	-1.639	-2.463
Cyprus	-2.441	-2.137	-2.655	-1.563	-2.728	-1.542
Democratic Korea	-0.309	-0.005	0.009	-0.123	0.119	-0.128
India	0.049	0.133	0.243	-0.038	0.310	-0.045
Indonesia	1.131	1.237	1.240	1.197	1.278	1.195
Iran (Islamic Republic of)	0.838	1.235	1.531	0.720	1.773	0.701
Iraq	0.566	0.611	0.632	0.568	0.655	0.567
Israel	-1.270	-1.222	-1.236	-1.220	-1.225	-1.220
Japan	-1.673	-1.763	-2.149	-1.230	-2.314	-1.210
Jordan	-4.235	-3.431	-4.371	-2.471	-4.418	-2.435
Lao	0.520	1.078	0.570	1.552	0.587	1.570
Malaysia	0.221	0.556	0.817	0.107	1.024	0.090
Mongolia	-1.595	-0.154	0.099	-0.963	0.693	-0.993
Myanmar	1.216	1.230	1.120	1.368	1.087	1.373
Nepal	1.547	1.290	1.597	0.977	1.614	0.966
Pakistan	0.946	1.036	1.219	0.769	1.313	0.759
Philippines	0.493	0.659	0.725	0.517	0.806	0.512
Republic of Korea	-1.895	-1.599	-1.425	-1.924	-1.261	-1.936
Saudi Arabia	1.238	-0.283	1.827	-2.463	2.032	-2.545
Sri Lanka	1.082	1.649	1.418	1.759	1.535	1.763
Syrian Arab Republic	0.986	0.583	0.954	0.237	0.943	0.224
Thailand	1.152	1.470	1.595	1.203	1.748	1.193
Timor-Leste	3.435	2.750	3.151	2.458	3.054	2.447
Turkey	-0.059	-0.210	0.072	-0.524	0.117	-0.536
Viet Nam	1.329	1.151	1.106	1.269	1.029	1.274
Yemen	-1.128	-0.646	-1.152	-0.147	-1.160	-0.128
PRODUCTION						
Afganistan	0.343	1.098	0.143	2.095	0.074	2.133
Bangladesh	2.626	2.594	2.335	2.942	2.235	2.955
Bhutan	0.633	1.269	1.144	1.219	1.322	1.217
Brunei Darussalam	-4.907	-1.859	-4.201	0.205	-3.956	0.284
China, mainland	2.629	3.202	3.757	2.297	4.150	2.263
China, Taiwan Province of	-1.368	-0.689	-0.443	-1.233	-0.121	-1.253
Cyprus	-1.399	-0.314	-0.230	-0.785	0.178	-0.803
Democratic Korea	0.089	0.755	0.890	0.359	1.168	0.344
India	2.484	2.360	2.469	2.261	2.463	2.258
Indonesia	3.574	3.587	3.881	3.202	3.988	3.187
Iran (Islamic Republic of)	3.268	3.214	3.615	2.714	3.735	2.695
Iraq	1.290	1.842	0.984	2.780	0.878	2.815
Israel	0.374	1.145	1.182	0.841	1.463	0.829
Japan	-1.133	-1.042	-1.224	-0.835	-1.256	-0.827
Jordan	-1.787	-1.340	-2.636	0.216	-2.929	0.275
Lao	3.841	4.077	3.715	4.470	3.671	4.485
Malaysia	1.328	1.758	1.926	1.396	2.134	1.383
Mongolia	-0.669	2.190	2.514	0.813	3.639	0.761
Myanmar	3.219	2.876	3.023	2.799	2.956	2.796
Nepal	2.257	1.935	1.849	2.155	1.708	2.163
Pakistan	3.302	3.454	3.810	2.943	3.987	2.924
Philippines	3.076	3.139	3.227	3.002	3.280	2.997
Republic of Korea	-0.338	-0.251	0.327	-1.024	0.558	-1.053
Saudi Arabia	5.330	1.925	4.515	-0.251	4.234	-0.333
Sri Lanka	2.711	3.176	3.055	3.176	3.175	3.177
Syrian Arab Republic	3.033	2.592	3.461	1.622	3.609	1.586
Thailand	2.426	2.755	2.778	2.616	2.900	2.611
Timor-Leste	4.369	3.328	3.647	3.260	3.399	3.258
Turkey	1.721	2.098	2.393	1.591	2.627	1.572
Viet Nam	3.767	3.259	3.041	3.713	2.790	3.730

Yemen	-0.629	-0.160	-0.689	0.372	-0.710	0.392
YIELD						
Afganistan	0.818	1.176	0.662	1.727	0.609	1.747
Bangladesh	2.135	1.860	1.582	2.315	1.391	2.332
Bhutan	1.010	1.157	0.507	1.957	0.334	1.987
Brunei Darussalam	-1.796	-0.997	-1.204	-0.996	-0.998	-0.996
China, mainland	2.806	3.136	3.780	2.196	4.120	2.161
China, Taiwan Province of	1.252	1.391	1.468	1.245	1.543	1.240
Cyprus	1.067	1.863	2.490	0.791	2.988	0.751
Democratic Korea	0.399	0.760	0.881	0.483	1.049	0.472
India	2.435	2.225	2.221	2.300	2.146	2.303
Indonesia	2.416	2.322	2.609	1.982	2.676	1.969
Iran (Islamic Republic of)	2.410	1.954	2.052	1.980	1.928	1.981
Iraq	0.720	1.224	0.350	2.199	0.222	2.236
Israel	1.666	2.397	2.448	2.086	2.721	2.075
Japan	0.549	0.734	0.945	0.400	1.083	0.387
Jordan	2.556	2.166	1.813	2.755	1.557	2.778
Lao	3.304	2.968	3.127	2.873	3.066	2.870
Malaysia	1.105	1.195	1.100	1.288	1.098	1.292
Mongolia	0.941	2.348	2.412	1.793	2.926	1.772
Myanmar	1.979	1.626	1.883	1.412	1.849	1.404
Nepal	0.699	0.637	0.248	1.166	0.092	1.186
Pakistan	2.335	2.394	2.560	2.158	2.639	2.149
Philippines	2.571	2.463	2.484	2.473	2.454	2.473
Republic of Korea	1.587	1.371	1.777	0.918	1.843	0.901
Saudi Arabia	4.042	2.214	2.639	2.268	2.158	2.270
Sri Lanka	1.612	1.502	1.614	1.393	1.615	1.389
Syrian Arab Republic	2.027	1.998	2.483	1.382	2.641	1.359
Thailand	1.259	1.266	1.164	1.396	1.132	1.401
Timor-Leste	0.903	0.563	0.481	0.783	0.335	0.792
Turkey	1.782	2.313	2.320	2.127	2.507	2.119
Viet Nam	2.406	2.084	1.913	2.413	1.743	2.425
Yemen	0.505	0.489	0.468	0.520	0.456	0.521

Table A1: Country wise Growth Rates defined by Alternative Procedure

AREA						
Country	LSGR	GMGR	RLSGR	IWGR	KWGR(I)	KWGR(E)
Afghanistan	22	20	23	15	23	15
Bangladesh	15	11	13	12	14	12
Bhutan	21	17	15	23	12	23
Brunei Darussalam	30	25	30	6	30	5
China, mainland	19	18	22	18	22	17
China, Taiwan Province of	29	29	27	29	27	30
Cyprus	28	30	29	27	29	27
Democratic Korea	20	19	21	20	20	20
India	17	16	18	19	19	19
Indonesia	7	5	7	8	8	7
Iran (Islamic Republic of)	11	6	5	11	3	11
Iraq	12	13	16	13	17	13
Israel	24	26	25	25	25	26
Japan	26	28	28	26	28	25
Jordan	31	31	31	31	31	29
Lao	13	9	17	3	18	3
Malaysia	16	15	12	17	11	18
Mongolia	25	21	19	24	16	24
Myanmar	5	7	9	4	9	4
Nepal	2	4	3	9	5	9
Pakistan	10	10	8	10	7	10
Philippines	14	12	14	14	15	14
Republic of Korea	27	27	26	28	26	28
Saudi Arabia	4	23	2	30	2	31
Sri Lanka	8	2	6	2	6	2
Syrian Arab Republic	9	14	11	16	13	16
Thailand	6	3	4	7	4	8
Timor-Leste	1	1	1	1	1	1
Turkey	18	22	20	22	21	22

Viet Nam	3	8	10	5	10	6
Yemen	23	24	24	21	24	21
PRODUCTION						
Afganistan	22	23	25	16	26	16
Bangladesh	13	12	17	8	17	7
Bhutan	20	21	21	20	21	20
Brunei Darussalam	31	31	31	26	31	25
China, mainland	12	7	4	13	2	13
China, Taiwan Province of	28	28	27	31	27	31
Cyprus	29	27	26	28	25	28
Democratic Korea	23	24	23	24	22	24
India	14	14	15	14	16	14
Indonesia	5	2	2	4	3	4
Iran (Islamic Republic of)	7	6	7	11	5	11
Iraq	19	19	22	10	23	9
Israel	21	22	20	21	20	21
Japan	27	29	29	29	29	29
Jordan	30	30	30	25	30	26
Lao	3	1	5	1	6	1
Malaysia	18	20	18	19	18	19
Mongolia	26	15	14	22	7	22
Myanmar	8	10	12	9	12	10
Nepal	16	17	19	15	19	15
Pakistan	6	3	3	7	4	8
Philippines	9	9	9	6	10	6
Republic of Korea	24	26	24	30	24	30
Saudi Arabia	1	18	1	27	1	27
Sri Lanka	11	8	10	5	11	5
Syrian Arab Republic	10	13	8	17	8	17
Thailand	15	11	13	12	13	12
Timor-Leste	2	4	6	3	9	3
Turkey	17	16	16	18	15	18
Viet Nam	4	5	11	2	14	2
Yemen	25	25	28	23	28	23
YIELD						
Afganistan	25	24	25	17	25	17
Bangladesh	11	16	19	5	20	5
Bhutan	22	25	26	15	28	13
Brunei Darussalam	31	31	31	31	31	31
China, mainland	3	1	1	9	1	9
China, Taiwan Province of	19	19	20	23	19	23
Cyprus	21	15	6	26	3	27
Democratic Korea	30	26	24	29	24	29
India	6	9	12	6	12	6
Indonesia	7	7	4	13	6	15
Iran (Islamic Republic of)	8	14	13	14	13	14
Iraq	26	22	29	8	29	8
Israel	15	4	9	12	5	12
Japan	28	27	23	30	23	30
Jordan	5	11	16	2	18	2
Lao	2	2	2	1	2	1
Malaysia	20	23	22	22	22	22
Mongolia	23	6	10	16	4	16
Myanmar	13	17	15	18	14	18
Nepal	27	28	30	24	30	24
Pakistan	10	5	5	10	8	10
Philippines	4	3	7	3	10	3
Republic of Korea	17	20	17	25	15	25
Saudi Arabia	1	10	3	7	11	7
Sri Lanka	16	18	18	20	17	20
Syrian Arab Republic	12	13	8	21	7	21
Thailand	18	21	21	19	21	19
Timor-Leste	24	29	27	27	27	26
Turkey	14	8	11	11	9	11
Viet Nam	9	12	14	4	16	4
Yemen	29	30	28	28	26	28

Table A2: Ranking of Countries According To Growth rates (1961-2013)

AREA								
	GROWTH RATES						% CHANGE IN WELFARE	
	1961 to 1986		1987to 2013		1961 to 2013		1961 to 2013	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
AREA								
Afganistan	-1.112	25	1.247	7	-0.471	22	3.423	12
Bangladesh	0.876	14	-0.558	12	0.481	15	3.123	13
Bhutan	2.400	3	-7.355	30	-0.373	21	-53.836	27
Brunei Darussalam	-3.447	29	-2.425	27	-3.168	30	-54.259	28
China, mainland	0.060	20	-0.784	14	-0.172	19	-9.761	20
China, Taiwan Province of	-0.992	24	-6.683	29	-2.587	29	-66.480	30
Cyprus	-5.608	31	6.460	1	-2.441	28	16.762	8
Democratic Korea	0.474	17	-2.351	25	-0.309	20	-23.967	24
India	0.538	16	-1.235	17	0.049	17	-10.140	21
Indonesia	0.965	13	1.572	6	1.131	7	40.259	6
Iran (Islamic Republic of)	2.022	7	-2.229	23	0.838	11	-6.322	16
Iraq	-0.064	21	2.251	4	0.566	12	35.486	7
Israel	-0.970	23	-2.061	22	-1.270	24	-33.859	25
Japan	-2.618	28	0.872	9	-1.673	26	-18.950	23
Jordan	-5.047	30	-2.053	21	-4.235	31	-60.847	29
Lao	-0.314	22	2.761	3	0.520	13	40.761	5
Malaysia	0.855	15	-1.438	18	0.221	16	-9.181	19
Mongolia	2.288	5	-11.171	31	-1.595	25	-74.733	31
Myanmar	0.162	19	4.056	2	1.216	5	78.056	1
Nepal	1.749	8	1.016	8	1.547	2	43.071	4
Pakistan	1.384	11	-0.204	11	0.946	10	15.391	9
Philippines	1.400	10	-1.870	20	0.493	14	-8.649	18
Republic of Korea	-1.696	27	-2.420	26	-1.895	27	-42.693	26
Saudi Arabia	2.045	6	-0.864	16	1.238	4	14.053	10
Sri Lanka	2.378	4	-2.269	24	1.082	8	-2.718	14
Syrian Arab Republic	1.605	9	-0.632	13	0.986	9	11.659	11
Thailand	2.555	2	-2.466	28	1.152	6	-3.364	15
Timor-Leste	5.505	1	-1.850	19	3.435	1	50.459	3
Turkey	0.223	18	-0.802	15	-0.059	18	-8.139	17
Viet Nam	1.003	12	2.197	5	1.329	3	53.569	2
Yemen	-1.678	26	0.342	10	-1.128	23	-15.104	22
PRODUCTION								
Afganistan	-0.037	25	1.355	13	0.343	22	20.176	19
Bangladesh	2.117	20	3.985	7	2.626	13	124.542	7
Bhutan	2.335	16	-3.735	26	0.633	20	-21.674	26
Brunei Darussalam	-3.220	30	-9.228	30	-4.907	31	-82.875	31
China, mainland	4.442	5	-2.018	25	2.629	12	29.416	18
China, Taiwan Province	0.486	24	-6.110	29	-1.368	28	-56.045	29
Cyprus	-2.670	29	2.043	11	-1.399	29	-5.371	23
Democratic Korea	2.297	17	-5.525	28	0.089	23	-40.060	28
India	2.931	14	1.312	14	2.484	14	72.213	13
Indonesia	4.875	2	0.211	18	3.574	5	86.714	11
Iran (Islamic Republic of)	3.838	9	1.777	12	3.268	7	104.910	9
Iraq	-0.226	26	5.411	6	1.290	19	103.312	10
Israel	1.230	22	-1.855	24	0.374	21	-10.356	24
Japan	-1.442	27	-0.311	20	-1.133	27	-20.164	25
Jordan	-5.323	31	8.220	2	-1.787	30	52.525	16
Lao	3.068	12	5.913	4	3.841	3	226.107	3
Malaysia	2.158	19	-0.836	21	1.328	18	16.116	20
Mongolia	4.501	4	-13.145	31	-0.669	26	-75.892	30
Myanmar	3.274	10	3.075	9	3.219	8	128.567	5
Nepal	1.069	23	5.468	5	2.257	16	140.680	4
Pakistan	4.663	3	-0.213	19	3.302	6	71.577	14
Philippines	4.106	8	0.399	17	3.076	9	74.855	12
Republic of Korea	1.325	21	-4.608	27	-0.338	24	-39.098	27
Saudi Arabia	4.114	7	8.618	1	5.330	1	426.579	1
Sri Lanka	4.321	6	-1.429	22	2.711	11	38.723	17

Syrian Arab Republic	2.925	15	3.322	8	3.033	10	126.553	6
Thailand	3.126	11	0.599	16	2.426	15	59.740	15
Timor-Leste	5.784	1	0.715	15	4.369	2	123.156	8
Turkey	3.018	13	-1.631	23	1.721	17	15.203	22
Viet Nam	2.265	18	7.848	3	3.767	4	281.043	2
Yemen	-1.899	28	2.812	10	-0.629	25	16.009	21
YIELD								
Afganistan	1.088	23	0.107	20	0.818	25	16.198	25
Bangladesh	1.230	21	4.568	4	2.135	11	117.742	6
Bhutan	-0.064	27	3.908	8	1.010	22	69.669	10
Brunei Darussalam	0.235	26	-6.972	31	-1.796	31	-62.562	31
China, mainland	4.379	1	-1.244	25	2.806	3	43.415	16
China, Taiwan Province	1.494	17	0.614	17	1.252	19	31.131	21
Cyprus	3.112	5	-4.149	30	1.067	21	-18.955	29
Democratic Korea	1.814	15	-3.250	29	0.399	30	-21.166	30
India	2.380	10	2.579	13	2.435	6	91.647	8
Indonesia	3.873	2	-1.340	26	2.416	7	33.121	20
Iran (Islamic Republic of)	1.780	16	4.098	6	2.410	8	118.738	5
Iraq	-0.162	28	3.090	10	0.720	26	50.061	13
Israel	2.221	11	0.210	19	1.666	15	35.535	19
Japan	1.208	22	-1.173	24	0.549	28	-1.498	27
Jordan	-0.291	30	10.488	1	2.556	5	289.558	2
Lao	3.393	3	3.068	11	3.304	2	131.674	4
Malaysia	1.292	19	0.611	18	1.105	20	27.854	23
Mongolia	2.163	12	-2.221	27	0.941	23	-4.589	28
Myanmar	3.106	6	-0.943	23	1.979	13	28.368	22
Nepal	-0.668	31	4.408	5	0.699	27	68.224	11
Pakistan	3.235	4	-0.009	21	2.335	10	48.692	14
Philippines	2.669	9	2.312	15	2.571	4	91.411	9
Republic of Korea	3.074	7	-2.243	28	1.587	17	6.273	26
Saudi Arabia	2.027	13	9.565	2	4.042	1	361.699	1
Sri Lanka	1.897	14	0.860	16	1.612	16	42.599	17
Syrian Arab Republic	1.299	18	3.979	7	2.027	12	102.897	7
Thailand	0.557	24	3.143	9	1.259	18	65.301	12
Timor-Leste	0.264	25	2.613	12	0.903	24	48.317	15
Turkey	2.789	8	-0.835	22	1.782	14	25.409	24
Viet Nam	1.250	20	5.530	3	2.406	9	148.125	3
Yemen	-0.225	29	2.461	14	0.505	29	36.647	18

TableA3: Growth Rates, Percentage Change in Welfare with ranking of Countries.