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REFLECTIONS ON PARTIAL FACTOR PRODUCTIVITY BASED ON EMPIRICAL EVIDENCES

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Abstract:

The importance of the quantity and productivity of individual inputs such as land, labour, capital, etc. has remained critical in explaining considerable proportion both of the economic analysis on the Indian agricultural sector and the agro-oriented policy efforts of the Government. Partial Factor Productivity analysis in the context of Indian agriculture has accumulated an appreciable stock of debates, discussion, theoretical and empirical issues, and other related aspects. A detailed literature review has been undertaken on the major and seminal studies in this area and important insights have been derived in the form of various conceptual and empirical matters pertaining to Partial Factor Productivity analysis. These issues range from measurement and estimation related aspects to the various economic and econometric dimensions of productivity analysis in the context of Indian agriculture. In the course of extracting these analytical insights on the evidences available on Partial Factor Productivities, noteworthy contributions of various studies as well as several limitations and lacunae of existing works were found. Subsequently, it has been concluded that good amount of scope still exists for a more exhaustive, rigorous and empirically richer analysis of both disaggregate and aggregate Partial Factor Productivities and their inter-relationships.

Keywords: Agricultural Production, Agricultural Productivity, Indian Agriculture, Partial Factor Productivity, Productivity analysis.

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1. Introduction

Agricultural productivity analysis has evolved considerably in the past decade particularly with the advent of better methodological frameworks being developed and the continuous refinement of the definitions and measurement of various agricultural inputs. These developments have been accompanied by a constantly improving statistical environment that has been supplying better quality data on various aspects of agricultural inputs both at the aggregate and disaggregate levels of productivity estimation. Thus, the concept and measurement of agricultural productivity, roughly measured as the quantity of total output per unit of an input, has become more inclusive by increasingly taking into account newer inputs and outputs in the estimation of productivity. Among these developments, the importance of the quantity and productivity of individual inputs such as land, labour, capital, etc. has remained critical in explaining considerable proportion both of economic analysis thrown at the agricultural sector and the agro-oriented policy efforts of the Government. This fact can probably be corroborated by the advent of the KLEMS[1] era which has been gaining considerable importance in productivity analysis across the major economies in the world and which has developed more comprehensive and broader definitions and measurements of key agricultural inputs.

Associated with each input in the agricultural production process are at least two important dimensions: one, the quantity of inputs and two, the productivity of those inputs. When the productivity of a single input such as land or labour is considered in isolation from the productivity and quantity of other inputs, the output per unit of the single input is defined as Partial Factor Productivity (PFP). PFP analysis in the context of Indian agriculture has a considerable stock of debates, discussion, theoretical and empirical issues, and other related aspects. Given that PFP analyses are dispersed across many research issues and can be traced back to the analysis and usage of traditional PFP measures, such as the Yield per Hectare (YPH) and output per unit of man hour worked, in explaining the underlying theoretical agricultural productivity, this review attempts to organize the key and critical issues in PFP tradition by reviewing the seminal and important studies in this area.

Accordingly, Section 2 presents a brief literature review of studies in this area, while section 3 elaborates on the key and major issues associated with PFP analysis in the Indian

context. Section 4 then summarizes this paper and draws important research oriented conclusions and suggests the scope for future research on this matter.

2. Brief Literature Review

The available evidences pertaining to PFP analysis in the Indian context have covered various aspects such the nature, estimation and determinants of conventional inputs such as land, labour and capital, and have also covered some non-conventional inputs such as tank irrigation, water resource, etc. Even though the early and seminal works in PFP analysis focused primarily on land and labour factor productivities, some investigation has also been thrown on the disaggregated analysis of capital factor productivity without much delving into the aggregation of diverse kinds of capitals into a single composite measure of total capital input and thereby estimating the productivity of total capital input. However, some evidences on the empirical assessment of aggregate land and labour productivities were found. Among the studies that have focused upon various conventional factor productivities the major ones have been Gopinath, Narasimhayya and Gupta (1972), Bardhan (1973), Singh and Sirohi (1973), Bhalla and Alagh (1983), Mahadevan (2003), Gupta (2011) and Mundhe (2015), while Jana, Palanisami and Das (2012) and Singh, Singh and Singh (2014) are some examples of the studies that have investigated the nature, measurement, growth and determinants of some non-conventional factor productivities. Most of these studies are primarily focused on the disaggregate behaviour of various Partial Factor Productivities.

3. Various Issues and Reflections based on the evidences

Agricultural productivity analysis has been an ever-evolving collection of not only controversies and debates but also of consensus on matters that have large-scale impact on the welfare and development of Indian economy in general and Indian agriculture in particular. A variety of such issues emerge from the examination of the above surveyed studies and which range from methodological and measurement related matters to the various macro-micro dimensions of the behaviour of Partial Factor Productivities.

First, the use of multiple and often competing partial measures of productivity to estimate the underlying theoretical agricultural productivity poses several problems that need to be investigated both theoretically and empirically. Even though depending on the research context,

data availability and other concerns, a researcher may utilize one specific partial measure such as land or labour productivity to analyze agricultural productivity *per se*, the problem of incompleteness inherent in any partial measure to exhaustively capture all the dimensions of productivity always remains a constraint in letting anyone make a universal generalization based on a single factor productivity. This problem becomes all the more pronounced when seen with reference to recent economic and technological developments whereby agricultural production has been evolving into an increasingly complex process with highly heterogeneous inputs being simultaneously employed in the cultivation process for several major crops. Perhaps, it is no more possible to observe the dominance of any one or small group of factors as contributing the most to cultivation of the major crops. Traditional capital inputs, labour, land, modern inputs such as latest irrigation systems, traditional irrigation systems, technologies in terms of organizational innovations at rural grassroots, technology as embodied in conventional inputs due to usage of modern output-augmenting factors, etc. are all being utilized simultaneously in the cultivation process. This makes it all the more difficult to justify the reliance on only a single input which is what any partial productivity measure inevitably does. This is not to deny that there is no usefulness in estimating these measures but that such an approach to agro productivity should rather be deployed along with Total Factor Productivity (TFP) measures so as to extract maximum possible behavioural information from observed output and input levels, growth and their patterns. Such concerns were found to be largely absent among the reviewed studies.

Second, it has been found that there is a dearth of aggregate level PFP analysis in the available works. Even though several studies have undertaken sizeable aggregation across crops, districts and even states, it was not evident if there are enough studies using all-India level agro output and agro input information to construct and estimate all-India level agricultural partial production functions and partial factor productivities. The thrust on disaggregation comes at the cost of what one may possibly term as the “disaggregation bias” whereby in the pursuit of detailed patterns and truths, the bird’s eye view is overlooked and it can have serious policy implications. Aggregate level studies can also provide good amount of idea on the structural transformation occurring in economies (Kuznets, 1971) including transitional and emerging nations and can even supply a benchmark to compare state wide and possibly region-wide productivities with national level productivity performance.

Third, in line with the observations made above, the use of primary data was found to be highly prevalent and it could probably be inferred that cross-section analysis of conventional and non-conventional partial productivities was more popular than time series investigation of the same. This might imply that the patterns of PFP over space are more pronounced than their evolution over time in case of productivity analysis of the Indian agricultural sector. There are several rich and diversified studies which have gone deep into the disaggregated and even micro level analysis of productivity of single crops, individual districts and even sub-sets of inputs. The insights derived from these researches are of great value for policy making particularly at state and regional levels. These studies also supply good amount of insights into the dynamics surrounding the production and productivity behaviour of specific regions, crops, etc. which are critical for micro-level policy intervention and support programmes.

Fourth, it was also observed that most of the studies that utilized primary data did not go much deeper into the econometric foundations of the observed productivity behaviour even though some studies did investigate determinants and sources of individual factor productivities by using some appropriate econometric methods. The problem that emerges here is that establishing a causal nexus among productivity and its determinants requires much more than multivariate regression analysis which in the best understanding of the authors, none of the studies attempted to investigate. It should be noted here that the discourses on TFP for Indian agriculture have been more exhaustive in terms of the quantitative frameworks employed.

Fifth, though the problem of aggregating heterogeneous inputs is to some extent present even in partial productivity analysis, combining different outputs across space has been a more important concern here. This is because the data on inputs across crops, farms, districts, regions and states are generally available in the same measurement units while data on the quantity of output are generally dissimilar even if in the same measurement unit. As an illustration, crop output pertaining to pulses and cereals cannot be directly combined even if the data are in Kilograms for both crops because of economic heterogeneity between them. Hence, the usage of appropriate output prices[2] is warranted so as to aggregate these different outputs into a measure of total output. Furthermore, workforce data will generally be available in terms of number of workers, for land it would be in terms of area under cultivation as measured in hectares, for quantity-based

measures of capital the information would be in terms of number of units used and for value-based measures of capital the data will often be in terms of monetary units[3]. Such information availability makes it easier to aggregate inputs. Such aggregation inevitably presumes that diverse kinds of a single factor of production are economically the same. Were the assumption of economic similarity of different kinds of inputs to be rejected, then appropriate weighting factors would be warranted to aggregate these physically equivalent but economically different inputs.

Sixth, data on the key variables in PFP estimation itself have several dimensions that different studies have tried approaching differently. Econometric issues have also posed a good amount of challenge for the researchers in this area. Problem of heteroscedasticity has been evident in several cross-sectional productivity analyses though none of the studies that have been reviewed attempted to address this critical issue in much detail. Other econometric concerns have been the existence of multi-collinearity among the aggregate time-series of conventional inputs, etc. Analysis of such concerns was not readily evident in the available evidences.

Seventh, and as mentioned earlier, all PFP measures are essentially average productivity concepts and the dimension of marginal productivity has received only limited focus. After the marginalist revolution of the 1870s, the thrust on understanding economic reality by decomposing its behaviour into a series of marginal conditions required to guarantee their optimal levels, has also characterized microeconomic productivity analysis and off-lately[4] even macro-level productivity studies. It is interesting to find that the estimation of marginal productivities has not been undertaken at all in the Indian context. Data constraints, problems in constructing continuous time-series for marginal productivity, etc. might have been some of the factors that can explain this trend.

Lastly, capital as an input poses at least two dimensions that require a detailed analysis. First, the changes in its quantity help raise agricultural output and second, the variations in its productivity can also enable an increase in agricultural production. While the contribution of the quantity of both traditional and modern capitals have been exhaustively analysed with reference to their role in enhancing land, labour and some non-conventional Partial Factor Productivities, the impact of the productivity of capital on agro output and other Partial Factor Productivities has not received

much notable attention in the available researches. It can however be argued that the problems in aggregating diverse kinds of capitals into a single composite measure of aggregate capital might have been a factor causing this lacuna.

Having analyzed the various dimensions that have emerged through a detailed review of the available evidences, the next section summarizes the discussion undertaken so far and concludes with a note on scope for future research on this vibrant area.

4. Summary and Conclusion

In the course of investigations on PFP in the context of Indian agriculture, several concerns have preoccupied the interest of researchers and chief among them has been to articulate proximate estimates for the actual PFP with a single measure. Land productivity as measured by YPH has been by far the most popular among these. Noteworthy among the debates in this area have been the celebrated inverse relation paradox between farm size and farm productivity which again is measured by YPH, beginning from the classic work by Sen (1962). As this issue has a vast literature in itself, the present study has thus excluded it.

The currently available analysis on PFP still poses good amount of scope for more detailed and exhaustive empirical examinations for future work in this area. In particular, the simultaneous analysis of multiple PFPs in a single study along with a special emphasis on their aggregate behaviour is an important dimension that needs to be addressed. Moreover, the ways in which PFPs can be extended to more kinds of agricultural inputs and in particular to intermediate and non-conventional agricultural inputs is another area that can be illuminated by further research. Usage of sophisticated and sound quantitative frameworks, analysis of both disaggregate and aggregate productivities, construction of better and more information-intensive estimates of PFPs, accounting for qualitative and compositional evolution of various inputs into the measures of their productivities, and an examination of the theoretical and empirical nexus between PFPs and Total Factor Productivity among others, remain worthy of more detailed and rigorous analysis in the coming future.

However, it should be noted that the available evidences on PFP in the Indian context have unearthed good amount of insights on the nature, estimation and determinants of Partial Factor Productivities and are not only limited to the traditional land productivity measures bur rather have encompassed different critical dimensions of labour productivity and to some extent of capital factor productivity also. In terms of the broad trends in the PFP tradition in India, the analytical frameworks have definitely been sharpened with time and the relative importance of sound quantitative approaches to productivity estimation has become more pronounced across the analysis of all major conventional and non-conventional Partial Factor Productivities. Despite the lack of adequate sector-wide studies in the current context, the richness of the disaggregate and micro level analyses on PFP must be applauded for throwing considerable light on the local specificity of Partial Factor Productivities across different districts, states and regions in India. Mention should also be made of the emergence and application of newer and better information on inputs and outputs that take into account, to some extent, the qualitative and economic differences and variations in production processes and productivity behaviour across space and probably through time too.

With the structural changes that have been ongoing in the Indian economy and its subsequent impact on different occupational sectors, the social relations of production within and between these sectors are also experiencing the impact of these aggregate economic forces. In particular, the Indian agriculture sector has historically been characterized by not only unequal distribution of land holdings, agricultural productivity and economic power across major agro-regions but it also displays skewed access to social resources and non-agricultural opportunities across the rural and agro-dependent population of India. Even though there has not been any substantial change on this account, the broad trends do show some positive development in the direction of slight reduction in the various kinds of inequalities embodied in the production relations across the Indian agricultural sector. Productivity changes might have been important in inducing some degree of change in the income and wealth of at least the medium and large farmers if not for the small and marginal farmers. The question of the impact of PFP on incomes, wealth and even agricultural prices requires a very exhaustive investigation and the observations made here on this issue are at best tentative and rudimentary. Future research work can definitely throw a more meaningful light on this matter. Finally, the analytical nexus between PFP and agricultural

prices, and in particular the impact of productivity changes on not only the Minimum Support Pricing policy of the Government but also on the farm gate, mandi and the retail prices of agro produce leave considerable room for more detailed analysis of the various dimensions of agricultural productivity. It is hoped that the present study provides some useful input for more analytical and empirically exhaustive studies in the future.

Notes:

1. KLEMS (K = Capital, L = Labour, E = Energy, M = Materials. S = Services) is a new and emerging statistical framework that provides more refined measurements of key agricultural inputs both at industry and aggregate levels as well as has produced better estimates of partial factor and total factor productivities by taking into account a more exhaustive set of agricultural inputs in the productivity estimation method. India-KLEMS is a research project being undertaken by the Centre for Development Economics, Delhi School of Economics in collaboration with the Reserve Bank of India (RBI). It is one of the many such research projects globally and their database are available on the World-KLEMS website.
2. Farm prices, mandi prices, market prices of the produce, etc. are some of the price-weighting factors used in various studies to add diverse outputs.
3. The quantity-value conundrum associated with the capital input in aggregate production analysis culminated to its peak during the roughly Cambridge controversy era into the works of Nicholas Kaldor, Joan Robinson, Henry Schultz, Pierro Sraffa, etc. More details on these debates can be located in Nadiri (1970).
4. This statement is with reference to the increasing focus on micro-foundations of macroeconomic theories of wage determination, productivity, etc. which are being increasingly analysed with reference to the microeconomic logic associated with firm level wage and productivity determination. Conceptualizing the aggregate production function as an aggregation over the individual production functions presupposes a microeconomic essence for this macroeconomic concept. One can trace the emergence of such theoretical frameworks to the works of Henry Schultz, Robert Solow, etc.

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