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Abstract

The present analytical study, based on regular time series data (for 30 years period from 1980/81 to 2009/10), aims at analyzing sources of output growth in the states of Punjab and Haryana vis-à-vis the overall Indian economy. Specifically, objective of the paper was to examine whether output growth in these economies has been driven primarily by inspiration or perspiration or by both. For this purpose, output-oriented DEA-based Malmquist Productivity Index approach was adopted with Net Domestic Product as output, and Labour, Capital and Electricity Consumption as three inputs. It was observed that in each of the periods (viz., pre-reforms, post reforms and the overall span), both output growth and TFP growth were the fastest in case of Haryana, followed next by the overall Indian economy. The TFP growth in Punjab continued to remain negative during all the three time spans. In a majority sectors of each of the two states' economies, TFP growth has failed to pick up its pace during post-reforms vis-à-vis pre-reforms period. Nevertheless, tertiary sector (as also its sub-sectors) of the aggregated Indian economy registered a significant improvement in TFP growth during the reforms period. Further, as per decomposition analysis of the sources of growth, inspiration component has contributed negatively whereas perspiration component has contributed positively to output growth in all the sectors of Punjab. On the other hand, both inspiration and perspiration components have contributed, in general, positively in the Haryana state and the aggregated Indian economy. Nevertheless, growth in factor accumulation has surpassed that in TFP in all the sectors of these economies. Thus, as per the findings, the three economies, in general, and Punjab economy, in particular, need to strive for a productivity-driven economic growth, so as to achieve sustainability in the growth process. As primary sector has fared quite poorly in all the three economies and during all the periods/ sub-periods; therefore, stringent measures (such as consolidation of rural infrastructure, and promotion of agro-based rural industrialization) need be adopted for providing resilience to this sector of crucial importance (providing employment to a large chunk of the population), so as to achieve inclusiveness in the growth process.

Key Words: Sources of Growth; Total Factor Productivity; Malmquist Productivity Index; Data Envelopment Analysis.

JEL Classification: C02, D24, O30.

Introduction

Growth of an economy is broadly governed by two distinct factors *i.e.*, quantity and quality of resources. Quantity of resources corresponds to *factor accumulation* (*i.e., perspiration component*), while quality of resources refers to *productivity* (*i.e., inspiration component*). The *input driven growth* is achieved through an increase in labour, capital stock, energy *etc*., while *productivity driven growth* (attributed to an advancement in knowledge, technological progress, efficient use of resources, improvement in organizational and human resource management, enhancement of information technology, *etc*.) is the growth in output that cannot be explained by the growth in total inputs. Of the two components, productivity occupies a pivotal role in accelerating the pace of economic growth. As per Krugman (1994), "Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker."

There is a broad consensus among the economists and policy makers that the dominance of inspiration component can lead to sustainable output growth, since it ensures efficient utilization of key resources. The output growth generated merely through factor is associated with diminishing returns to scale and is, therefore, not sustainable in the long-run. Both the components have their own individual importance to augment the output growth and, therefore, a harmonious increase the components is required to attain the maximum potential growth of output (Cororation and Caparas, 1999; Mahadevan, 2007; Sosa *et al.,* 2013). In this context, the present paper is an attempt to examine as to whether output growth in each of Punjab, Haryana and the overall Indian economy is primarily driven by factor accumulation growth or TFP growth. Specifically, the study endeavors to analyse the sources of growth at the aggregated/ disaggregated levels in Punjab and Haryana states *vis-à-vis* the Indian economy, covering the period from 1980/81 to 2009/10.

Literature Reviewed

With a view to lay down an adequate foundation for the present investigation, a brief review of the recent literature on productivity performance through *data envelopment analysis* (DEA) based *Malmquist index* has been made in this section. Kruger (2003) measured the total factor productivity for 87 countries over the period 1960-1990. The study concluded that technological progress over the study period occurred only within OECD countries, whereas all other country groups suffered from technological regress. Qingwang *et al.* (2006) estimated TFP growth, efficiency change and the rate of technological progress of Chinese provincial economy. As per its findings, rate of growth in TFP and technological progress in China was very meager and efficiency deterioration existed widely during the study span. In another similar study, Chen *et al.*, (2008) observed that the major source of TFP growth in agriculture sector was technical progress, rather than efficiency. Covering the period 1971-2004, Jajri (2007) analysed TFP growth in Malaysia, and observed that the output growth was attributed primarily to perspiration than to inspiration component (due to the negative contribution of technical efficiency). Singh (2007) estimated technical efficiency of 36 sugar mills in Uttar Pradesh (spanning over the period 1996-2002) to be 93 per cent, implying thereby that an average mill could make reduction in all its inputs by 7 per cent without adversely affecting its output levels. Sahoo (2008) decomposed the total factor productivity growth into technical change and efficiency change for 28 Indian *sunrise industries* over the period 1978 to 1993, and found the prevalence of productivity decay from pre-liberalisation to transition period (due to growing inefficiencies on the part of most of the industries). Vassdal and Holst (2011) estimated TFP change for Atlantic Salmon in Norway for the period 2001-08. The results demonstrated that TFP increased during the period 2001-2005, but regressed subsequently due to corresponding regress in the technical change. Mallikarjun (2012) observed deterioration in the TFP growth of the Indian manufacturing sector during the period 1980-81 to 1997-98, primarily due to technological regress. Arora and Kumar (2013) decomposed the output growth of Indian sugar industry into inspiration and perspiration components for the period 1974-75 to 2004-05. Their results indicated that TFP contributed positively, while factor inputs contributed negatively to output growth of the.industry.

Besides, there are a number of other studies (such as, Hoff, 2006; Balcombe *et al*., 2008; Galdeano-Gomez, 2008); Tortosa-Ausina *et al.*, 2008; Majumdar and Rajiv, 2009; Murugeshwari, 2011; *etc.*), which also have estimated and decomposed (into constituent components) total factor productivity in India and elsewhere. However, so far as the productivity performance of the crucial (from the point of view of their importance towards ensuring food security) economies of Punjab and Haryana are concerned, scant attention seems to have been paid. Therefore, in order to fill up the existing void in literature, the present investigation endeavours to analyse the sources of output growth, at the aggregated and sectoral levels of the two states *vis-a-vis* the overall Indian economy.

Data

The empirical analysis is confined to the period of 30 years from 1980-81 to 2009-10. For the Indian economy as a whole, requisite data on Net Domestic Product (NDP) and Net Fixed Capital Stock (NFCS) (at both current and constant prices) were sourced from various issues of National Accounts Statistics. And, for Punjab and Haryana states, the data on Net State Domestic Product (NSDP, again at both current and constant prices) were compiled from Statistical Abstracts of the corresponding states. By following Kruger (2003), and Nehru and Dhareshwar (1993), capital stock series for the two states were generated through *perpetual inventory method* (as outlined in Sethi and Kaur, 2012). Data on working force (*proxy* for labour force) were compiled for different sectors/ sub-sectors of the states of Punjab and Haryana, and overall Indian economy at the census years of 1981, 1991 and 2001. Through the usual compound growth rate law, interpolations were made so as to generate regular time series on working force in each of the activities.

Data on domestic product and capital stock were available in parts at differential base years; therefore, by making use of information in respect of the overlapping years, the time series were spliced together so as to get comparable series at 2004-05 constant prices. Aggregations were then made (for each of income, capital stock and working force) in respect of major sectors, *viz.* Primary [PRM, comprising of Agriculture and Allied Activities; Forestry and Logging; Fishing; and Mining & Quarrying]; Secondary [SEC, comprising of Registered Manufacturing; Unregistered Manufacturing; Construction; and Electricity, Gas & Water Supply]; Tertiary-1 [TR1, comprising of Railways; Transport by Other Means; Storage; Communication; and Trade, Hotels & Restaurants]; Tertiary-2 [TR2, comprising of Banking & Insurance; Residential Buildings and Dwellings; Public Administration; and Other Services]; Aggregated Tertiary [TRT, comprising of TR1 and TR2]; and Aggregated Income [AGG, comprising of PRM, SEC, and TRT].

Data on electricity consumption (*proxy* for energy) for the three economies were sourced from various issues of Statistical Abstracts of Punjab/ Haryana states. The information was available in respect of five activities *viz.*, Agriculture, Industrial, Commercial, Domestic and Public Lighting. For the purpose of proximity with domestic product and capital stock, data on electricity consumption were re-defined as, Primary [PRM, comprising of Agriculture]; Secondary [SEC, comprising of Industrial]; Tertiary-1 [TR1, comprising of Commercial]; Tertiary-2 [TR2, comprising of Domestic and Public Lighting]; Aggregated Tertiary [TRT, comprising of TR1 and TR2]; and Aggregated electricity consumption [AGG, comprising of PRM, SEC, and TRT]. Due to major changes in macroeconomic policy governing the Indian economy, the study span was sub-divided into: (i) Pre-reforms period (1980-81 to 1990-91), and (ii) Post-reforms period (1990-91 to 2009-10).

Analytical Techniques

Growth in TFP can be measured by estimating frontier production functions and then deriving shifts in the frontier (*i.e.*, productivity changes) from the changes in each of inputs and output of the economy. The basic building block of the frontier methods is the distance of observations (on inputs and output) from this frontier function, which is then interpreted as inefficiency. For the estimation of frontier functions, two distinct approaches are available: (a) Parametric Stochastic Frontier Analysis (*i.e.,* SFA); and (b) Non-Parametric Data Envelopment Analysis (*i.e.,* DEA). A pre-requisite of SFA lies in the specification of the underlying functional form of the production function. Furthermore, certain distributional assumptions are necessary for the separation of distance to the frontier function from measurement error (Kruger, 2003). Monte-Carlo studies of Gong and Sickles (1992) and Banker *et al.*, (1993) have demonstrated that the strength of SFA is questionable in small- and medium-sized samples. On the contrary, DEA neither requires inputs in monetary terms nor does it rely on assumptions of a particular functional form or a particular statistical distribution (Hirschberg and Lye, 2001). Consequently, in the present study, we have opted for the DEA approach to calculate the distances. It may be mentioned that based on Farrell's (1957) work, Charnes *et al.* (1978) introduced this nonparametric technique for measuring the relative efficiency of a set of similar units, referred to as *decision making units* (DMUs). The DEA technique is directed to compute a score which defines the relative efficiency of a given DMU versus all other DMUs observed in the sample. In the present investigation, major sectors of the economies have been taken as DMUs.

Malmquist Index of TFP Growth

Malmquist (1953) provided the foundations of a quantity index for its application in consumption analysis, which now bears his name. Later on, Caves *et al*., (1982) adapted Malmquist's idea to production analysis, which allows us to handle multiple inputs and outputs (Grifell-Tatje and Lovell, 1999). Subsequently, Fare *et al*. (1992) merged Farrell's (1957) measurement of efficiency with Caves *et al*.'s (1982) measurement of productivity to develop a new *Malmquist index of productivity change*, and demonstrated that the resulting total factor productivity (TFP) index was decomposable into *efficiency change* (EFCH) and *technical change* (TECH) components. Fare *et al.* (1994b) illustrated that efficiency change could further be decomposed into *pure technical efficiency change* (PECH) and *scale efficiency change* (SECH) – a development that has made the Malmquist index widely popular as an empirical index of productivity change.

Basically, Malmquist productivity index (MPI) is geometric mean of two ratios of distance functions of the type

$$D^t\left(x^t,y^t\right)=\left[\sup\left\{\theta:\left(x^t,\theta y^t\right)\in S^t\right\}\right]^{-1} \qquad \text{... (1)}$$

which give the reciprocal of the maximum augmentation of the output in period t (assuming inputs to remain at a fixed level) that is needed to reach a boundary point of the technology set. Equivalently, the distance function is reciprocal of the Farrell's output-oriented measure of efficiency, which can be calculated using DEA as

$$D^t\left(x^t,y^t\right)=\inf\left\{\theta:\ \left(x^t,y^t/\theta\right)\in S^t\right\} \qquad \text{... (2)}$$

where at time 't', x^t represents an N-dimensional vector of input quantities (*i.e.*, $x^t\in R^N_+$); y^t represents an M-dimensional vector of output quantities (*i.e.*, $y^t\in R^M_+$); and S^t describes production possibility set that is feasible using the technology available at that time. That is,

$$S^t=\left\{\left(x^t,y^t\right):\ x^t\geq 0 \text{ can produce } y^t\geq 0\right\} \qquad \text{... (3)}$$

It may be clarified that the term $\inf\left\{\theta:\ \left(x^t,y^t/\theta\right)\in S^t\right\}$ in equation (2) states that, of the set of real numbers θ, where θ is such that the input-output combination $\left(x^t,y^t/\theta\right)$ is part of the production possibility set that is technically feasible given time t technology, we need to find the infimum (or the greatest lowest bound) of θ. In other words, the infimum of θ is the biggest real number that is less than or equal to every number in θ. This infimum is equivalent to finding the reciprocal of $\sup\left\{\theta:\left(x^t,\theta y^t\right)\in S^t\right\}$. That is, we determine the reciprocal of the supremum of the set of real numbers θ, such that for a given input vector x^t, the input-output combination (x^t,y^t) is part of the production possibility set that is technically feasible, given time 't' technology. The supremum of θ is the smallest real number that is greater than or equal to every number in θ.

Caves *et al.* (1982) defined the Malmquist productivity index (M^t) as the ratio of two output distance functions which were based on technology at time 't' as the reference technology:

$$M^t = \frac{D^t\left(x^{t+1}, y^{t+1}\right)}{D^t\left(x^t, y^t\right)} \qquad \text{... (4)}$$

The superscript 't' associated with D refers as to which period's production frontier is used as reference technology. The numerator in the above equation indicates the output distance function at time 't+1' based on period 't' technology, while denominator refers to the output distance function at time 't' based on period 't' technology. Instead of using period 't's technology as the reference technology, we may similarly construct output distance functions based on period 't+1's technology, thus getting Malmquist productivity index:

$$M^{t+1}=\frac{D^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D^{t+1}\left(x^t, y^t\right)} \qquad \text{... (5)}$$

With a view to avoid arbitrariness in the choice of base period, Fare *et al.* (1994a, b) proposed using geometric mean of the indexes for the periods 't' and 't+1', thus resulting in the Malmquist index of productivity change, given by

$$M^{t+1}\left(x^t, y^t, x^{t+1}, y^{t+1}\right) = \left[\frac{D^t\left(x^{t+1}, y^{t+1}\right)}{D^t\left(x^t, y^t\right)} \times \frac{D^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D^{t+1}\left(x^t, y^t\right)}\right]^{1/2} \qquad \text{... (6)}$$

The three inputs (*viz.*, capital stock, labour and energy) of a given sector in period 't' are contained in the input vector $x^t = (K_t, L_t, E_t)'$ and output (*viz.*, real net domestic product of the sector) is stated as $y^t = (Y_t)'$. It may be reiterated that $D^t\left(x^t, y^t\right)$ refers to *the output distance function* based on the input and output vectors at time 't', and period 't' technology; $D^t\left(x^{t+1}, y^{t+1}\right)$ refers to the *output distance function* at time 't+1' based on period 't' technology; $D^{t+1}\left(x^t, y^t\right)$ refers to the *output distance function* at time 't' based on period 't+1' technology; and $D^{t+1}\left(x^{t+1}, y^{t+1}\right)$ refers to the *output distance function* at time 't+1' based on period 't+1' technology.

The calculation of distance functions and how they can be used to give insights about efficiency change and technical change is illustrated diagrammatically in Figure 1 below.

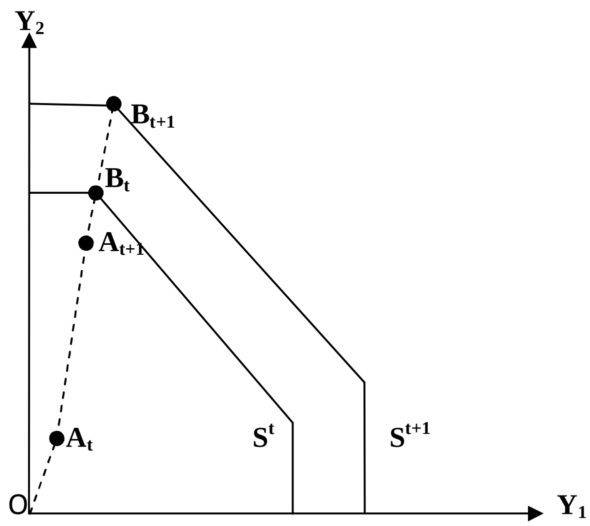

Figure 1: Production Possibility Set for Periods 't' and 't +1'
(Source: Nin *et al*., 2003)

In the figure, production possibility sets are depicted for two decision making units A and B and for the two different time periods 't' and 't+1'. As is evident, B is lying *on* the production possibility frontier in both the time periods, thereby implying that it is fully technically efficient. On the other hand, input-output combination points of A lies inside the production frontier during both the time periods, meaning thereby that this DMU, in comparative terms, is less efficient. For A, the distance from the production point in time period 't' to the frontier in time period 't', that is, $D^t\left(x^t, y^t\right) = OA_t/OB_t$. Evidently, this ratio is less than unity, implying that A is comparatively inefficient. In case of B, the distance from its production point to the frontier equals unity as it lies on the frontier. Similarly, A's distance of its production point from the frontier in time period 't+1' is $D^{t+1}\left(x^{t+1}, y^{t+1}\right) = OA_{t+1}/OB_{t+1}$. A comparison of these two distance functions tells about the performance of the DMU A on efficiency front; if A has become more efficient in time period 't+1' than it was in 't', then its production point in 't+1' would be closer to the same period frontier than in the preceding period. In other words, the distance computed from $D^{t+1}\left(x^{t+1}, y^{t+1}\right)$ would be greater than $D^{t}\left(x^{t}, y^{t}\right)$.

The above distances have been calculated from the corresponding period's production frontier. However, the distances can also be computed using some other period's production frontier/ technology. For example, for the DMU A, distance of its production point in time period 't' can be calculated with respect to the frontier of time period 't+1', *i.e.*, $D^{t+1}\left(x^{t}, y^{t}\right) = 0A_{t}/0B_{t+1}$. Similarly, the distance of A's production point in time period 't+1' can be computed using time period 't's frontier as reference technology, *i.e.*, $D^{t}\left(x^{t+1}, y^{t+1}\right) = 0A_{t+1}/0B_{t}$. A comparison of these mixed-periods' distance functions can assist us in revealing as to whether or not technical change has taken place in a given DMU. If the distance computed of period 't's production point from period 't+1's frontier exceeds that from period 't's frontier $\left[\textit{i.e.}, \text{ if } D^{t+1}\left(x^{t}, y^{t}\right) > D^{t}\left(x^{t}, y^{t}\right)\right]$ then it implies an outward shift of production frontier in time period 't+1' compared to the time period 't'.

As per the above discussion, Malmquist productivity index is based on such distance functions. The index points towards positive (negative) TFP growth between the time periods 't' and 't+1', if its value is larger (smaller) than *unity*. In other words, an improvement (or deterioration) in the components of TFP are indicated by values larger (or smaller) than one[1]. Rewriting equation (6), we have

$$M^{t+1}\left(x^{t}, y^{t}, x^{t+1}, y^{t+1}\right) = \underbrace{\left[\frac{D^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D^{t}\left(x^{t}, y^{t}\right)}\right]}_{\text{EFCH}} \times \underbrace{\left[\frac{D^{t}\left(x^{t+1}, y^{t+1}\right)}{D^{t+1}\left(x^{t+1}, y^{t+1}\right)} \times \frac{D^{t}\left(x^{t}, y^{t}\right)}{D^{t+1}\left(x^{t}, y^{t}\right)}\right]^{1/2}}_{\text{TC}} \qquad \ldots (7)$$

Thus, a striking feature of the Malmquist index is that it is capable of decomposing total factor productivity growth into two mutually exclusive and non-additive components: *technical efficiency change* – an index of catching up; and *technical progress* – an index of technological innovations or upgradation of technology, reflecting the changes in input-output mix and representing the movement of a given DMU towards the best practice frontier under *learning-by-doing* process (Kalirajan *et al*., 1996). In this sense, TFP growth is a *composite measure* of technological change and changes in the efficiency with which known technology is applied to production processes (Ahluwalia, 1991). It may be emphasized that a value of the efficiency change component of the Malmquist index greater than unity implies that the production unit is closer to the frontier in period 't +1' than it was in period 't' (*i.e.,* the production unit is catching up to the frontier). However, a value of the index less than unity indicates efficiency regress. Values of the technical change component of total factor productivity can be interpreted similarly.

Estimation of Malmquist productivity index requires the quantification of four distance functions: $D^t\left(x^t, y^t\right)$, $D^t\left(x^{t+1}, y^{t+1}\right)$, $D^{t+1}\left(x^t, y^t\right)$, and $D^{t+1}\left(x^{t+1}, y^{t+1}\right)$. These quantifications are made by solving linear programming problem, which may either be input-oriented or output-oriented distance functions. An input-oriented distance function characterizes the production technology by looking at the minimal proportional contraction of input vector, given an output vector whereas, on the other hand, an output-oriented distance function considers the maximal proportional expansion of output vector, given an input vector. The output-oriented DEA model[2] (adopted in the present study) has been stated as follows:

For a given sector k, $D^t\left(x^t, y^t\right)$ can be computed as

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[1]For the decomposition and Meaning of Malmquist index, Fare *et al*., (1994b) provided a detailed explanation.

[2]The basic input-oriented DEA model can be deduced from it by switching each of the inputs and outputs into the place of the other.

$$\left.\begin{aligned}
&\left[D^{t+i}\left(x^{t+j},y^{t+j}\right)\right]^{-1} = \max_{\theta_K,\,\lambda_K} \theta^k \\
&\text{s.t.} \\
&\theta^k\; y_m^{k,\,t+j} \le \sum_{k=1}^{K} \lambda^{k,\,t+i}\; y_m^{k,\,t+i}\;;\;\; m = 1, 2, ..., M \\
&\sum_{k=1}^{K} \lambda^{k,\,t+i}\; x_n^{k,\,t+i} \le x_n^{k,\,t+j} \qquad ;\;\; n = 1, 2, ..., N \\
&\lambda^{k,\,t+i} \ge 0 \qquad\qquad\qquad ;\;\; k = 1, 2, ..., K
\end{aligned}\right\} \qquad ...(8)$$

where

$$\left.\begin{aligned}
&(i, j) = (0, 0) \text{ for solving for } D^t\left(x^t, y^t\right); \\
&(i, j) = (0, 1) \text{ for solving for } D^t\left(x^{t+1}, y^{t+1}\right); \\
&(i, j) = (1, 0) \text{ for solving for } D^{t+1}\left(x^t, y^t\right); \text{ and} \\
&(i, j) = (1, 1) \text{ for solving for } D^{t+1}\left(x^{t+1}, y^{t+1}\right).
\end{aligned}\right\} \qquad ...\ (9)$$

In the above linear programming problems, λ^k indicates the intensity at which a particular sector is employed in constructing frontier of the technology set. The technology specified here is non-parametric but assumes constant returns-to-scale and strong disposability of inputs and outputs. Following Afriat (1972), one may allow for variable returns to scale (increasing, constant or decreasing) by way of imposing the constraint $\sum \lambda^k = 1$ in all the linear programs. Thus, by estimating the distance functions defined by model (8) under the restriction $\sum \lambda^k = 1$, we can decompose the efficiency change into *pure efficiency change* (PECH) and *scale efficiency change* (SECH), as follows

$$\underbrace{\frac{D^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D^t\left(x^t, y^t\right)}}_{\text{EFCH}} = \underbrace{\frac{D_v^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_v^t\left(x^t, y^t\right)}}_{\text{PECH}} \times \underbrace{\frac{D_c^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_v^t\left(x^{t+1}, y^{t+1}\right)}}_{\text{SECH}} \qquad ...\ (10)^3$$

Pure efficiency change refers to the managerial efficiency change, whereas scale efficiency change explains the changes in efficiency due to changes in the scale of operations.

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[3]Subscripts c and v represents the constant returns to scale and variable returns to scale respectively

The analysis was carried out by using the '*nonparaeff*' package (due to Oh, 2012) in R-language, suitably adapted by the senior author of this paper.

Main Findings

Findings from the study have been discussed in brief under two sections. The first section is devoted to the discussion on the results pertaining to inter-temporal and inter-sectoral variations in the output growth in Punjab, Haryana and the Indian economy, while the second section deals with the decomposition of output growth into the growth of inputs and TFP.

Inter-Temporal and Inter-Sectoral Variations in Output Growth

During the 30 years' study span, the aggregated output in the country has grown at an average annual rate of 5.88 percent. At the states level, the rate was marginally higher at 5.99 percent in Haryana, but only at 4.33 percent in Punjab (Table 1). In both Indian and Haryana economies, tertiary-1 sector experienced the fastest rate of growth, but in case Punjab it was the secondary

Table 1: Average Annual Kinked Rates of Growth in Output - Punjab, Haryana and the Indian Economy

Sector	Pre-Reforms Period	Post-Reforms Period	Entire Period
		PUNJAB	
PRM	5.105	2.398	3.153
SEC	6.329	6.353	6.347
TR1	2.315	6.319	5.177
TR2	3.144	3.945	3.719
TRT	2.818	4.870	4.289
AGG	4.289	4.341	4.327
		HARYANA	
PRM	4.587	2.528	3.103
SEC	5.347	6.259	6.001
TR1	6.324	10.976	9.646
TR2	4.908	7.309	6.628
TRT	5.408	9.092	8.043
AGG	4.791	6.461	5.988
		INDIA	
PRM	3.223	2.826	2.938
SEC	4.754	6.496	6.003
TR1	4.959	9.062	7.891
TR2	7.786	7.358	7.478
TRT	6.531	8.174	7.666
AGG	4.701	6.350	5.883

Source: Authors' Computations

Notes: For the sub-periods, *kinked rates of growth* were computed by following Sethi (2008, 2010).

sector which had an edge. Further, at the aggregated level, the pace of growth in each of Indian and Haryana economies was perceptibly faster during post-reforms *versus* pre-reforms period. But, the pace has remained virtually stagnant in case of Punjab. At the sectoral level, the major gainer (from pre- to post-reforms spans) was tertiary-1 sector whereas, on the contrary, the major loser was primary sector. Although the observations are well-known (in the sense of tertiarisation of the Indian economy by way of liberalization policy); yet it may be emphasized that a slippage of primary sector needs be viewed as a matter of serious concern (from the angle of employment provider to a large chunk of population in these economies).

Decomposition of Output Growth

An analysis of the rates of growth in output has thus revealed that except for primary sector, the output from all other sectors of the three economies have registered comparatively faster growth (although through varying extents) during post-reforms period. Thus the reforms measures seem to have induced positive effects on the growth process in these economies. This prompts us to go in for studying the causes of such a growth performance. The exploration of these causes entails the decomposition of output growth into two mutually exclusive components *viz*., *Inspiration Component* (*i.e.,* TFP growth) and *Perspiration Component* (*i.e.,* Input growth). In other words, the decomposition analysis will enable us to gauge as to whether growth in output has been driven primarily by that in productivity or inputs.

Inspiration Component **(*i.e.,* TFP growth)**

Inspiration component of the output growth corresponds to the TFP growth in an economy, which has been estimated using *output-oriented*[4] *DEA-based Malmquist productivity index* (MPI). Inter-temporal and Inter-sectoral variations in computed values of the index for each of the three economies have been presented in Table 2. It may be clarified that a value of MPI exceeding unity indicates improvement in productivity; equaling unity denotes absence of productivity change; and a value of the MPI falling below unity indicates a deterioration in productivity. From the computed value of the index, rate of growth in TFP was simply obtained as

$$\text{TFPG (\%)} = \left(\text{MPI - 1}\right) \times 100 \qquad \text{... (11)}$$

Table 2: Inter-Temporal and Inter-Sectoral Variations in Total Factor Productivity and its Constituent Components in Punjab, Haryana and India

Span	PUNJAB						HARYANA						INDIA					
	Sector						Sector						Sector					
	PRM	SEC	TR1	TR2	TRT	AGG	PRM	SEC	TR1	TR2	TRT	AGG	PRM	SEC	TR1	TR2	TRT	AGG
	Total Factor Productivity[#]						**Total Factor Productivity**						**Total Factor Productivity**					
Pre[1]	0.989	0.971	0.966	0.989	0.969	1.001	1.010	1.059	1.034	1.015	1.031	1.050	0.989	1.028	0.998	1.023	1.021	1.010
Pst[2]	0.997	0.988	0.976	0.983	0.981	0.994	0.984	0.998	1.031	1.010	1.025	1.021	0.989	0.999	1.018	1.026	1.031	1.004
Ent[3]	0.994	0.982	0.973	0.985	0.977	0.997	0.993	1.019	1.032	1.012	1.027	1.031	0.989	1.010	1.011	1.025	1.028	1.006
	Technical Efficiency[$]						**Technical Efficiency**						**Technical Efficiency**					
Pre	1.000	0.968	1.000	1.000	1.000	0.980	1.000	1.000	1.000	0.991	0.995	1.022	1.000	1.000	1.000	1.000	1.000	0.991
Pst	1.000	1.013	1.000	1.000	1.000	1.009	0.941	0.982	1.000	0.975	0.988	0.979	0.976	0.967	1.000	1.000	1.000	0.984
Ent	1.000	0.997	1.000	1.000	1.000	0.999	0.961	0.988	1.000	0.981	0.990	0.993	0.984	0.978	1.000	1.000	1.000	0.986
	Pure Efficiency						**Pure Efficiency**						**Pure Efficiency**					
Pre	1.000	0.969	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.993	1.000	1.000	1.000	0.987	1.000	1.000	1.000	1.000
Pst	1.000	1.014	1.000	1.000	1.000	1.000	0.959	0.987	1.000	0.980	1.000	1.000	1.000	0.968	1.000	1.000	1.000	1.000
Ent	1.000	0.998	1.000	1.000	1.000	1.000	0.973	0.992	1.000	0.985	1.000	1.000	1.000	0.975	1.000	1.000	1.000	1.000
	Scale Efficiency						**Scale Efficiency**						**Scale Efficiency**					
Pre	1.000	0.999	1.000	1.000	1.000	0.980	1.000	1.000	1.000	0.998	0.995	1.022	1.000	1.014	1.000	1.000	1.000	0.991
Pst	1.000	0.999	1.000	1.000	1.000	1.009	0.981	0.995	1.000	0.995	0.988	0.979	0.976	0.998	1.000	1.000	1.000	0.984
Ent	1.000	0.999	1.000	1.000	1.000	0.999	0.988	0.997	1.000	0.996	0.990	0.993	0.984	1.004	1.000	1.000	1.000	0.986
	Technological progress						**Technological progress**						**Technological progress**					
Pre	0.989	1.003	0.966	0.989	0.969	1.021	1.010	1.059	1.034	1.024	1.036	1.028	0.989	1.028	0.998	1.023	1.021	1.019
Pst	0.997	0.976	0.976	0.983	0.981	0.985	1.046	1.016	1.031	1.036	1.038	1.043	1.013	1.035	1.018	1.026	1.031	1.020
Ent	0.994	0.985	0.973	0.985	0.977	0.997	1.033	1.031	1.032	1.032	1.037	1.038	1.005	1.032	1.011	1.025	1.028	1.019

Source: Authors' Computations

Notes: [1]Pre refers to pre-reforms period (*i.e.*, 1980-81 to 1990-91)
[2]Pst refers to post-reforms period (*i.e.*, 1990-91 to 2009-10)
[3]Ent refers to the Entire study period (*i.e.*, 1980-81 to 2009-10)
[#]Index of Total Factor Productivity is the product of Technical Efficiency and Technological Progress.
[$]Index of Technical efficiency is the product of Pure Efficiency and Scale Efficiency.

The same procedure was adopted to compute the rates of growth in other components of the Malmquist productivity index.

For the Punjab state as a whole, the value of MPI (= 0.997) computed from the entire study span (Table 2) indicates that on an average, total factor productivity in the state has undergone a decay at a rate of 0.3 percent per annum. On the other hand, Haryana state (associated with the value of MPI equaling 1.031) registered an average growth in total factor productivity at a rate of 3.1 percent per annum, which was even higher than that (equaling 0.6 percent per annum) for all India. A comparison of such a low rate of TFP growth (for the aggregated Indian economy in general, and Punjab economy in particular) with the relatively higher output growth reflects factor inputs to be the primary contributor to the growth process.

As per the inter-sectoral analysis, all the sectors in Punjab state have registered negative TFP growth during the entire study span (Table 2). However, in Haryana state and the overall Indian economy, all the sectors (except primary) experienced positive TFP growth, with Tertiary-1 and Tertiary-2 sectors, having been the best performers in the two economies, respectively.

As regards sub-period analysis, performance of TFP in the Punjab state has been rather dismal (particularly during the pre-reforms period), thereby pointing towards a non-sustainable output growth in the state in the long run. In Haryana, however, the situation was just the other way round; although TFP growth continued, in general, to be positive, yet its pace slowed down during the post-reforms period. In the Indian economy as a whole, tertiary sector (as also its sub-sectors) registered a significant improvement in TFP growth by way of the reforms process.

As already mentioned, TFP growth is a composite measure of efficiency change and technical progress. Furthermore, efficiency change is decomposable into (a) pure efficiency and (b) scale efficiency. We shall now make a brief discussion on such a break-up (Table 2), as follows:

Efficiency Change in the Three Economies

A glance at Table 2 reveals that in case of Punjab, the value of efficiency change index for each of PRM, TR1, TR2 and TRT sectors remained, more or less, static at unity for all the years. Somewhat a similar picture emerged in case of Tertiary-1 sector of Haryana and Aggregated Tertiary sector of the Indian economy. These sectors have, thus, undergone no temporal change in efficiency. These findings are, of course, not unusual; Nasir (2008), too, observed that mining as well as construction sectors of Indonesia was associated with a value of efficiency change equaling unity during his study span, 1992-2004.

Further, by way of economic reforms, no significant improvement was noticed in technical efficiency of a majority of the sectors in Punjab. Secondary sector was the only exceptional case wherein growth rate of technical efficiency improved from (-) 3.2 percent during pre-reforms period to 1.3 percent per annum during post-reforms period. Notably, the observed efficiency improvement in the sector was mainly attributed to pure efficiency rather than to scale efficiency; the reason being that the value of pure efficiency index increased from 0.969 (during pre-reforms period) to 1.014 (during post-reforms period), while that of scale efficiency remained stagnant at 0.999. In other words, pure efficiency in the sector has undergone growth through 4.4 percentage points by way of the economic reforms, whereas scale efficiency has remained static over the entire study period. With respect to efficiency change, the Punjab state on the whole has portrayed a pattern quite similar to that of its secondary sector. Nevertheless, the prime contributor in this change was scale efficiency rather than pure efficiency (Table 2). On the other hand, Haryana state has witnessed a somewhat different pattern of growth of technical efficiency. All the sectors experienced deterioration in efficiency change during the reforms period, which had resulted largely due to corresponding deterioration in scale efficiency, rather than in pure efficiency. At the aggregated level, technical efficiency in the state grew at a rate of 2.2 percent per annum during pre-reforms period, which declined to (-) 2.1 percent during post-reforms period. Quite a similar picture (regarding efficiency change) has emerged in the aggregated Indian economy as also in its primary sector; in these aggregates, efficiency deteriorated during the reforms period and that the deterioration has again resulted from a decline in scale efficiency. Efficiency in secondary sector, too, has declined during the reforms period, but the decline was due to a dip in both pure and scale efficiency. Nonetheless, aggregated tertiary (and its sub-sectors) of the Indian economy have witnessed no change in efficiency (Table 2).

Technological Progress in the Three Economies

Technological progress is the result of activities like R&D, innovations, *etc.*, generating knowledge. Values of technological progress (or, equivalently, technical progress[4]) component of *Malmquist Productivity index* to be greater (less) than unity, indicates the phenomenon of technological progress (regress). It may be reiterated that the product of efficiency change and technical change components, by definition, equals TFP change index, even though the individual components could be moving in non-harmonious directions.

In case of Punjab state, the phenomenon of technological regress (as indicated by value of the technological progress index, TPI, equaling 0.997; Table 2) was found to be present during entire study span, while in the other two economies, there has been the prevalence of technological progress (values of the TPI being 1.038 for Haryana and 1.019 for India). At the sectoral level as well, TPI in Punjab was estimated to be less than unity in all the sectors, while in Haryana and the overall Indian economy, the values turned out to be greater than unity in all the sectors. In Haryana state, the fastest growth (equaling 3.8 percent) in technical progress happened to be in tertiary sector, followed by (3.3 percent) in primary sector, while in the Indian economy as a whole, secondary sector gained the momentum in terms of technical progress at an annual rate equaling 3.2 percent.

As per inter-temporal analysis of technological progress, values of this index for the Punjab state were estimated to be less than unity during pre- as well as post-reforms period, thereby indicating towards an inward shift in the production frontier (implying technical regress). This regress might be responsible for a negative growth in TFP in majority sectors of the state. The findings are indicative of non-adoption of the improved technology in these sectors as quickly as it should ideally have been. A comparison of the values of technological progress index with efficiency index (Table 2) evinces that a majority sectors of the Punjab state have been lagging behind largely in terms of technical change rather than efficiency change. On the other hand, in case of Haryana state and the Indian economy, a vertically opposite picture has emerged during the three time spans; values of technical change index turned out to be greater than unity in majority cases, thereby indicating towards an outward shift in the production frontier (thereby reflecting technical progress). It may further be highlighted that in these two economies, it was the technical progress (rather than efficiency change) which acted as the dominant source of productivity gains.

[4]The terms technical change, technological progress and technical progress have been used interchangeably throughout the study.

Perspiration Component (i.e., Input Growth)

In a given economy, input growth − the second component of output growth − was worked out as *residual* (by deducting TFP growth from output growth). Table 3 presents the estimates of input growth for the three economies considered in the study. As is evident from the table, input

Table 3: Average annual Growth Rate in Inputs in Punjab, Haryana and Indian Economy

Sector	Pre-Reforms Period	Post-Reforms Period	Entire Period
	PUNJAB		
PRM	6.205	2.698	3.753
SEC	9.229	7.553	8.147
TR1	5.715	8.719	7.877
TR2	4.244	5.645	5.219
TRT	5.918	6.770	6.589
AGG	4.189	4.941	4.627
	HARYANA		
PRM	3.587	4.128	3.803
SEC	-0.553	6.459	4.101
TR1	2.924	7.876	6.446
TR2	3.408	6.309	5.428
TRT	2.308	6.592	5.343
AGG	-0.209	4.361	2.888
	INDIA		
PRM	4.323	3.926	4.038
SEC	1.954	6.496	5.003
TR1	5.159	7.262	6.791
TR2	5.486	4.758	4.978
TRT	4.431	5.074	4.866
AGG	3.701	5.950	5.283

Source: Authors' Computations

growth was, in general, positive; secondary sector and aggregated economy of the Haryana state during pre-reforms period were the only exceptional instances to have experienced input growth at negative rates (of -0.55 and -0.21 percent per annum, respectively). During the entire study span, the average annual rate of growth in inputs was 4.6 percent for Punjab, 2.9 percent for Haryana and 5.3 percent for India.

A comparison of the temporal rates of growth evinces that in Punjab state, the pace of growth in factor inputs has retarded in case of primary and secondary sectors during post-reforms period, whereas that in tertiary and its sub-sectors has accelerated. However, in Haryana state, none of the sectors experienced temporal deceleration in input growth during the reforms period. As far as Indian economy is concerned, primary and tertiary2 sectors have experienced a slow-down, while the remaining activities have gained improvement in the rate of inputs' growth.

Sources of Output Growth in the Three Economies – Whether Inspiration or Perspiration Drives the Output Growth?

Now an obvious question arises as to whether a high or a low rate of growth in factor inputs could be viewed as a healthy sign for a given economy. In other words, we would be interested in knowing as to whether it is TFP growth or input growth which acts as a dominant source of output growth. A concrete answer to this could possibly be provided (as in the present section) through the relative contribution of inputs to output growth. If a rapid growth in inputs leads to a still rapid growth in output of the economy, then such a growth in factor inputs could be considered as desirable, otherwise not. Tables 4, 5 and 6 depict such an analysis for Punjab, Haryana and the Indian economy, respectively. Further, In order to have a lucid picture about the sources of output growth, the contribution made by the inspiration and perspiration components in output growth have also been depicted diagrammatically (Figure 1 for Punjab, Figure 2 for Haryana and Figure 3 for India).

As per Table 4 (for the Punjab state), growth in factor inputs at a rate of 4.6 percent has led to growth in output at a rate of 4.3 percent, thereby indicating a negative contribution of TFP growth, equaling (-) 0.34 percent per annum. At the sectoral level as well, growth in inputs have outweighed growth in output in all the sectors during pre-reforms, post-reforms as well as the entire period, thereby indicating a negative contribution of inspiration component. This paints a rather gloomy picture of the Punjab state. Alternatively, such a performance of TFP could be stated (as already mentioned) as technological regress in the state. Turning to sub-period analysis, it was observed that during pre-reforms period, as high as 97.2 percent of the contribution in output growth was attributable to perspiration component, while just 2.8 percent was due to inspiration component, which further fell to (-) 1.3 percent during post-reforms period (Table 4; Figure 1). We may, thus, conclude that in the Punjab state, it was the perspiration component (*i.e.*, factor accumulation) which was the major driving force behind the growth in output. Since factor inputs are known to be associated with diminishing returns; therefore, such a growth pattern would not be sustainable in the long-run. Moreover, an increase in output

Table 4: Sources of Growth in respect of Major Sectors during Different Time Spans – Punjab

Time-Period	Av. Annual Growth Rate (%) in	Primary	Secondary	Tertiary-1	Tertiary-2	Tertiary	Aggregated Economy
Pre-Reforms Period	Output Growth	5.11 (100.00)	6.33 (100.00)	2.32 (100.00)	3.14 (100.00)	2.82 (100.00)	4.29 (100.00)
	Inspiration Component	-1.11 (-21.72)	-2.90 (-45.81)	-3.40 (-146.55)	-1.05 (-33.44)	-3.07 (-108.87)	0.12 (2.80)
	Perspiration Component	6.22 (121.72)	9.23 (145.81)	5.72 (246.55)	4.19 (133.44)	5.89 (208.87)	4.17 (97.20)
Post-Reforms Period	Output Growth	2.40 (100.00)	6.35 (100.00)	6.32 (100.00)	3.95 (100.00)	4.87 (100.00)	4.34 (100.00)
	Inspiration Component	-0.34 (-14.17)	-1.18 (-18.58)	-2.41 (-38.13)	-1.66 (-42.03)	-1.93 (-39.63)	-0.58 (-13.36)
	Perspiration Component	2.70 (112.50)	7.55 (118.90)	8.72 (137.97)	5.65 (143.04)	6.77 (139.01)	4.94 (113.82)
Entire Period	Output Growth	3.15 (100.00)	6.35 (100.00)	5.18 (100.00)	3.72 (100.00)	4.29 (100.00)	4.33 (100.00)
	Inspiration Component	-0.61 (-19.37)	-1.77 (-27.87)	-2.75 (-53.09)	-1.45 (-38.98)	-2.33 (-54.31)	-0.34 (-7.85)
	Perspiration Component	3.75 (119.05)	8.15 (128.35)	7.88 (152.12)	5.22 (140.32)	6.59 (153.61)	4.63 (106.93)

Table 5: Sources of Growth in respect of Major Sectors during Different Time Spans – Haryana

Time-Period	Av. Annual Growth Rate (%) in	Primary	Secondary	Tertiary-1	Tertiary-2	Tertiary	Aggregated Economy
Pre-Reforms Period	Output Growth	4.59 (100.00)	5.35 (100.00)	6.32 (100.00)	4.91 (100.00)	5.41 (100.00)	4.79 (100.00)
	Inspiration Component	0.95 (20.70)	5.87 (109.72)	3.40 (53.80)	1.49 (30.35)	3.06 (56.56)	5.00 (104.38)
	Perspiration Component	3.64 (79.30)	-0.52 (-9.72)	2.92 (46.20)	3.42 (69.65)	2.35 (43.44)	-0.21 (-4.38)
Post-Reforms Period	Output Growth	2.53 (100.00)	6.26 (100.00)	10.98 (100.00)	7.31 (100.00)	9.09 (100.00)	6.46 (100.00)
	Inspiration Component	-1.55 (-61.26)	-0.17 (-2.72)	3.12 (28.42)	1.03 (14.09)	2.51 (27.61)	2.06 (31.89)
	Perspiration Component	4.08 (161.26)	6.43 (102.72)	7.86 (71.58)	6.28 (85.91)	6.58 (72.39)	4.40 (68.11)
Entire Period	Output Growth	3.10 (100.00)	6.00 (100.00)	9.65 (100.00)	6.63 (100.00)	8.04 (100.00)	5.99 (100.00)
	Inspiration Component	-0.70 (-22.58)	1.87 (31.17)	3.22 (33.37)	1.19 (17.95)	2.70 (33.58)	3.07 (51.25)
	Perspiration Component	3.80 (122.58)	4.10 (68.33)	6.45 (66.84)	5.43 (81.90)	5.34 (66.42)	2.89 (48.25)

Table 6: Sources of Growth in respect of Major Sectors during Different Time Spans – India

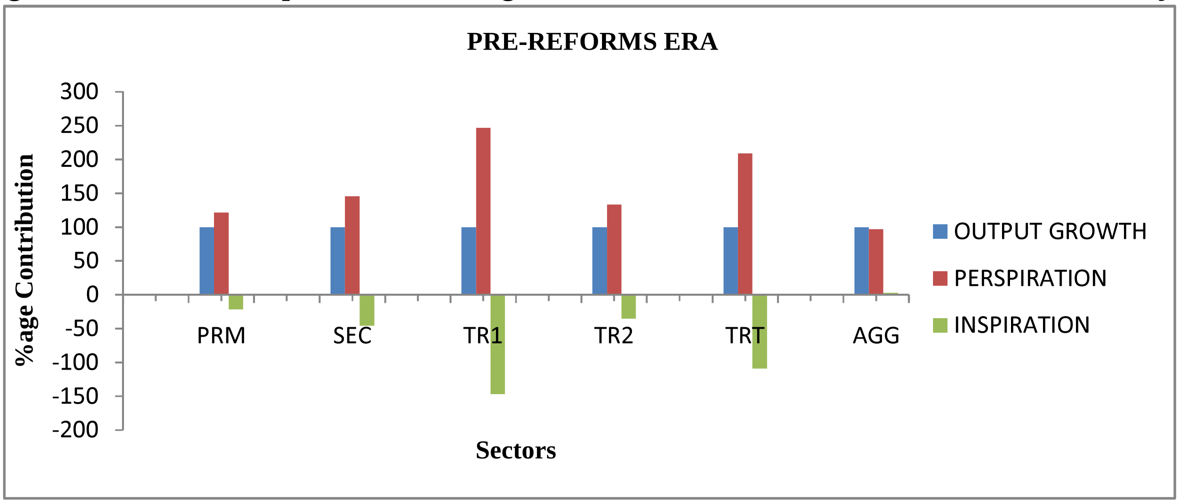
Time-Period	Av. Annual Growth Rate (%) in	Primary	Secondary	Tertiary-1	Tertiary-2	Tertiary	Aggregated Economy
Pre-Reforms Period	Output Growth	3.22 (100.00)	4.75 (100.00)	4.96 (100.00)	7.79 (100.00)	6.53 (100.00)	4.70 (100.00)
	Inspiration Component	-1.08 (-33.54)	2.79 (58.74)	-0.22 (-4.44)	2.30 (29.53)	2.05 (31.39)	0.99 (21.06)
	Perspiration Component	4.32 (134.16)	1.95 (41.05)	5.16 (104.03)	5.49 (70.47)	4.43 (67.84)	3.70 (78.72)
Post-Reforms Period	Output Growth	2.83 (100.00)	6.49 (100.00)	9.06 (100.00)	7.36 (100.00)	8.17 (100.00)	6.35 (100.00)
	Inspiration Component	-1.09 (-38.52)	-0.002 (-0.03)	1.85 (20.42)	2.63 (35.73)	3.13 (38.31)	0.40 (6.30)
	Perspiration Component	3.93 (138.87)	6.50 (100.15)	7.26 (80.13)	4.76 (64.67)	5.07 (62.06)	5.95 (93.70)
Entire Period	Output Growth	2.94 (100.00)	6.00 (100.00)	7.89 (100.00)	7.48 (100.00)	7.67 (100.00)	5.88 (100.00)
	Inspiration Component	-1.09 (-37.07)	0.95 (15.83)	1.13 (14.32)	2.51 (33.56)	2.76 (35.98)	0.60 (10.20)
	Perspiration Component	4.04 (137.41)	5.00 (83.33)	6.79 (86.06)	4.98 (66.58)	4.87 (63.49)	5.28 (89.80)

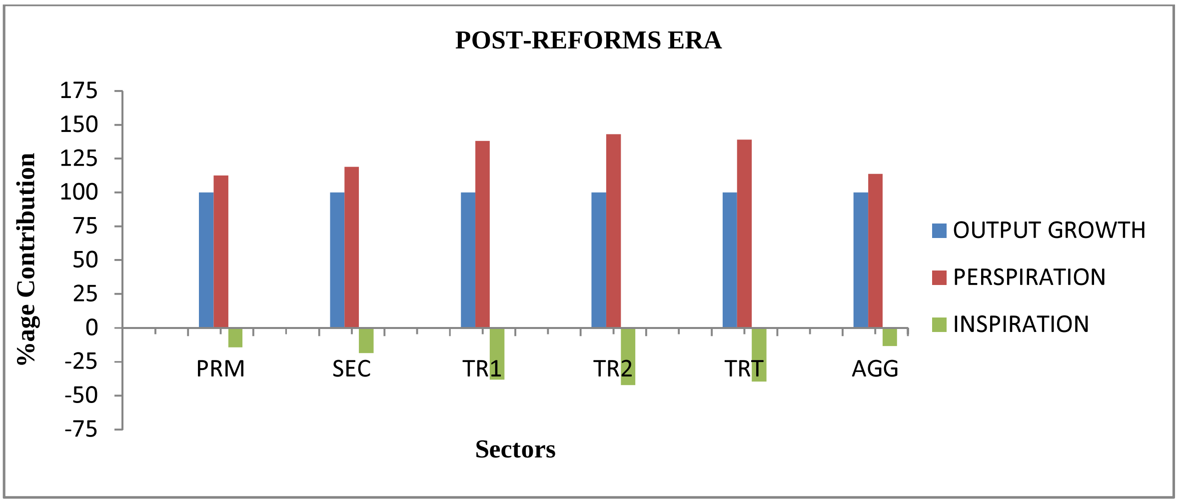
Source: Authors' Computations ;
Note: Figures in parentheses in the Tables indicate percent contribution in output growth.

generated by an increase in quantity of inputs alone (rather than by productivity) also enhances the cost of production in the economy.

On the other hand, Haryana state portrayed a different picture; in the state, 2.9 percent rate of growth in inputs coupled with 3.1 percent rate of growth in TFP brought about 6 percent rate of growth in output (Table 5). Thus, productivity growth was the dominant source of output growth in the state's economy during the entire study period. During pre-reforms period as well, it was the inspiration component that happened to be the forerunner in all the major activities (except for primary sector). But a slippage in the productivity performance was observed in all the activities during post-reforms period and that the slippage was all the more glaring in secondary sector (as is evident from the Table 5 and Figure 2 that rate of TFP growth in the sector declined from 5.9 percent during pre-reforms to (-) 0.2 percent during post-reforms period). Nevertheless, the productivity performance of Haryana state, on the whole, was comparatively far better than that of the Punjab state. Somewhat a similar picture has emerged for the overall Indian economy as well. No doubt, the growth rate in factor productivity has been less than that in factor accumulation, but still it has been contributing positively in the growth in output in majority sectors (Table 6, Figure 3).

Figure 1: Sources of Output Growth during Pre-Reforms, Post-Reforms and Entire Period - Punjab





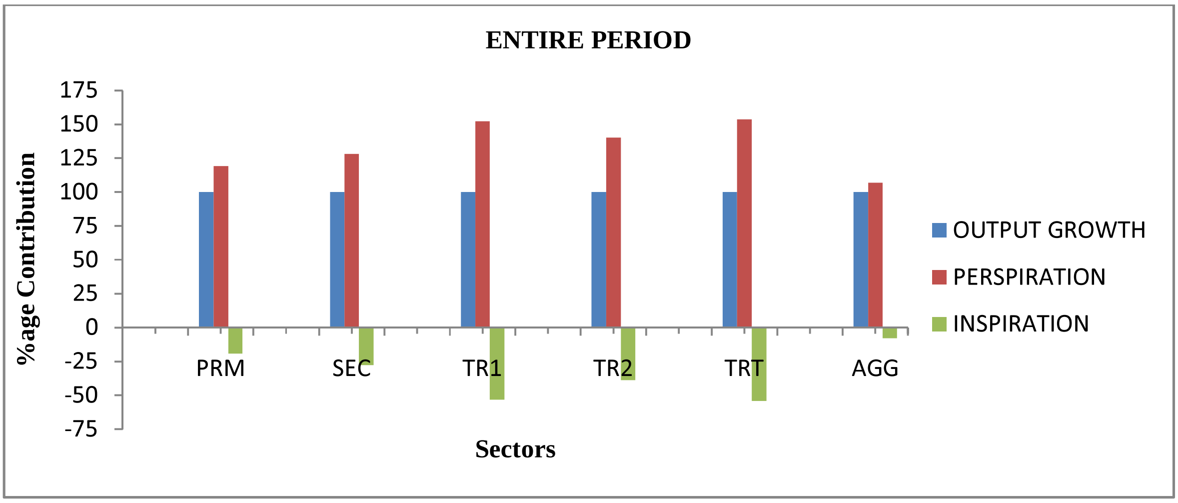


Figure 2: Sources of Output Growth during Pre-Reforms, Post-Reforms and Entire Period- Haryana

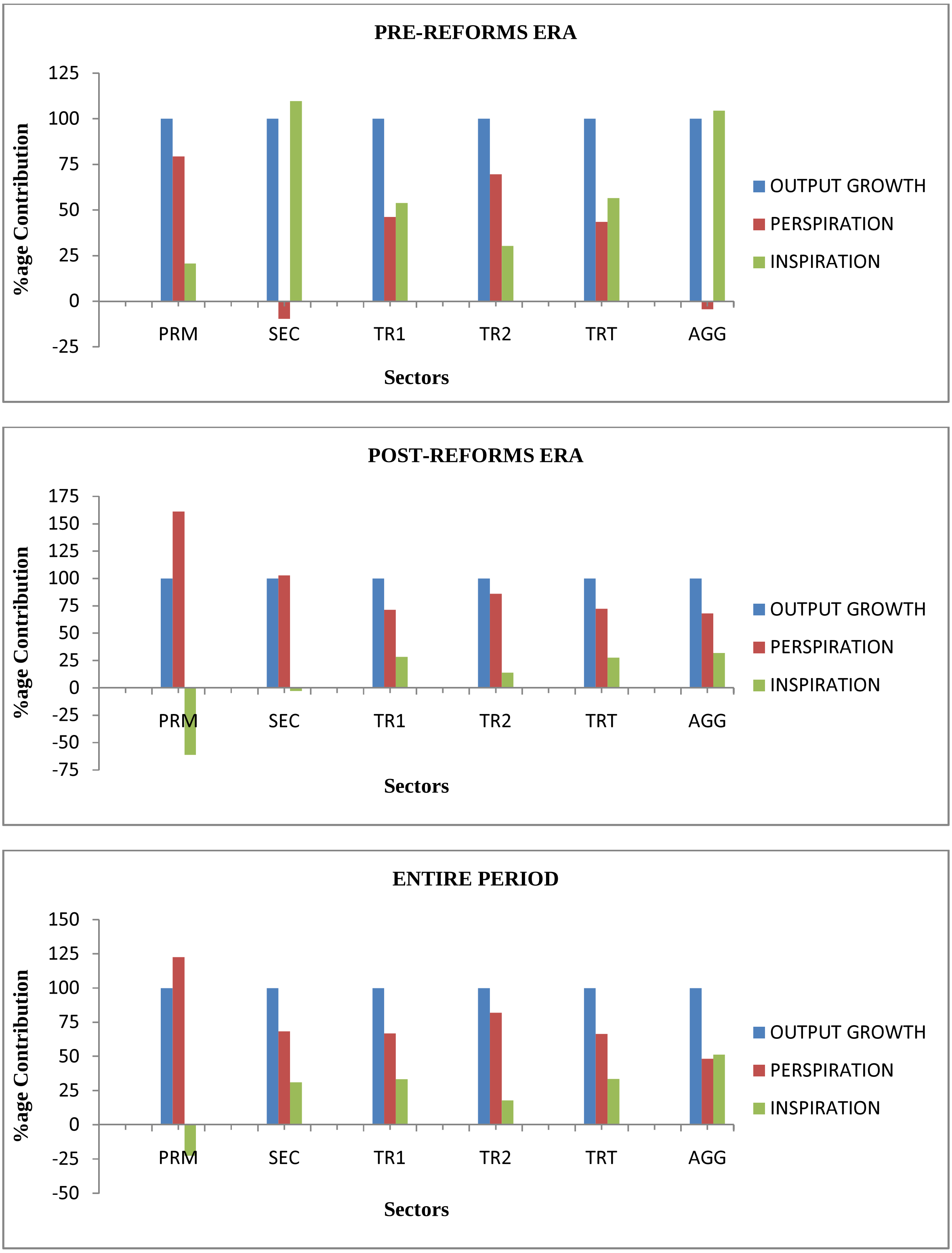
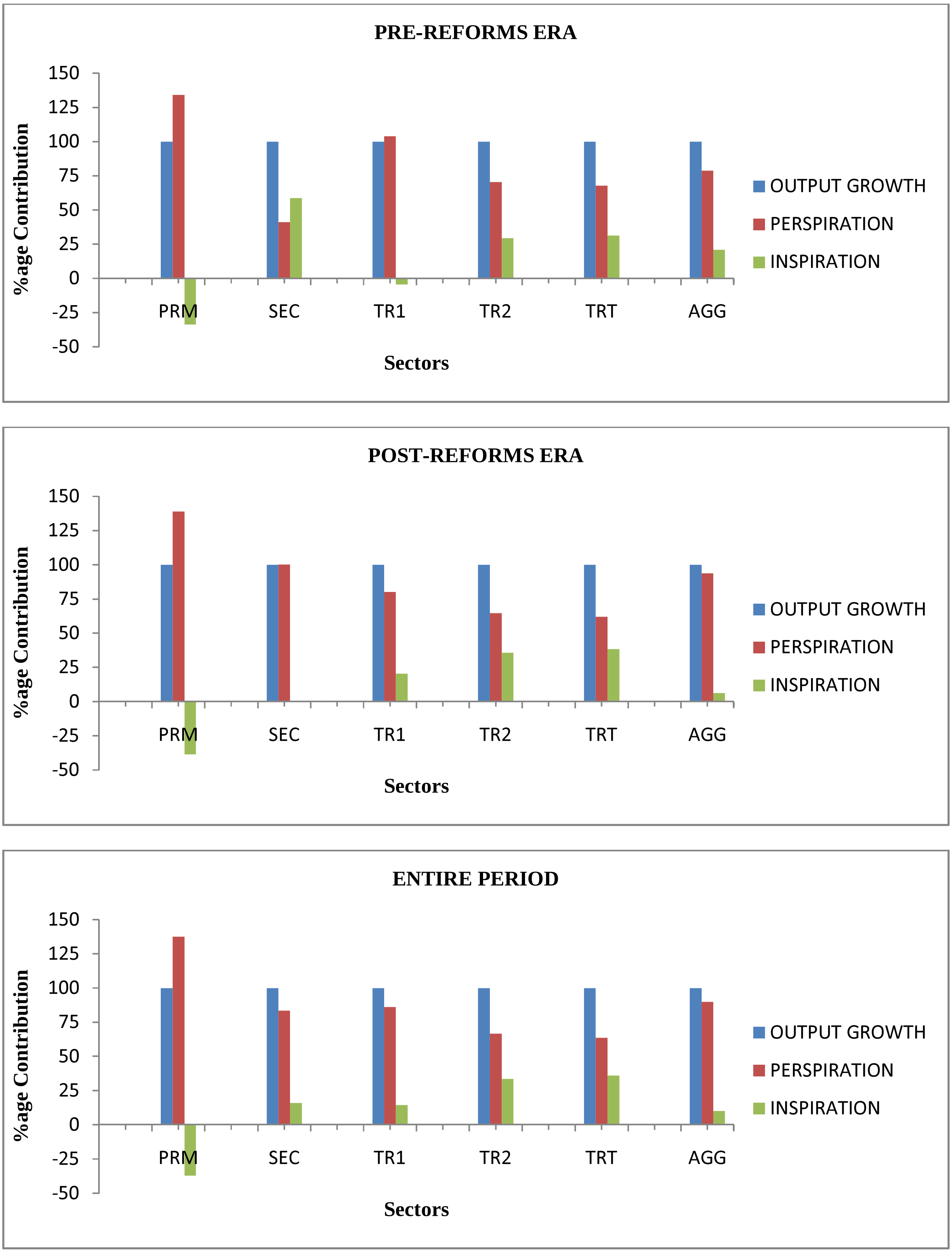


Figure 3: Sources of Output Growth during Pre-Reforms, Post-Reforms and Entire Period- India



During the reforms period, primary and secondary sectors experienced deterioration in growth in total factor productivity, while tertiary and its sub-sectors consolidated their status during post-reforms period.

It may, thus, be concluded that Punjab state has been a laggard economy on productivity front, which of course, is a cause of worry. Inspiration component in the state contributed negatively in all the sectors during pre- as well as post-reforms periods. While in Haryana state, TFP contributed positively in all the sectors (except primary sector) during the study span. As far as the Indian economy is concerned, activities *viz*., primary and tertiary-1 during pre-reforms, and primary and secondary during post-reforms period portrayed negative contribution of TFP growth. However, during the entire study span, TFP growth in all the activities (except for primary) was observed to be positive.

No doubt, the productivity performance of Haryana state and the Indian economy has been comparatively better *vis-à-vis* Punjab state, yet the economic reforms have failed to induce desirable impact on TFP growth in any of the three economies; rather TFP Growth got depressed during post-reforms period. Further, growth in output from majority sectors of each of the three economies was driven primarily by perspiration component – findings similar to Jorgenson and Griliches (1967); Dholakia (1986); Das *et al*. (2010).

Conclusions and Policy Implications

The analysis has thus revealed that during the entire study span, output growth in Haryana state exceeded that in the overall Indian economy, while the growth in Punjab state has been far slower. This possibly happened because in Punjab state, the inspiration component contributed negatively (due to technical regress), while in each of Haryana state and the aggregated Indian economy, both inspiration and perspiration components have contributed, in general, positively. Nevertheless, growth in factor accumulation has surpassed that in TFP in all the sectors in both Haryana state and the Indian economy. Primary sector was the lone exception having been associated with a negative contribution of TFP in output growth. Further, economic reforms have not been able to bring about improvement in TFP growth in each of the three economies.

Thus, as per the findings, the three economies, in general, and Punjab economy, in particular, need to strive for a productivity-driven economic growth, so as to achieve sustainability in the growth process. Emphasis needs be laid on diverting huge expenditure incurred on non-developmental activities towards strengthening of R & D activities, and social & physical infrastructure. Secondly, deterioration in TFP growth in a majority sectors of each of Punjab and Haryana states during post-reforms period might be taken to indicate that earnest efforts have not been made to implement the reforms measures by the state governments. In the era of ever-increasing competition, we need to identify the areas with a comparative advantage to make our production process effective and efficient. There is an urgent need not only to make a mere accumulation of factor inputs, but also pay a due attention towards qualitative improvements of both inputs and outputs, so as to accelerate TFP growth. Thirdly, as primary sector has fared quite poorly (on productivity front) in all the three economies and during all the periods/ sub-periods; therefore, stringent measures need be adopted for providing resilience to this sector of crucial importance (providing employment to a large chunk of the population), so as to achieve inclusiveness in the growth process. As has been stated by Lewis (1954), "… It is not profitable to produce a growing volume of manufactures unless agriculture production is growing simultaneously. This is also why industrial and agrarian revolutions always go together and why economies in which agriculture is stagnant, do not show industrial development." Adoption of measures like (a) making higher outlays for rural industrialization, (b) doing away with across-the-board distribution of free electricity and water in agriculture sector, and (c) bringing big farmers under tax net would help in generation of resources required for strengthening rural infrastructure and, thereby making the primary sector of each of the economies under study a sustainable one.

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