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Total Factor Productivity Growth: A Review of Measurement Issues in the Indian Context of Crop Sector

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SUMMARY

The productivity growth in agriculture is both a necessary and sufficient condition for the development of the sector as well as the economy. While the partial productivity does not truly reflect whether the productivity growth is because of more use of inputs or improvement in the efficiency of their use or technology improvement, the total factor productivity (TFP) measures the net growth of output per unit of total inputs. This paper reviews the different methods of measuring TFP and highlights some issues related to measurement of TFP in agriculture, especially in the Indian context.

INTRODUCTION

There is no debate among the scholars regarding the fact that India is growing at a higher rate. However, there is no general consensus among the economists regarding how the economy is growing. Therefore it is very important to study the underlying factors of economic growth in the economy. It is well established that an economy can grow mainly through two channels, one is through factor accumulation and the other is through productivity growth. But, there has been no clear agreement among scholars on the fact whether economic growth in India is caused by factor accumulation or productivity growth. Das et al (2010) have argued that rise in the economic growth during 1980-2004 has been mainly caused by the factor accumulation rather than productivity growth. On the other hand, several scholars (Bosworth et al, 2007 and Gupta, 2008) have found that output growth in India till 1980s is associated with factor accumulation while the acceleration in the economic growth in the post 1980s has been mainly due to the rise in the productivity growth. There are different types of productivity measures which are mainly categorized as the single or partial factor productivity such as labour and capital productivity on one hand and total or multi-factor productivity. However, there is no agreement among the economists regarding the best measure of productivity. But, it is argued that if we want to throw light on productivity trend for a shorter period then labour productivity is a better measure. On the other hand, if we are interested in long term productivity trend then Total Factor Productivity2 (TFP) serves as a better indicator than labour productivity (Sargent and Rodriguez, 2000). Therefore, the economists tend to focus more on total factor productivity and its determinants (Easterly and Levine, 2001).

TFP Growth in India

TFP is defined as increase in output growth which is not caused due to the factor accumulation. Thus, TFP may include all those factors which contribute to the generation of output other than labour and capital. This can happen because of several reasons such as, change in the quality of inputs, output, introduction of new techniques, inputs and outputs, better organization and so on. We have observed that TFP growth in India has been fluctuating during the study period. On an average TFP has grown by 1.49 during the study period 1961-2008. Whereas, during 1961 to 1970 the average TFP growth in India was although positive but it was very low and almost close to zero. Similarly, the economy experienced on an average negative TFP growth during the period 1971 to 1980 implying that there had been technological regress in the economy instead of technical progress.

Issues Related to Measurement of TFP in Agriculture

Index Number

The TFPG index is computed as the ratio of output index to the total input index. To construct an index of all outputs overall inputs, we must be able to aggregate the inputs together and the outputs together. The Laspeyres index was the most popular method of constructing such output and total input indices until Diewert (1976, 1978) proved that the Theil–Tornqvist is the superlative index. But, the basic problem of Laspeyres index is that it implicitly assumes that the production function is linear (Kumar et al., 2008). The restrictive properties

of linear production function constant marginal product and perfect substitutability between inputs, suggest that the TFPG measure based on Laspeyres index is suffer from certain fundamental deficiencies. Since Diewert proved that the Theil–Tornqvist index (which is exact for the linear homogeneous Translog production function) is a superlative index– the use of Translog index has become quite common to calculate the output and total inputs indices for estimating TFPG index. The principle advantage of the Translog index is that it is not based upon simplistic linear production function assumptions, as are Laspeyres and Paasche indices. A further advantage of the Translog index is that it accounts for changes in quality of inputs. Because current factor prices are used in constructing the weights, quality improvements in inputs are incorporated, to the extent that these are reflected in higher wage and rental rates (Rosegrant and Evenson, 1995).

Value Added of Output vs. Gross Output

It is important to consider whether value added or gross value of output will be considered for calculating the output index of TFPG index. The use of value added for measuring the TFPG index means exclusion of intermediate inputs in the measurement process. The exclusion of intermediate inputs assigns all measured technical progress to capital and labour inputs, ruling out increased efficiency in the use of physical inputs. As a result the TFPG index based on the value added understates the TFPG. Therefore, TFPG estimation should be based on gross output, rather than value added.

Determinants of TFP in Agriculture

Technical progress in agriculture is invariably embodied in new inputs like irrigation, HYV seeds, modern agriculture machinery and equipments, fertilizers, etc. The use of modern inputs imposes the marginal productivity of the land, labour and capital. They also induced better utilization of these basic inputs, which gets reflected in increased cropping intensity. Moreover, it would also capture the effect of proper timing, improved quality of labour, better farm management practices, greater utilization of resources, like land equipment, which leads to increased crop intensity, changes in cropping pattern in favour of high value added crops, etc. The former represents new physical inputs, while the latter represents scientific knowledge. Therefore, technical progress in agriculture captures the growth in output associated with both of these (Dholakia and Dholakia, 1993).

Technical change in agriculture is influenced by both the price factors and non–price factors like government investment in agricultural research, education, extension, and infrastructure like rural roads, regulated markets, etc. (Desai and Namboodiri, 1997). While the role of price incentives to induce technical change is obvious, that of non–price factors arises from the shifts in structural change in agriculture. Dholakia and Dholakia (1993) pointed out that TFPG in agriculture is most likely to be governed by the application of modern agricultural inputs like irrigation, fertilizers, HYV seeds, etc. Their specified model explains 99 percent variation in the TFPG for the period 1950–51 to 1988–89. The model finds that the basic determinants of TFPG in Indian agriculture are the use of modern agricultural inputs and weather. As per their estimate, TFPG index would increase by 0.21 percent point when the modern inputs index increases by one percent.

Thus, we can see that the contribution of improved technology, which is measured as TFPG, can be further decomposed into several factors, viz. research, extension, education, infrastructure, health of natural resources and so on. The input growth is also influenced by several factors like input–output prices, technological innovations, institutions, infrastructure, policy initiatives, etc. The sources of growth in TFP in agriculture can be understood through TFP decomposition analysis. The decomposition of TFPG is discussed in the next section.

Scope of the Agricultural Sector

Agriculture sector, in general, includes crop farming, animal husbandry, plantation, fishery and logging, which can be divided into two categories farm sector and non–farm or livestock sector. There are inseparable interlinks between the farm sector and these other sectors, and sometimes their inputs are joint products in the sense that inputs used for their production are practically inseparable. So, it is important to specify the scope of the agricultural sector since what agricultural output will be considered for computing the output index, is one of the important issues of computing TFPG index. However, there are studies those estimating the TFP for different sectors (e.g. farm sector, livestock sector etc.) or different crops (e.g. rice, wheat etc.

Further, what agricultural inputs will be considered for computing the total input index is another issue of concern in estimating the TFP index. Desai and Namboodiri (1997) have considered 11 farm inputs namely land, labour, seeds, organic manure, fertilizers, pesticides, diesel, electricity, irrigation charges, private and public capital (that consists of land improvements, farm equipments and tools, public and private irrigation, agricultural machinery, farmhouses, livestock, and inventories) for computing the TFP index for the agriculture and allied sectors. The point is that the higher the coverage of the inputs used in the production process, the better will be the representation of the contribution of technological change by the TFP index. But, the problem is that of lack of a comprehensive long run time series data set on agricultural statistics in India. Again, the aggregation of all the inputs together for computation of the total input index and outputs together for computing output index has raised further problem, as all the inputs and outputs are not measured in a common unit.

CONCLUSION

The productivity growth in agriculture is both a necessary and sufficient condition for the development of the sector as well as the economy. The partial productivity does not truly reflect whether the productivity growth is because of more use of inputs or improvement in the efficiency of their use or technology improvement. Therefore, the interest shifts to the TFP. TFP measures the net growth of output per unit of total inputs. As such, its level is determined by how efficiently and intensely the inputs are utilised in production. This paper has reviewed the different methods of measuring TFP and highlighted some issues related to measurement of TFP in agriculture, especially in the Indian context. Considering the determinants of TFPG in agriculture, the existing literature suggests that TFPG in agriculture is invariably embodied in new inputs like irrigation, HYV seeds, modern agriculture machinery and equipments, fertilizers, etc., improved quality of labour, better farm management practices, greater utilization of resources, etc. The paper also focused on the trend in TFPG in Indian agriculture. It is found the TFPG in Indian agriculture was very low in the pre green revolution period and it declined (and even become negative) during the 1970s. However,even during the 1980s the growth rate of TFP in agriculture was relatively higher compared to the earlier period, during the 1990s the TFPG in Indian agriculture has come down. There is considerable evidence to argue that the observed decreases in the rate of TFPG is in large part a consequence of a substantial decrease of investments, notably public–sector investments in Indian agriculture. However, considering the share of TFP in agricultural GDP growth, it is found that the share has increased during the 1980s and 1990s. Since technological progress and technical efficiency are the two key sources of agricultural TFPG and they declined in recent periods, our study argues for more government investment in agricultural R& D, technology development, and extension programmes and infrastructure including agricultural credit in order to sustain the growth.

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