Decomposition Analysis of Agricultural Growth: A Review of Measurement Issues

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In developing country like India, agriculture even at the present times overwhelmingly important as it provides livelihood for the more than half of total work force and supplies food to the whole nation. Hence, agriculture growth performance has become a serious issue of concern for both academicians and policy makers as it is subject to various fluctuations. Since independence its sources of growth have been changing. For effective policy measures one need to understand what contributes to the agricultural growth. Many scholars have attempted to understand the key sources of agricultural growth through decomposition analysis. In the literature, two schemes of analysis is widely discussed one id additive scheme of decomposition and the other is multiplicative scheme of decomposition of agricultural growth. In this paper, an attempt has been made to systematically review the studies on decomposition analysis and changes and development in the decomposition analysis since the independence. From the literature it is observed that the sources of agricultural growth varied according to study undertaken. Finally, this paper provides the advantages and drawbacks of the decomposition analysis and makes some suggestions on the comprehensive measure of decomposition analysis.

Key Words: Agricultural Growth; Decomposition Analysis

1. Introduction:

In developing country like India, agriculture even at the present times overwhelmingly important as it provides livelihood for the more than half of total work force and supplies food to the whole nation[1]. The performance of agricultural sector is crucial for the economy in several ways like eradication of poverty, and employment opportunities etc. One thing that stands out in the growth performance of agriculture since independence is that while sources of growth have changed over time, the overall growth rate of agricultural production has failed to get accelerated. In fact, despite technological change, the growth rate in the 1960's decelerated from the level attained in 1950's (Dharm Narain, 1977). The principal factor pulling down the growth rate of agricultural was of course the slowing down in the rate of expansion of cropped area. In this context, it is necessary to figure out the key sources of agricultural growth. In a vast country like India which is marked by vast variations in climatic and soil conditions projection of long term production possibilities at the national level are of little important as the cropping pattern and growth vary according to the natural conditions. So we need to identify the major sources of growth across regions for appropriate policy implementation which will further enhance growth of agriculture. In this study, an attempt is made to understand the methodological changes and developments in the decomposition of agricultural growth by systematically and critically reviewing some of the studies in this line. In the next section an overview of existing studies is presented, third section gives a detailed explanation of the changes in the measurement of growth in the literature and the last section concludes with a critical evaluation.

2. Overview of existing studies on decomposition of agricultural growth:

A systematic scheme for decomposing the growth trend was first presented by Minhas and Vaidyanathan (1965), which equates changes in gross agricultural output to changes in four factors: area, yield, cropping pattern and interactions of later two. Vidya sagar (1977) later

[1] Economic survey (2008) reported that total 52 percent of work force depends on agriculture.

expanded the decomposition into seven component version, decomposing agricultural output at prevalent prices into three pure components, viz,. area, yield, price and their interactions (Area-Price, Area-yield, Yield-Price and Area-Price-Yield). Dharm Narain (1977) modified the Minhas and Vaidyanathan scheme by explicitly introducing a locational component to interpret the yield effect in agricultural growth. In the literature the above approaches are referred to as additive schemes since they decompose absolute growth in the value of output. Moreover, the additive schemes discussed above explicitly contain residual components termed as interaction components. In the literature there is an alternative approach which is multiplicative scheme, which decomposes the relative growth of output into growth rates of components. The first multiplicative scheme was introduced by Dayal (1966) which does not contain residual terms. This scheme is attempted towards the measurement of total changes in value of output due to particular component, avoiding residual term. Vidya Sagar (1980) developed his multiplicative scheme as an alternative over Dayal system which follows a consistent pattern of decomposing the index of gross agricultural output. Jamal and Zaman (1992) developed a new multiplicative scheme as a development of previous ones by introducing new indices.

3. A detailed analysis of decomposition analysis of agricultural growth:

From the previous section, it is observed that there are two schemes of decomposition in the literature are mainly discussed one is additive method and the other is multiplicative method. In this section, we review the studies in detail and observe the variation in the results and finally try to suggest the most appropriate method of decomposition. The first work in the line of decomposing agricultural growth is done by Vaidyanathan and Minhas in 1964. In their paper they decomposed agricultural growth for 28 states and 268 districts for the period 1951-54 to 1958-61. They followed additive scheme of decomposition. In each case the observed increase in aggregate output has been decomposed into (a) changes in area, (b) changes in per acre yield, (c) changes in cropping pattern and (d) the interaction

between yield and cropping pattern[2]. Components of increase in output: total growth of 3.57 percent of agricultural growth, 45 percent is attributed to area, 46 percent to yield increases, a little over 8 percent to cropping pattern and 1 percent to interaction effect. But these contributions vary region to region. In the states like Punjab, Rajasthan, Mysore and Madhya Pradesh area effect was high where the growth of agriculture is significantly higher than other states. Area expansion was found to be nearly zero in the states like Assam and West Bengal where the growth of output was also one of the lowest. In five states the contribution of yield is substantially higher than the national average they are Kerala, Madras, M.P and Mysore. But in Rajasthan and West Bengal yield has actually come down. In Punjab the most rapidly growing state, yields have shown no significant improvement. Contribution of cropping pattern to change in growth of output is very low. The proportion of area covered under cereals has gone down and area under wheat, pulses, oilseeds, sugarcane has increased. Though cropping pattern in insignificant at national level, it contributed significantly for some of the states like Gujarat, Madras, Punjab and Andhra Pradesh are the states. In the subsequent period, some other scholars like Kaul (1966), Mishra (1971), Rojender and Karam (1975) and Venkataraman and prohaladachar (1980) have used the same methodology that of Minhas and Vaidyanathan with minor changes. Kaul (1966) decomposed growth of output by adding two more interactions, one between area and yield and other between area and cropping pattern and there is one more interaction between area, yield and cropping pattern. In this seven factor model the sum of elements of interaction effect is higher than the four factor model. It is observed that the residual component of the expanded model was not larger than 9 percent in any of the fourteen states studies in Vaidyanathan and Minhas (1965). Kaul has studied the growth of output by component analysis by using seven factor additive scheme for Punjab and compared with four factor model. The residual element of four factor model was negligible and in seven factor model of expanded scheme this residual element amounts for 6.6 percent of the total. In other words, 0.35 percentage points of growth rete of 5.14 percent are

[2] Area effect means increase in output in the absence of any changes in yield and cropping pattern, yield affect shows effect of yield changes for constant cropping pattern and third element portrays the effect of changes in the cropping pattern on the absence of yield changes.

not accounted for by pure effects of changes in area and yield and cropping pattern. Mishra (1971) used the decomposition of crop output for Gujarat and by Rojender and Karam (1975) have used the same method to analyse a comparative analysis of the pre-green revolution period and post-green revolution periods. There are some other studies which used the same additive methodology but contested Minhas and Vaidyanathan component selection and used different components for decomposition. In the study of Vidya Sagar (1977), he argued that earlier studies have ignored the element of price structure which plays crucial role in agricultural growth. The strikes at the deficiency of earlier studies and includes a variable on price structure. Price structure here, is treated as variable and defined as the set of current year prices such that overall average price of agricultural commodities remains at a constant level, while at the same time it incorporates the moment in prices of relative to each other. In this paper, he decomposed growth into area effect, yield effect, cropping pattern effect, price effect[3] and interactions of yield and cropping pattern, yield and price structure, cropping pattern and price structure and yield cropping pattern and price structure. The overall growth of production during 1956-61 to 1969-74 approximated 40 percent. This implies an annual compound growth rate of 2.4 percent. Yield increases alone contributed for 63.64 percent or nearly two thirds of the total output growth. The contribution of area growth was 38.45 percent of output growth. The other positive components of growth are 7.82 percent due to changes in relative price structure and 3.5 per cent due to interaction between cropping pattern and yield. Negative components added up to 13 percent of the total output growth. These include the cropping pattern effect (-2.19) percent, interaction effect due to changes in area and price structure (-4.24) and interaction between changes in yield and price structure (-6.52). These values are in sharp contrast with the results of Minhas and Vaidyanathan. The yield component which was negative for Rajasthan during 1951-61 in the former study is not only positive but has contributed more than overall productivity. The single major factor of output growth viz., area during that period has gone down to second place. The changes in cropping pattern which contributed 6.9 percent in the former study give a negative contribution in this study. This implies that

[3] Price effect shows how increase or decrease in price of the crops contributes for the growth.

cropping pattern shifts in favour of those crops for which the money value of output per hectare was relatively low in the base period, are dominant. This could be due to variety of reasons like price structure which is a new element, has contributed even though the share of all the cereals in this component was negative. Using the same additive methodology, Dharm Narain (1997) decomposed agricultural productivity with a new element, locational shifts[4]. The growth of productivity is thus made up of three components respectively reflecting the contribution of cropping pattern changes, locational shifts of area under individual crops and pure increases in the yields of individual crops in the different states. The results of decomposition both in terms of the absolute changes in per hectare productivity valued at constant prices of the base period and in terms of growth rates of index numbers of productivity. The study covers a time period from 1952-53 to 1972-73 and the total period has been split in to two parts one 1952-53 to 1960-61 and 1961-62 to 1972-73 to capture the effects in the pre and post-green revolution period. Decomposition results show that almost 70 percent of the increase in productivity in the first period was produced by changes in the cropping pattern and locational shifts and only about 30 percent by the pure increase in per hectare yields. The picture underwent a reversal in the second period with pure increase in yields accounting for over 60 percent of the increase in productivity while cropping pattern and locational shifts accounted for under 40 percent of increase. It was observed that the percentage distribution of the total cropped area among crops did not undergo any dramatic changes during the period. It was pure cropping pattern effect which, contributed to the growth of productivity in the first period, the interaction effect having been negative and rather small. But in the later period, the most dramatic change in the later period was registered by wheat. It increased its total area from 8.7 percent to 12.0 percent. Bajra, Miaze and Rice increased its share compare to the first period. Wheat, jowar and other pulses have lost their share in the second period. From non food grains which had made a leading contribution to the overall increase in the pure cropping effect in the first period, rape and mustard continued to improve its relative weight in the cropping

[4] Locational shift effects on the shifting of crops from low yielding areas to high yielding areas or shifting of crops from the areas where price is low a crop to areas where price is high for the crop

pattern but the improvement in sugarcane and groundnut got nearly halted and jute and mesta have lost its share. Among the non price factors, apart from the new technology, the expansion of irrigation is an important force bearing upon cropping pattern change. To examine the effect of prices on cropping pattern the author has deflated the relative price of each crop by the index of agricultural commodity prices specially constructed for this purpose

Locational shifts of area under crops. It was already mentioned that around one third of total productivity was due to locational shifts in the areas under individual crops. Unlike the cropping pattern the bulk of it estimated from the interactions between locational shifts and changes in the per hectare yields of individual crops in the different states. If the states which improve over time their relative share in the total cropped area under a crop also register increases in it's per hectare yield and vice versa, locational interaction should make a positive contribution to productivity growth. in the overall, the real gain in productivity resulting from locational shifts, though significant in the second period , is rather small, thus reflecting on the limited role of market forces in bringing out the interregional specialization in the production of crops. The crop which contributed most to the increase in pure locational effect in the first period was rice. While its contribution in the second period declined, that of sugarcane and wheat increased and sugarcane became most important contributor to the increase. The share of southern states Andhra Pradesh, Karnataka and Tamilnadu in the total rice acreage was increasing and that of eastern states Assam, Orissa and West Bengal was declining in the first period whereas in the second period, the share of former declined while that of eastern states registered a mild improvement. Since per hectare yields of rice were higher in the southern compare to the eastern states, this southward shift of rice acreage in the earlier period produced an increase in the pure locational effect. A good part of explanation for this change is found in the fact that the explanation of irrigation and total cropped area in the first period was faster in the southern states whereas in the later period, it was other way around. The contribution of locational shifts in the area under wheat to the growth of productivity in the second period derived from the relative shift of wheat acreage from the states lacking irrigation facilities, Rajasthan, Maharashtra, Gujarat and Madhya Pradesh to those more advantageously

placed like Punjab, Haryana, and Utter Pradesh. The per hectare yield of wheat being generally higher in the second compared to the first group of states, these locational shifts produced an increase in productivity.

While many studies have used the additive method of decomposition, some other the scholars contested this analysis as it contains a residual term (interaction effect) which does not reflect a true picture of growth and sometimes allowing residual component in the decomposition analysis might mislead because no systematic method of indexing is used in the residual component. Unlike additive schemes which decompose absolute increase and hence linear growth rate of output, the multiplicative scheme explains its compound rate of growth in terms of the component growth rates. So Dayal (1966) has used a new method of decomposition, multiplicative split up method to decompose the effects of area, yield and cropping pattern changes in the total crop production in 12 countries. Though this method is simple it is not conceptually clean, it evaluates crop pattern effect at final year yields. In this paper, impact of cropping pattern changes given the base year yields and prices but like additive model, this multiplicative scheme also has residual element in it. The problem in this paper is in his decomposition analysis he did not show the residual element. In his analysis of cross country, for India it is found that agriculture is growing at 3.47 percent; where area, yield and cropping pattern have been growing at the respective annual rates of 1.68 percent, 1.51 percent, 0.22 percent. Interaction has been insignificant. There are large differences in growth rates may be the result of using internally inconsistent data for different index numbers. Minhas (1966) gave his multiplicative scheme of decomposition as an improvement over Dayal version by adding a measure of cropping pattern effect at base period yields and in the process introduces a residual component. Most of the studies on decomposition have computed growth in output and its components by comparing the end points of the base year series. To reduce the effect of short term weather induced fluctuations three to five years are generally considered. Studies which base their decomposition on the entire time series of observations have been conducted at aggregate level. At the aggregate level a series of observations is more likely to show a smooth trend. As demonstrated by Minhas in the context of multiplicative scheme, the results obtained by the end points method do not differ from one obtained from entire time series. Vidya Sagar

(1980) developed more efficient analysis without a residual term using multiplicative analysis. He decomposed agricultural growth by bringing in the element of seasonality. Seasonal growth is decomposed into cropping pattern, crop location, yield and change in price structure. Seasonality gives the contribution of shifts in the distribution of gross cropped area in different seasons, growth in seasonal crop productivities and relative change in seasonal price structure. A positive interaction between price and seasonal pattern of area may imply, for example, a shift in seasonal pattern of area in favour of the season observing higher increase in its crop prices. Analysis of decomposition was applied to some of the cereals like wheat, bajra etc for different regions in Rajasthan. The results show that 60 percent of total output growth is contributed by yield alone and the rest is contributed for 40 percent. Though these studies used multiplicative scheme, the previous multiplicative system implicitly contains residual as they use single index (Laspeyre's) for prices which includes all elements and assigns equal weights so Jamal and Zaman (1992) attempted to decompose growth trend in agricultural output without any residual elements by introducing two indices i.e. Laspeyre's and Paasche's where Laspeyre's, generally expected to have over estimate and Paasche's index will do exactly opposite. This index is basically to decompose output into price and quantity elements. They decompose total output into area effect, price effect, yield effect and crop mix effect. With the introduction of new indices the residual term is completely eliminated. The two indices are indices of price changes and they have applied the decomposition analysis for price changes. Apparently, prices seem as a major component of growth of value of output. About 75 percent of growth was due to price contribution, changes in cropping pattern are not significantly contributing to the output growth.

4. Conclusion:

In the literature, it is observed that there are different studies done on the decomposition analysis of agricultural growth by taking different components in the analysis of decomposition and used different methods of decomposition (additive and multiplicative). But unfortunately there is no general consensus on the most appropriate measure of decomposition. Though multiplicative scheme of decomposition seems to be a better

measure of decomposition than additive as it eliminates the residual component (which did not show significant contribution in any of the studies), it has a problem of indexing of prices and assigning weights to the components. Different studies have used different components like Vidya Sagar (1977) introduced a price structure in the component analysis and in his paper in 1980,he decomposed seasonality of growth in the analysis and Dharm Narain (1977) introduced the locational shifts in the crops and price structure. But the factors used in the analysis did not show a significant contribution to the total growth. Most importantly, these studies have ignored the component of area in the decomposition analysis which, contributed significantly (nearly about 40 percent) to the overall growth in the previous studies. This might mislead the sources of growth. The multiplicative analysis of Dayal (1966) and Vidya Sagar (1980) had problem of single indexing in the decomposition analysis which implicitly contains residual component but the attempt by Jamal and Zaman (1992) solved this problem of indexing and decomposed growth into area effect, yield effect, cropping pattern effect and price effect. This scheme of decomposition seems most appropriate as it includes all the crucial components which affect crop output. However, all the studies ignored the technology component which significantly contributes to the growth of agriculture. Though, Minhas and Vaidyanathan (1965) mentioned the importance of technology in the growth of agriculture they did not bring in their analysis. It should be noted that irrigation is very important factor whose effects spans all the component of crop output which is not studied by any of the studies. One needs to consider all these factors and develop a decomposition scheme. It would be good area to explore the sources of agricultural growth through decomposition analysis in the recent past as agriculture growth is decelerating and by doing so an effective policy measure could be implemented for a better growth performance in agriculture.

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