

Econometric Analysis on the Farm and Non-Farm Linkages with Respect to Employment and Output: The Post-Independent Indian Scenario

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Strong relationships across different sectors are the preconditions for the sustainable growth and development of any economy in the world. Though, the reality is that, in many economies such good coordination does not work properly. Agriculture, industry and service are the three prime sectors in an economy out of which the first one is the farm sector and the remaining two taken jointly is the non-farm sector. The contributions of output and employment by the sectors constitute almost the entire economy's output and employment. The present study investigates whether there are long run and short run linkages in output and employment within and between the farm and non-farm sectors in India for the period 1973-2018 using the time series econometric approach. The study finds stable long run relations between output and employment in levels and growth rates for industry and service sectors. Regarding the farm and non-farm sectors' linkages in levels and growths of

output and employment, the results show that agricultural GDP maintains long run relations with total non-farm GDP but the results do not hold in case of employment. In the short run, the study observes, in most cases, that levels and growths of GDP become the causal factors of levels and growths of employment but not the reverse. Hence, it is recommended that the economic and sectoral expansions are necessarily required for employment generation for the country.

Keywords: Farm sector; non-farm sector; GDP; employment; linkage; long run; short run; cointegration; causality

JEL: E01; E24; O13; O14; O17; Q12; C32

Introduction

The progress of an economy depends, among others, upon the interactions between its farm and non-farm sectors, particularly in the developing countries like India, where there are large scale operations of the farm sector and non-farm sector. The farm sector consists of the primary sector, the agriculture and allied activities, and the non-farm sector consists of the industry and service sectors. The farm sector mainly uses

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the unskilled labour with a very few amount of fixed capital of mostly backward technology whereas the non-farm sector uses the skilled labour with a large number of fixed capitals, which are mostly of developed technology. Given the stock of fixed capitals used in both the farm and non-farm sectors the interactions may happen between the two sectors in terms of the exchanges of the labour force from the farm to the non-farm sector. The interactions follow the well-known Lewis (1954) model and Harris and Todaro (1970) model, where the farm sector maintains mainly a subsistence wage rate due to low wage paid, which is further due to surplus labour force with low productivity. On the other hand, the non-farm sector uses skilled labour force with high productivity and scarcity of labour force which leads to wage gap between the two sectors. The positive wage gap becomes the source of interactions which leads to a flow of labour from the labour surplus farm sector to the labour scarce non-farm sector, the surplus and low paid workers move to the high paid non-farm sector making expansion of the non-farm sector in terms of more output and profit, which lead to more fixed capital formation. More capital formation further leads to the expansion of the sector and it pulls further labour force from the farm sector leading to an increase in the economy's output as well as employment, and wage rates in both the sectors, but the rate of increase in the wage rate is relatively more in the farm sector leading to a reduction of the wage gap in the long run. Therefore, the two sectors get benefitted and the economy as a whole gets benefitted in terms of high growth and development.

India, being a labour surplus economy, has its own features to fit well with the above interaction model. It has a huge population base and the majority of its labour force are

engaged in the farm sector where they are paid a very low wage rate even under the minimum wage law regime. On the other hand, the non-farm sector comprising the industry (mining, manufacturing, construction, gas, water supply etc.) and the service sector (trade, banking & finance, information and technology, transport, etc) pays relatively high wage rates to their employees. The high growth and high development requirements of a labour surplus economy like India can be fulfilled through these linkage effects. How much the interactions between the farm and the non-farm sectors in India help in increasing output (income) and employment becomes the key research question of the present study. The study analyses the interactions between the two sectors through a basic theoretical model, and goes for empirical verifications using econometric methods for the time period of 1974 to 2018.

In the economic literature it is argued that the economic growth performance at the macro-level is expected to grow over time with a significant amount of structural transformation which is accompanied by diversifications in the sectoral composition of the output and employment (Kuznets, 1974). The roles of the agricultural sector and fundamental industrial sectors upon the economies' output and employment determinations cannot be denied because of their linkage effects, which are responsible for expanding the economy (Lewis, 1954; Harris and Todaro, 1970; Kaldor, 1979). India's growth history in the eighties revealed some short of slow but steady rate, known as 'Hindu Rate of Growth' which was due to public sector led large scale industrialization. But the rate was too low compared to the six per cent growth achieved by the developing countries as a whole (Ahluwalia, 1988; Bardhan, 2007). The

spectacular growth performance during the post-liberalization phase in India was mostly due to the high growth in the service sector which was further due to the large scale rise in the use of information and communication technology (ICT) in the production of service sector's outputs (Nayyar, 2006). But the rising growth wheels get halted during the Covid 19 pandemic. There are several studies which have evidenced that Covid 19 has adversely impacted the farm sector, rural non-farm sector and the industry and service sectors in India (NABARD, 2020; Jaacks et al., 2021; Saroj et al., 2022; Alsamhi et al., 2022; Mahmood et al., 2024).

Theoretical Underpinnings

There are two types of labour in the economy, the unskilled and the skilled. The farm sector mainly uses the unskilled (US) labour in higher proportions compared to the skilled (S) labour and the non-farm sector uses the skilled labour in higher proportions compared to the US labour. The capital stocks are taken as fixed in both the sectors but the non-farm sector can use its profits upon accumulating these capital stocks. The production function for the farm sector (F) is-

$$QF = f(USF, SF) \tag{1}$$

where $dQF / dUSF > 0$, $dQF / dSF > 0$ and the second orders of the changes are negative reflecting the diminishing productivity rule.

Again, the production function for the non-farm sector (NF) is-

$$QNF = f(USNF, SNF) \tag{2}$$

where $dQNF / dUSNF > 0$, $dQNF / dSNF > 0$ and the second orders of the changes are negative.

The resource constrains for the two sectors are-

$$A_{USF} \cdot QF + A_{USNF} \cdot QNF = US_0 \tag{3}$$

$$A_{SF} \cdot QF + A_{SNF} \cdot QNF = S_0 \tag{4}$$

Where A_{USF} is the unit of the US labour per unit of output in the farm sector,

A_{USNF} is the unit of the US labour per unit of output in the non-farm sector,

A_{SF} is the unit of the S labour per unit of output in the farm sector,

A_{SNF} is the unit of the S labour per unit of output in the non-farm sector and

US_0 & S_0 are the endowments of unskilled and skilled labour force in the country. Again, $A_{USF} / A_{SF} > 1$ and $A_{USNF} / A_{SNF} < 1$ since the farm sector is more intensive to the US labour and the non-farm sector is more intensive to the S labour.

Let us solve for QF and QNF from equation (3 & 4). The coefficient matrix is computed as $\Delta = A_{SF} \cdot A_{SNF} [A_{USF} / A_{SF} - A_{USNF} / A_{SNF}]$

Since $A_{USF} / A_{SF} > 1$ and $A_{USNF} / A_{SNF} < 1$, hence, $\Delta > 0$.

The expressions for the outputs are

$$QF = [US_0 \cdot A_{SNF} - S_0 \cdot A_{USNF}] / \Delta$$

$$\text{and } QNF = [S_0 \cdot A_{USF} - US_0 \cdot A_{SF}] / \Delta$$

Now the parametric effects of US_0 and S_0 upon QF and QNF in line with the Rycbzyński theorem tells us that

$$dQF / dUS_0 = A_{SNF} / \Delta > 0,$$

$$\text{and } dQNF / dUS_0 = -A_{SF} / \Delta < 0$$

Again, $dQF / dS_0 = -A_{USNF} / \Delta < 0$ and $dQNF / dS_0 = A_{USF} / \Delta > 0$

Now,

$$(dQF / dUS_0) / (dQNF / dUS_0) = (A_{SNF} / \Delta) / (-A_{SF} / \Delta)$$

$$\text{or, } dQF / dQNF = -A_{SNF} / A_{SF} < 0$$

$$\text{Similarly, } dQF / dQNF = -A_{USNF} / A_{USF} < 0$$

The above relations show that as QNF expands, QF contracts and vice-versa. Thus, the results show that there is an interlink between the farm and the non-farm sectors. Further, as being the F sector more intensive to the US labour and the NF sector to the S labour, an increase in the stock of US labour will definitely expand the F sector and contract the NF sector. But the irony is that the countries like India are having problems with the disguised labour in the farm sector, hence, increase in US labour force actually works as an incentive to move to the NF sector, the NF sector will expand, and as a result of the linkage effect, the F sector will also expand. The reverse arguments will work when the increase in the endowment of the S labour increases, it will lead to expansion of the NF sector but to contraction of the F sector. After new capital formation in the NF sector is made due to the expansion, the F sector will get benefit as a linkage effect. Hence, the output and employment of labour will increase due to the farm and non-farm linkages.

Review of Related Studies

For the sake of the justification of taking up the present research the study goes through some works related to the farm and non-farm sectors' linkages in India, in particular. In an earlier work by Mellor (1976) the farm and non-farm sectors are intimately linked as the growth of the former leads to increases in the demand for consumers' goods produced by the latter. In another work, Vyas and Mathai (1978) mentioned that there

was the dominance of the agriculture sector in the generation of rural employment and the problem of excess labour force could not be solved through agro-based policies like crop diversification, modernization etc. The study thus pointed out the role of the rural based non-farm activities in order to make interactions with the traditional farm sector to solve the labour force problem. Hazzel and Haggblade (1991) investigated the rural-urban growth linkages in India through highlighting the impacts of agricultural growth upon rural non-farm output and employment. According to the study, one unit of growth in the agriculture output leads to 0.37 units increase in the output of the non-farm sector in the rural economy. Ray (1994) showed that the problem of unemployment in the labour surplus economy, at least at the rural belt, could be solved by the growth of the rural non-farm sector in particular, and through the farm and non-farm sectors interactions in general. Chakrabarty et al (2011) analyzed the farm, rural non-farm and the formal non-farm sectors linkages and opined that the non-farm sector unambiguously expands due to the linkage effects, where the impetus came from three sources; a rise in agricultural productivity, land-reforms as well as a shift of cropping-pattern towards basic food crops. Papola (2012) admitted that employment had grown at slower rates in the post-reforms period than that in the pre-reforms period for India, justifying a gloomy picture of the reform effect. The evidence of the study of Chandrachud and Gajalakshmi (2013) was that the Indian economy was growing in a sustainable way following jobless growth during the post-liberalisation period. In an attempt to see whether the growth of income in India influences employment, Ghose (2014) reveals that India's rapid economic growth

has failed to generate sufficient employment since 1980. Pandey (2015) has examined the pattern of production and consumption linkages between the rural farm and non-farm sectors in Uttar Pradesh and finds a substantial role of farm and non-farm production linkages via backward production linkages in the growth of the rural non-farm sector, however, consumption linkages have a significant bearing on the development of the rural non-farm sector in the state. Dev (2017) observes that the farm and non-farm linkages in India depend upon several factors such as agricultural diversification, agro-based industry and retail trade, rural non-farm sector, urbanisation, technological change and globalisation. Nguyen (2018) investigates how the non-farm sector affects agricultural production in the context of imperfect markets and the development of Vietnam's rural economy and the results confirmed a significant and positive effect of non-farm activities on agricultural expenses in the country. Das and Ray (2020) investigate the relationships between employment and globalisation in countries as well as a panel of the countries in the South Asian region and found no long-run relations between the two for India as well as the panel of the countries. However, globalisation makes a cause to employment in the panel of the countries in the short run. In a recent study Das (2022) has attempted to see whether the aggregate economy and the sectors in India are moving towards jobless, job-loss or job-enabled growth for the period 1973–2018 using the elasticity approach and obtains that the values of the output elasticity of employment show no sign of sparking employment growth like that of the income. The average values of the elasticity of employment lie mostly less than half which signify the emergence of

jobless growth. The results, thus, indicate that the Indian economy is not going in the right direction so far as employment opportunity is concerned which puts a big question on attaining the sustainable developmental goal.

Some studies are also available with respect to the forward and backward linkage effects between the farm and non-farm sectors in India. The forward linkage refers to the situation when the progress in the agriculture (or the farm) sector influences the progress of the industry and service (or the non-farm) sectors; and the backward linkage effects work when the reverse scenario happens. The studies such as Rangarajan (1982), Bhattacharya and Rao (1986), Mythili and Harak (2013), etc. reported weak forward linkages while that of Sastry et al (2003) revealed strong backward linkages due to the upsurge in the service sector's activities during the post reform period. Chowdhury and Chowdhury (1995) examined the linkage of growth among the agriculture, industry and services sectors of the economy, using both an input-output (I-O) and a simultaneous equation framework and found that the agricultural sector still played an important role in determining the overall growth rate of the economy through demand linkages with other sectors of the economy. Kaur et al. (2009) examined inter-sectoral linkages for the period 1968-69 to 2003-04 using input-output tables and showed that the use of industrial inputs in agriculture had increased. In another study, using a computable general equilibrium model, Parikh et al. (2013) examined the magnitude by which the agricultural sector should grow to have sound development in the overall economy of India.

The agriculture and its allied sectors have been hit hard by the Covid 19 pandemic. In a NABARD (National Bank for Agriculture and

Rural Development) report (2020) it is pointed out that agriculture production was adversely affected by the impact of COVID-19. Magnitude wise, production in allied sector had declined significantly like that in poultry farm and dairy farm. Jaacks et al., (2021) assess the impact of the COVID-19 lockdown on agricultural production, livelihoods, food security, and dietary diversity in India through a phone interview survey and found that 79 per cent of households with wage-workers witnessed a decline in wages and 49% of households with incomes from livestock witnessed a decline. Saroj et al. (2022) evaluate the role of rural non-farm employment (RNFE) in livelihoods and in likely impacts of shocks such as COVID 19 and found that RNFE has been adversely affected by the pandemic because of repeated lockdowns. In a recent work, Mahmood et al. (2024) have shown that COVID-19 has a deep impact on the economic, environmental, and social life of the global population particularly, it disturbed the entire agriculture supply chain due to a shortage of labor, travel restrictions, and changes in demand during lockdowns. It consequently led the world population into food insecurity. Alsamhi et al. (2022) examine the impact of the pandemic (Covid-19) on the financial performance of some of the selected Indian sectors and obtained that there is a significant decline in total income net sales of the firms after the pandemic in the sectors like food, construction, etc.

Besides all the above, there are some related studies which are in other countries and with additional factors under discussion in respect of such linkages. Sarkar et al (2013) examined the magnitudes of farm and non-farm employment linkages measured using farm survey data from Bangladesh and found that the modern technology driven rice production system led to employment

generation in various farm and non-farm activities in the country. Hardati et al (2020) explore the correlation between the agricultural and non-agricultural sectors in the rural area affected by the manufacturing industry agglomeration of Semarang of Indonesia and find weak linkages between large-scale manufacturing industries and the agricultural economy. In a study with a little bit flavour on the said linkage, Das et al (2021) have sought to examine the linkage between urbanization and non-agricultural activities with environmental pollution as the third factor and find that non-agricultural activities influence urbanization.

Research Gap and Objectives

The studies reviewed so far have attempted for different ways of explaining the linkages using several alternative methods for a small or medium range of data which do not entirely cover the structural changes that happened in India during the last three decades. Further, they have used the level data on output mainly and did not cover up the employment linkage, and growth-to-growth linkages across the segregated sectors in India. The present study fills the gaps up in the literature by considering agriculture as the farm sector and two sectors under the non-farm activities, the industry and service, considering levels as well as growths of output and employment; using time series econometric approaches for investigating their long run and short run linkages for India taking the long period of 1973-2018. The present study, thus, aims to investigate the interrelationships between the farm sector and the non-farm sectors in India in respect of GDP and employment for some pre-liberalization periods and post liberalization periods.

Data and Methodology

The pre-liberalization phase has three time points, 1973, 1978 and 1983 in which the employment surveys are carried out by the NSSO (National Sample Survey Organization). The post liberalization period is taken for 1991-2018. The main source of GDP is the Reserve Bank of India and the World Bank. Employment source (level and shares across the sectors) is ILO (International Labor Organization) and NSSO. Data on labour force/labour force participation is not available from the past years before 1991. So, we take age group population in 15-64 as the proxy for labour force. Then we derive the labour employment in the three sectors using the data on total labour force and the share of labour employment in the three sectors in India.

The growth rates of GDP and employment in total and across the sectors are computed by the simple growth calculation formula, $Y_t = (Y_t - Y_{t-1}) / Y_{t-1} * 100$. Graphical presentation is done for the trend analysis for GDP and employment in aggregate and three sectors, agriculture as the only farm sector and industry and service sectors as the two non-farm sectors. Descriptive statistical analysis, mainly the Mean, SD and correlation values, are derived.

For farm and non-farm sector linkages, time series econometric exercises such as unit root test, cointegration test and causality analysis are done. As the study has data points of 32 years there is a natural chance that the series will be non-stationary. Thus, before attempting for finding long run relationships between farm and non-farm output and employment we need to test for unit roots in the series. The Augmented Dickey-Fuller, ADF (1979) test is used for unit root or non-stationarity test of the series. For a data set

$(x_t, t = 1, 2, \dots, T)$, where t denotes time, let us consider the following linear regression set up for unit root test for two versions of the ADF(p) regression—viz., for the case of without time trend,

$$\Delta x_t = \alpha + \beta x_{t-1} + \sum_{j=1}^p \gamma_j \Delta x_{t-j} + u_t \quad (5)$$

And for the case of with time trend, the equation to be estimated is-

$$\Delta x_t = \alpha + \delta t + \beta x_{t-1} + \sum_{j=1}^p \gamma_j \Delta x_{t-j} + u_t \quad (6)$$

If $\beta = 0$ (or $\rho = 1$) is rejected by the ADF statistic then it is said that the series is stationary.

As having two series, output and employment (either in levels or growths) for the aggregate as well as sectors, the Engle-Granger (1987) test technique is used for cointegration or long run relationships between the pairs. The Johansen test could be considered for the cointegration test but for a bi-variate system the Engle-Granger test gives the results with good precision. The Engle-Granger test methodology is given below.

If two series y and x are both $I(1)$ and are related by the equation as

$$y_t = \alpha + \beta x_t + u_t \quad (7),$$

and their linear combination $u_t = y_t - \alpha - \beta x_t$ is $I(0)$, then both the series of y and x will be cointegrated. Thus, a non-spurious equilibrium relation between two series can be obtained. Thus, the estimated error term, $\hat{u}_t = y_t - \hat{\alpha} - \hat{\beta} x_t$, becomes $I(0)$. If the series of \hat{u}_t is found to be $I(0)$ or stationary then we can say that the series

are cointegrated in EG sense. The estimated coefficients $\hat{\alpha}$ and $\hat{\beta}$ give us the long run equilibrium relation between y and x . The regression equation for the country is

$$y_{it} = \hat{\alpha} + \hat{\beta}x_{it} \quad (8)$$

Testing stationarity of the estimated error term, \hat{u}_{it} , can be checked in line with the ADF test by estimating the following equation

$$\Delta \hat{u}_{i,t} = \lambda \hat{u}_{i,t-1} + \sum_{j=1}^p \theta_j \Delta \hat{u}_{i,t-j} + \varepsilon_{i,t} \quad (9)$$

Here it is required to test for whether $\lambda = 0$ (null hypothesis) against $\lambda < 0$ (alternative hypothesis). If the hypothesis of $\lambda = 0$ is rejected, then it is said that y and x are cointegrated series and there exists an equilibrium or a long run relation between them.

Thereafter, Error correction mechanism (ECM) is used for short run dynamics around the long run or equilibrium relation between output and employment in levels and growths in aggregate and sectors.

The ECM can be written as follows-

$$\Delta y_{it} = a + \eta \Delta x_{it} + \gamma \hat{u}_{i,t-1} + e_{i,t} \quad (10)$$

Here $\hat{u}_{i,t-1}$ stands for the error correction term and γ stands for the speed of convergence or divergence. If the estimated γ is found to be negative and significant, then we say that the series are converging and the short run deviations are corrected.

But for the short run, the Granger (1969) test technique is used for finding causal interplays between output and employment in levels and growths in aggregate and as well as across the sectors. It is modelled as follows.

For a bivariate non stationary model with both I(1) property Granger Causality Test

is done by estimating equation (7 and 8) in the first differenced forms of the variables including the error correction terms for y on x and x on y (Granger, 1969). The model is:

$$\Delta y_t = v_{yx} + \sum_{j=1}^{T_{11}} \alpha_{1j} \Delta y_{t-j} + \sum_{j=1}^{T_{12}} \beta_{1j} \Delta x_{t-j} + \eta_{yx} ECY_{t-1} + u_{1t} \quad (11)$$

$$\Delta x_t = v_{xy} + \sum_{j=1}^{T_{21}} \alpha_{2j} \Delta y_{t-j} + \sum_{j=1}^{T_{22}} \beta_{2j} \Delta x_{t-j} + \eta_{xy} ECX_{t-1} + u_{2t} \quad (12)$$

where Δ denotes the first difference operator; T_{lm} , $l, m = 1, 2, 3$ denotes the number of lagged values of Δy and Δx that affect the current values of these differenced variables; v , α , β and η denote regression parameters; u_{it} , $l = 1, 2$ are the equation disturbance terms with white noise properties. The nature or direction of Granger Causality is determined by the values of the F statistics under the following decisions:

1. If $\beta_{1j} = 0$, for all j and $\eta_{yx} = 0$, x may be said not to *Granger cause* y .
2. If $\alpha_{2j} = 0$ for all j and $\eta_{xy} = 0$, y may be said not to *Granger cause* x .
3. If (1) holds but (2) does not, *Granger causality* may be said to be *unidirectional from y to x*.
4. Conversely, if (1) does not hold but (2) does, *Granger causality* may be said to be *unidirectional from x to y*.
5. If both (1) and (2) do not hold, *Granger causality* between x and y is said to be *bi-directional or feedback*,
- and 6. If both (1) and (2) holds, there is no *Granger causality* between x and y .

Empirical Results and Analysis

Before doing the econometric analyses we have presented the line diagrams for the trends on aggregate and sectoral output, and employment, and trends of growth rates of aggregate and sectoral output, and employment to have brief ideas on the series

Articles

at a glance. Figure 1 shows the trends of aggregate and sectoral GDP in India.

It is observed that the trends of GDP in aggregate and sectors are rising over the time but the rate of increase is highest in the service sector compared to that of the industrial and agriculture sectors.

Figure 2 shows that the trend of total labour employment is rising over time. At the sectoral

level, agriculture is the leading sector in terms of employment generation compared to the service sector and the industrial sector. The rising trend of employment in the agriculture sector gets halted in the year 2005 onwards. The employment trends in the industrial and service sectors are rising over time. The total farm employment is greater than the total non-farm employment.

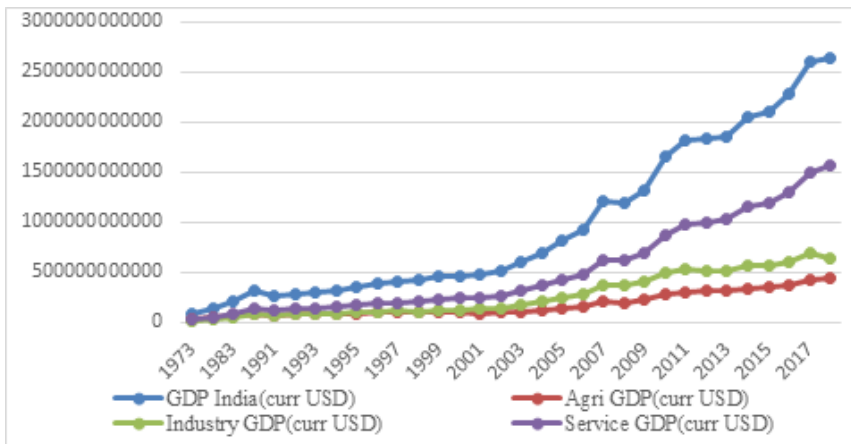


Figure 1. Trends of GDP at aggregate and farm, and non-farm levels during 1973-2018

Source: Author's calculation

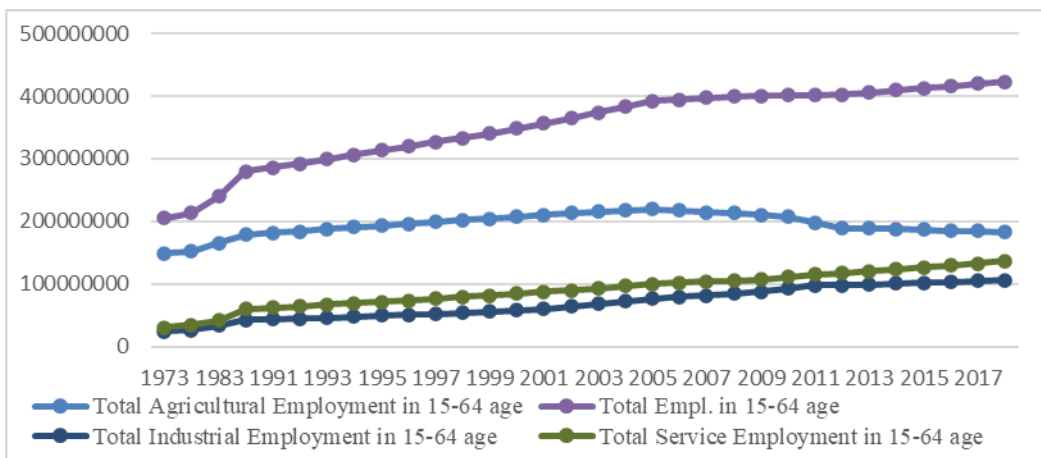


Figure 2. Trends of employment in aggregate and farm, and non-farm levels during 1973-2018

Source: Author's calculation

The column diagrams (Figure 3) show that the aggregate and farm, non-farm GDP take the highest average values during the period of second and third generations reforms in India, which is the period of 2001-2018. But, out of the non-farm sector, the service sector surpasses the industrial sector in all the four different phases in producing economic outputs. Hence, the service sector becomes

the driving force of all the sectors in India particularly during the reform period.

Figure 4 shows that the aggregate, farm, and non-farm employment take the highest average values during the major reform period 2001-2018. The Agriculture sector generates more employment relative to the total non-farm sectors. But, out of the non-farm sector, the service sector surpasses the industrial

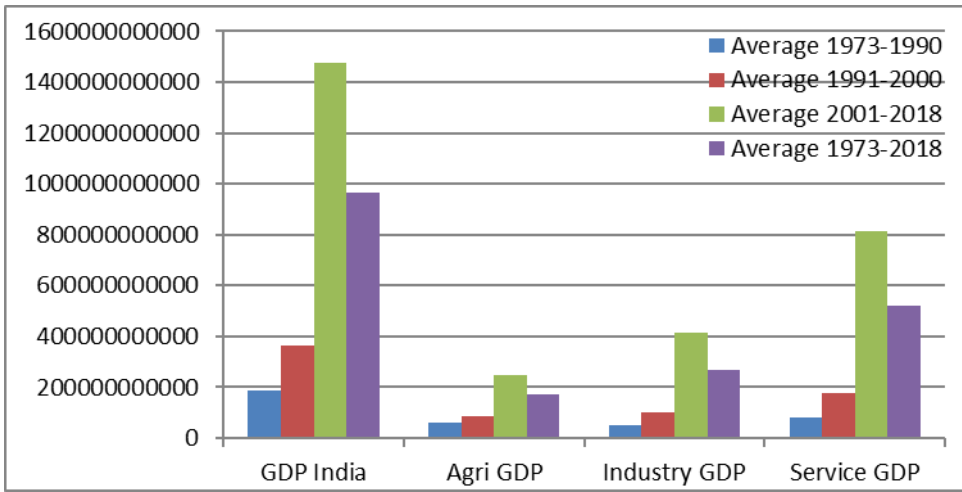


Figure 3. Average values of GDP in aggregate and sectoral levels in different phases

Source: Author's calculation

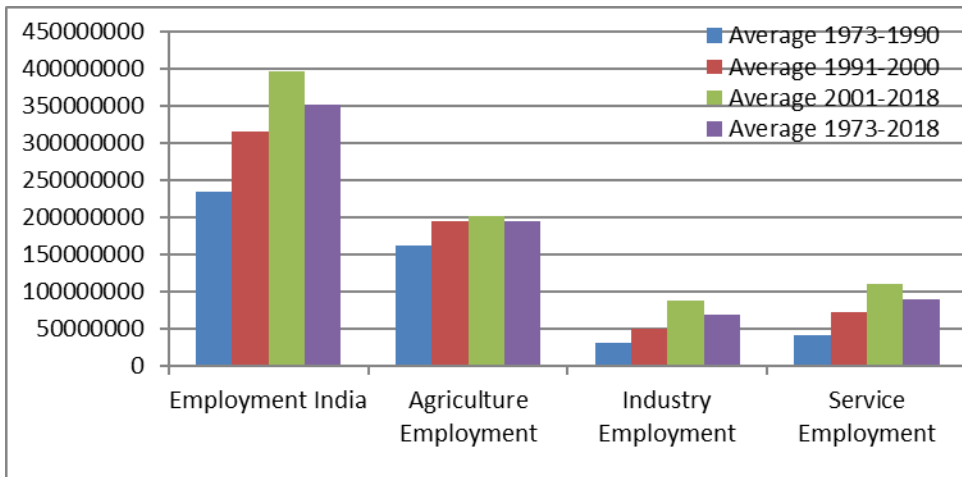


Figure 4. Average number of employments in aggregate and sectoral levels in different phases

Source: Author's calculation

sector in all the four different phases of employment. But the irony is that the non-farm sector produces more but employs less unlike the farm sector, where relatively low output is coupled with high employment rate. Hence, the service sector becomes the driving force

of all the sectors in India's GDP but agriculture is the driving force in employment generation. So, there are job-less growth in India.

Figure 5 and Figure 6 respectively show the trends of the growth rates of GDP and employment in aggregate as well as across

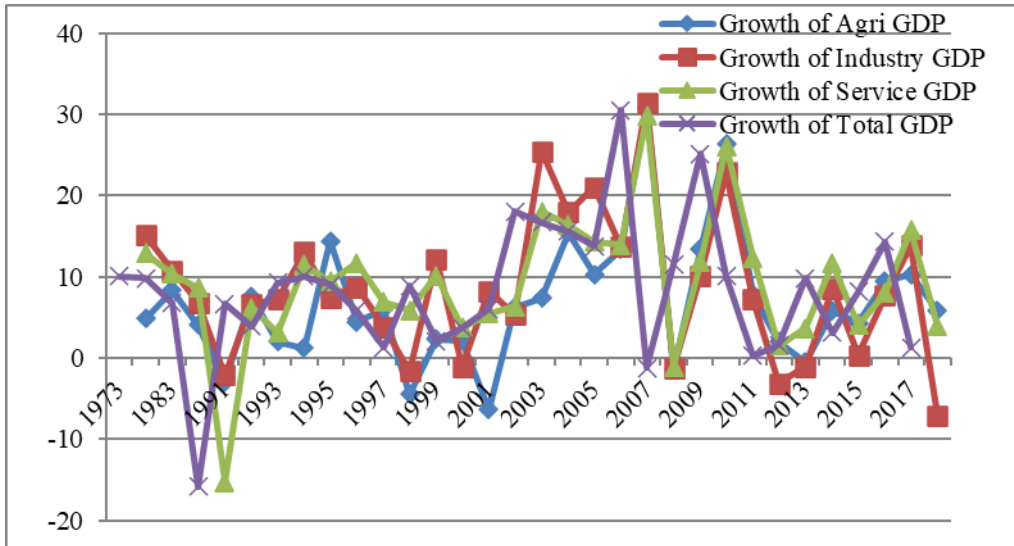


Figure 5. Trends of growth rates of aggregate and sectoral GDPs during 1973-2018
 Source: Author's calculation

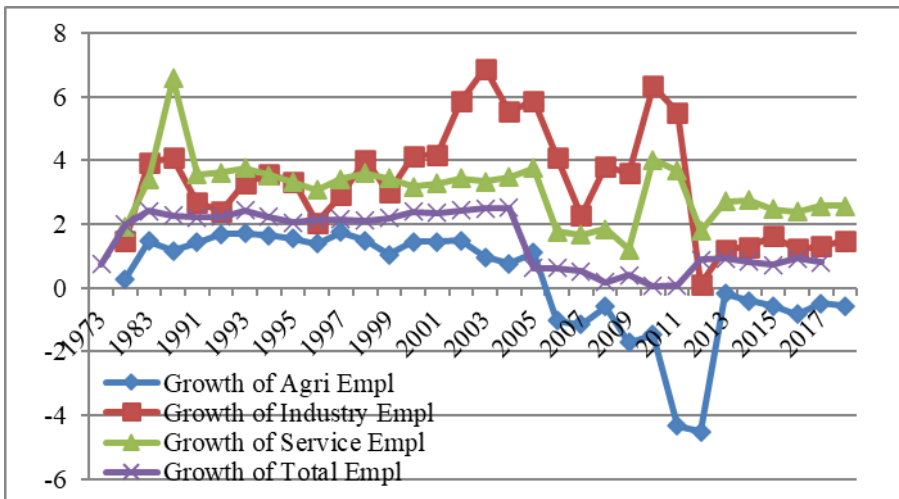


Figure 6. Trends of growth rates of aggregate and sectoral employment during 1973-2018
 Source: Author's calculation

the farm and non-farm sectors. It is observed from Figure 5 that the growth rates of output are rising over time, though with fluctuations in several phases, in aggregate and sectors.

On the other hand, as depicted from Figure 6, there are declining trends in the growth rates of employment in aggregate economy as well as in the farm and non-farm sectors. There is again a reverse matching of GDP growths and employment growths in India giving an indication of job-less growths. The observations are similar to the study of Bardhan (2007), Das and Ray (2020), Das (2022), among others.

Table 1 and Figure 7 show that the service sector's growth of output during the periods of the second and third generations reform is greater than that of the aggregate and other two sectors; the farm sector's growth is relatively low. Aggregate and farm, non-farm employment take the highest average values during the major reform period, 2001-2018. The Agriculture sector generates more employment relative to the total non-farm sectors. But the irony is that the non-farm sector produces more but employs less unlike the farm sector, where relatively low output is coupled with a high employment rate. Hence, the service sector becomes the driving force of all the sectors in India's GDP but agriculture is the driving force in employment generation. On the other hand, the average growth of employment is relatively better in the industrial sector compared to the service and agriculture sectors.

To examine the linkage between GDP and employment we have primarily attempted for a simple product-moment correlation analysis (as given in the lower part of Table 1). The correlation is computed for 'within sector' which justifies whether output and employment in a particular sector are correlated. Positive

associations between employment and GDP in the aggregate, industrial sector and service sector, are observed, all are statistically significant also. But there is no such strong correlation between output and employment in the agriculture sector. Hence output and employment are correlated in the non-farm sector but not in the farm sector. But with respect to the correlation between output growth rates and employment growth rates in aggregate, farm and non-farm sectors, it is found that there is a significant correlation only in the industrial sector (both the trends are negatively sloped) while all the remaining sectors produce negative, though insignificant, correlation between output growth and employment growth.

Let us move to the rigorous time series econometric analyses for examining long run and short run linkages between the farm and non-farm sectors in terms of level and growth values. Table 2 presents the unit root test results along with the Engle-Granger cointegration and EC results. The sets of hypotheses to be tested here are:

A. For testing long run relation between output and employment levels and growths in aggregate and within a sector-

Null Hypothesis (H0): *There is no cointegration between output and employment levels and growths in aggregate and within a sector*

Alternative Hypothesis (H1): *There is cointegration between output and employment levels and growths in aggregate and within a sector*

B. For testing the long run relation between output and employment levels and growths in aggregate and across the sectors, the farm and non-farm linkage:

Null Hypothesis (H0): *There is no cointegration between output and employment*

Table 1. Descriptive statistics and correlation results

	Average 1973-1990	Average 1991-2000	Average 2001-18	Average 1973-2018	SD 1973-1990	SD 1991-2000	SD 2001-18	SD 1973-2018
Total GDP	187972858440	365337640526	1474617869702	967137171677	101339085803	70832539725	711853764310	790592817258
Agri GDP	58415361387	88256159028	247858586287	174302424656	23216790843	10993600278	113275202639	119944128375
Indus GDP	48175701332	99710131104	413895179527	269997417121	28505644509	18730258533	179263246445	213376139039
Serv GDP	81381795721	177371350394	812864103887	522837329900	49775046281	41891543104	422590204556	459530190410
Total Empl	234491997.7	316510430.9	397356074.5	351733801.3	33623340.42	20731347.01	18112685.86	61615702.41
Agri Empl	161313335.5	194691524.4	202391643.2	194850567.6	13502756.71	8889993.586	13966868.92	18047756.48
Indus Empl	31708886.46	50124338.85	87611722.86	68909060.81	8031970.394	4727297.737	14996561.07	25130749.69
Serv Empl	41573224.5	73051106.71	111001617.7	90463533.88	13138986.7	7421182.925	15087027.98	28437075.49
Growth of Total GDP	1.48	4.133	10.471	8.272	0.104	7.67	8.727	8.348
Growth of Agri GDP	0.961	3.275	8.921	6.794	0.127	5.351	9.069	7.905
Growth of Industry GDP	1.821	5.446	10.078	8.666	0.23	5.528	10.654	8.933
Growth of Service GDP	1.776	5.352	11.238	9.283	0.121	7.855	8.237	8.056
Growth of Total Empl	0.286	2.201	1.094	1.511	0.048	0.106	0.895	0.88
Growth of Agri Empl	0.161	1.508	-0.676	0.188	0.035	0.207	1.674	1.648
Growth of Industry Empl	0.527	3.14	3.455	3.325	0.082	0.668	2.176	1.728
Growth of Service Empl	0.66	3.447	2.708	3.068	0.133	0.211	0.827	0.994
Correlation coefficients between output and employment in total values and growth rates (Within sectors: effects)								
	Aggregate Sector	Agriculture Sector	Industry Sector	Service Sector				
Total Terms	0.81	0.04	0.96	0.77				
Growth Terms	-0.158	-0.293	0.421	-0.055				

Note: The bold figures indicate statistically significant correlation results

Source: Author's calculation

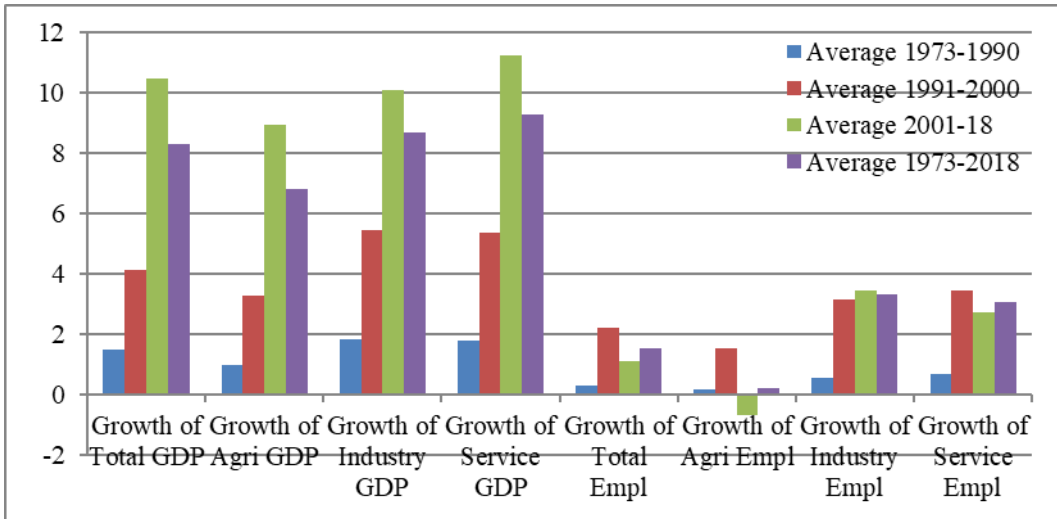


Figure 7. Mean of growth rates of GDP and employment in aggregate and sectors in different phases

Source: Author's calculation

levels and growths of the farm sector with that of the total non-farm and individual non-farm sectors

Alternative Hypothesis (H1): *There is cointegration between output and employment levels and growths of the farm sector with that of the total non-farm and individual non-farm sectors*

It is derived that the series for total and sectoral GDP and employment levels, and total and sectoral GDP and employment growth rates are non-stationary in almost all the cases but stationary at their first differences (Column 2 & 3). Following the Engle-Granger theorem we run the cointegration test through the unit root tests of the residuals generated out of the regression of employment upon GDP, the results are given in Column 4 & 5. The rows for employment show only the ADF values of the total and sectoral employments, not the ADF of the residuals after regression as the results for the ADF of the residuals are given in the rows just preceding the rows for

employments. Table 2 shows the cointegration results between output and employment in a single sector, not across the sectors.

Notes: Regression (Regr.) is done for Employment upon GDPs in total and sectors. Grth means Growth, Empl. Means employment, Agri. means Agriculture, Indus. means Industry and Serv. means Service.

The cointegration test results show that there are long run relations between output and employment in total and growth rates for industry and service sectors, and the errors are also corrected (Column 6). So, there is a stable equilibrium relation in industry and service sectors in totals and growths. But the study does not find any such long run relation between output and employment in the agriculture sector.

Let us analyse the results for the farm and non-farm linkages in the long run for 'output to output' and for 'employment to employment' in terms of their levels and growth values, the results are given in Table 3. Here the first

Table 2. Unit roots and cointegration tests results

	ADF at Levels (Prob.)	ADF at First Differences (Prob.)	Regr. of Empl. on GDP		ADF of Residual (Prob.)	Error Correction Term	Remarks
			Constant	Coeff.			
Total GDP	2.44(0.99)	-4.15(0.00)	29800000	0.000058	-0.95(0.75)	-	No cointegration
Total Empl.	-2.54(0.11)	-3.49(0.01)					
Agri. GDP	2.43(0.99)	-3.71(0.00)	19800000	-0.0000091 (0.00)	-1.42(0.55)	-	No cointegration
Agri. Empl.	-1.31(0.66)	-3.03(0.04)					
Indus. GDP	0.62(0.98)	-4.73(0.00)	39654611	0.00011 (0.00)	-2.98(0.04)	-0.11(0.05) Error is corrected	Cointegration exists
Indus. Empl.	-0.59(0.85)	-3.62(0.01)					
Serv. GDP	3.56(0.99)	-6.17(0.00)	63677662	0.000053 (0.00)	-3.71(0.00)	-0.18(0.00) Error is corrected	Cointegration exists
Serv. Empl.	-2.16(0.22)	-4.41(0.00)					
Total GDP Grth	-4.65(0.00)	-6.60(0.00)	1.647	-0.016(0.40)	-1.64(0.44)	-	No cointegration
Total Empl. Grth	-1.48(0.52)	-5.68(0.00)					
Agri. GDP Grth	-4.56(0.00)	-5.84(0.00)	0.601	-0.06(0.11)	-2.30(0.17)	-	No cointegration
Agri. Empl. Grth	-1.83(0.35)	-5.93(0.00)					
Indus. GDP Grth	-4.50(0.00)	-5.91(0.00)	2.61	0.08(0.01)	-3.93(0.00)	-0.53(0.00) Error is corrected	Cointegration exists
Indus. Empl. Grth	-2.64(0.09)	-6.01(0.00)					
Serv. GDP Grth	-4.91(0.00)	-6.54(0.00)	3.13	-0.007(0.75)	-4.03(0.00)	-0.64(0.00) Error is corrected	Cointegration exists
Serv. Empl. Grth	-3.90(0.00)	-4.30(0.00)					

Source: Computed by the author

exercise is done for agriculture to industry and service sectors separately and then agriculture with the total non-farm activities, the sum of industry and service sectors.

It is observed from the table that Agricultural GDP is cointegrated with Total Non-farm GDP which means there are long run relationships between the farm and non-farm outputs in India, but the same result does not hold for the head of employment. In addition, the short run errors get corrected in the equilibrium relations between the two in GDP.

On the other hand, when we segregate total non-farm output and employment between industry and service sectors, we do not find any such cointegration results between the farm and the individual non-farm sectors; either between the agriculture sector and the industrial sector or between the agriculture sector and the service sector. But in terms of the growth of GDP and employment in individual as well as total sectors we find some interesting cointegration results. Agriculture GDP growth and industry and service sectors'

Table 3. Cointegration results for farm and non-farm linkages

	Regr. of Farm GDP on Non-farm GDP		ADF of Residual (Prob.)	Error Correction Term	Remarks
	Constant	Coeff.			
Agri GDP & Indus GDP	2.43E+10	0.56	-1.15(0.68)	-	No cointegration
Agri GDP & Serv. GDP	3.91E+10	0.26	-2.49(0.13)	-	No cointegration
Agri Empl. & Indus Empl.	1.87E+08	0.175	-1.006(0.73)	-	No cointegration
Agri Empl. & Serv. Empl.	1.77E+08	0.206	-0.733(0.82)	-	No cointegration
Agri GDP & Total Non-farm GDP	1.05E+08	7.13E-05	-3.218(0.02)	-0.15(0.00) Error is corrected	Cointegration exists
Agri Empl. & Total Non-farm Empl.	1.80E+08	0.097	-1.28(0.77)	-	No cointegration
Agri GDP Grth & Indus GDP Grth	1.401	0.622	-6.51(0.00)	-1.09(0.00) Error is corrected	Cointegration exists
Agri GDP Grth & Serv. GDP Grth	-0.434	0.77	-2.98(0.05)	-1.08(0.00) Error is corrected	Cointegration exists
Agri Empl. Grth & Indus Empl. Grth	-0.47	0.19	-1.78(0.38)	-	No cointegration
Agri Empl. Grth & Serv. Empl. Grth	-2.15	0.76	-2.52(0.12)	-	No cointegration
Agri GDP Grth & Total Non-farm GDP Grth	5.48	0.161	-5.22(0.00)	-0.95(0.00) Error is corrected	Cointegration exists
Agri Empl. Grth & Total Non-farm Empl. Grth	-2.02	1.44	-4.77(0.00)	-0.68(0.01) Error is corrected	Cointegration exists

Source: Computed by the author

GDP growth rates are cointegrated and the errors are corrected around the equilibrium relations. Again, with respect to total non-farm and farm GDP and employment growths, it is observed that the growths of the agriculture sector's GDP and employment maintain long run relations with the growths in the output and employment in the total non-farm sector. Therefore, the farm and non-farm sectors are with equilibrium relations over the long run with significant converging results in growth of output and employment.

For the short run causal interplays between output and employment in levels and growths for within and across the sectors the study uses the Granger (1969) technique. The results are derived by estimating equation 11 & 12 and shown in Table 4 and 5. In each of the

interplays there is a pair of null hypotheses: 1) GDP does not cause Employment and 2) Employment does not cause GDP. The values of the F statistics are derived in order to see whether they are significantly larger than the tabulated values and their corresponding probabilities are with values less than or equal to 0.05. Column 1 of Table 4 displays the results for 'within the farm or non-farm sectors' in aggregate and sector-specific formats.

It is observed that, in most of the cases, where the causality results are significant, total GDP and growth of GDP become the causal factors of total and growth of employment but not the reverse. In addition, there are bilateral causal interplays in the industrial sector' GDP and employment. Hence, economic

Table 4. Granger causality test results between output and employment within the sectors

Group/Country	Lags	Test Statistics		Directions of Causality
		F Values	Prob.	
Within the sectors (Aggregate and sector-specific)				
Total GDP does not cause Total Empl.	2, 2	11.53	0.00	Δ GDP \rightarrow Δ Empl.
Total Empl. does not cause Total GDP	2, 2	1.97	0.16	No causality
Agri. GDP does not cause Agri. Empl.	2, 2	14.87	0.00	Δ Agri. GDP \rightarrow Δ Agri. Empl.
Agri. Empl. does not cause Agri. GDP	2, 2	2.29 --	0.12	No causality
Indus. GDP does not cause Indus. Empl.	3, 3	6.47	0.00	Bilateral causality between Indus GDP and Empl.
Indus. Empl. does not cause Indus. GDP	3, 3	4.17	0.01	
Serv. GDP does not cause Serv. Empl.	2, 2	3.69	0.04	Δ Serv. GDP \rightarrow Δ Serv. Empl.
Serv. Empl. does not cause Serv. GDP	2, 2	1.17	0.33	No causality
Total GDP Grth does not cause Total Empl. Grth	3, 3	0.48	0.69	No causality
Total Empl. Grth does not cause Total GDP Grth	3, 3	4.40	0.01	Δ Empl. Grth \rightarrow Δ GDP Grth
Agri. GDP Grth does not cause Agri. Empl. Grth	2, 2	6.36 --	0.00 --	Δ Agri. GDP Grth \rightarrow Δ Agri. Empl. Grth
Agri. Empl. Grth does not cause Agri. GDP Grth	2, 2	1.75	0.19	No causality
Indus. GDP Grth does not cause Indus. Empl. Grth	1, 1	3.84	0.05	Δ Indus. GDP Grth \rightarrow Δ Indus. Empl. Grth
Indus. Empl. Grth does not cause Indus. GDP Grth	1, 1	0.39	0.53	No causality
Serv. GDP Grth does not cause Serv. Empl. Grth	1, 1	2.56	0.12	No causality
Serv. Empl. Grth does not cause Serv. GDP Grth	1, 1	8.49	0.00	Δ Serv. Empl. Grth \rightarrow Δ Serv. GDP Grth

Source: Computed by the author

and sectoral expansions are required for employment generation.

On the other hand, so far as causal interplays between the farm and non-farm sectors 'output-output' and 'employment-employment' are concerned, there we get mixed results again (Table 5). Column 1 of the table displays the results for 'between the farm and non-farm sectors' in aggregate and sector-specific formats.

Like the significant cointegration between total farm and total non-farm sectors' GDPs in the long run, there are bilateral causality between total farm and total non-farm sectors'

GDPs in the short run too. Further, we find bilateral causality or both-way causality between farm employment and service sector employment in the short run. And industrial employment influences agriculture employment. Hence, the farm and non-farm sectors are highly interlinked in India.

Discussion

The study has started with some basic objectives: whether output and employment (in levels as well as growths) are with long run and short run relationships in the aggregate as well as individual farm and

Table 5. Granger causality test results between output and employment between farm and non-farm sectors

Group/Country	Lags	Test Statistics		Directions of Causality
		F Values	Prob.	
Between the farm and non-farm sectors (Aggregate and sector-specific)				
Agri. GDP does not cause Total Non-farm GDP	1, 1	2.67	0.11	No causality
Total Non-farm GDP does not cause Agri. GDP	1, 1	0.012	0.98	No causality
Agri. Empl. does not cause Total Non-farm Empl.	1, 1	3.95	0.05	Bilateral causality
Total Non-farm Empl. does not cause Agri. Empl.	1, 1	19.65	0.00	
Agri. GDP does not cause Indus. GDP	3, 3	2.25	0.11	No causality
Indus. GDP does not cause Agri. GDP	3, 3	0.22	0.87	No causality
Agri. GDP does not cause Serv. GDP	3, 3	0.84	0.92	No causality
Serv. GDP does not cause Agri. GDP	3, 3	1.89	0.15	No causality
Agri. Empl. does not cause Indus. Empl.	1, 1	0.87	0.35	No causality
Indus. Empl. does not cause Agri. Empl.	1, 1	19.62	0.00	Δ Indus. Empl. \rightarrow Δ Agri. Empl.
Agri. Empl. does not cause Serv. Empl.	1, 1	5.35	0.02	Bilateral causality between Agri. Empl. & Serv. Empl.
Serv. Empl. does not cause Agri. Empl.	1, 1	12.90	0.00	

Notes: '→' means direction of causality from left item to the right items.

Source: Computed by the author

non-farm sectors, and whether farm and non-farm sectors' output and employment are interlinked in India. The first ones are for within the sectors and the second ones are for between the sectors. The theoretical model gives one possible background of such interrelationships. The empirical results show positive correlations between output and employment within the sectors and the time series analysis justifies the existence of long run relationships within and between the sectors. As output of a sector increases the use of labour usually increases. This is prominent in case of aggregate, industrial and service sectors. Again, as the non-farm sector, say, expands, the need for rural labour emerges and they are absorbed in the non-farm sector. The receipts of high wage payments by the rural surplus labour absorbed in the total

non-farm sector raises the demands for non-agricultural consumption goods, retail trading activities, banking transactions, education, transport, etc. which lead to the expansion of the industrial and service sectors. For example, one USD increase in GDP of the total non-farm sector leads to increase in total farm GDP by USD7.13E-05 (= 0.0000713) units. Hence, the farm and non-farm sectors are highly interlinked in India. From Table 2 (second part of Column 3), where cointegration exists between output and employment, it is seen that increase in total industrial GDP by USD 1 lac leads to increase in employment by 11 people in the industrial sector and 5.3 people in the service sector. On the other hand, the cases where cointegration exists between output growth and employment growth, it is seen that a 1 per cent increase

in the growth of industrial GDP leads to 0.08 per cent increase in the growth of industrial employment while there is a decrease in the growth of the service sector's employment of 0.007 per cent when one per cent growth in the service sector's GDP is there. Further, the study has observed that the growths of the agriculture sector's GDP and employment are cointegrated with the growths in the output and employment in the total non-farm sector. In particular, farm sector's GDP growth rate and the industry and service sectors' GDP growth rates are cointegrated but the same results do not hold for the employment growths in the three sectors. A one per cent increase in the growth of industrial GDP leads to 0.62 per cent increase in the growth of agricultural GDP and a one per cent increase in the growth of service sector's GDP leads to 0.77 per cent increase in the growth of agricultural GDP (Row 9 & 10 of Table 3). On the other hand, farm GDP growth and total non-farm GDP growth as well as the farm employment growth and total non-farm employment growth are cointegrated. For instance, a one per cent increase in the growth of total non-farm sector's GDP leads to 0.16 per cent increase in the GDP growth of the farm sector; and a one per cent increase in the growth of total non-farm sector's employment leads to 1.44 per cent increase in the employment growth of the farm sector. The results go with the outcomes of the studies in the Indian context such as of Chakrabarty et al (2011), Dev (2017), Das (2022), etc. Therefore, the materials of achieving sufficient magnitudes of growth and development are inherent in the Indian economy, the policy makers need to nurture them properly.

Concluding Observations

Taking the objectives of the work as whether the farm and non-farm sectors in India do have any linkage in levels and growths of output and employment it is observed that the said sectors maintain long run relationships for the period 1973-2018 in many cases. The results show that there are long run relations between output and employment in levels and growth rates for industry and service sectors and the errors are converging to zero. So, there are stable equilibrium relations in industry and service sectors in levels and growths. The agriculture sector fails to find any such long run relation between output and employment for the period. Regarding the farm and non-farm sectors (aggregate and individuals) linkages in levels and growths of output and employment the results show that agricultural GDP is cointegrated with total non-farm GDP in a stable manner, which means there are long run relationships between the farm and non-farm outputs in India, but the same result does not hold for the head of employment. After segregating the total non-farm sector into the industry and service sectors the study does not find any such cointegration results between the farm and the individual non-farm sectors' output and employment. But the study finds some good results in growths of output and employment. Agriculture GDP growth maintains stable long run linkage with the industry and service sectors' GDP growth rates and the similar results hold for the growth of employment among the three sub-sectors.

Further, in the short run, the study observes that, in most of the cases, level of GDP and growth of GDP become the causal factors of level and growth of employment but not the reverse. Hence, economic and sectoral expansion are required for employment

generation. On the investigation on the causal interplay between the farm and non-farm sectors, bilateral causality is found between the pairs of employment. Further, there is bilateral causality between farm employment and service sector employment.

Policy Prescriptions

The results so far exhibited that the farm and non-farm sectors were highly interlinked in India. Therefore, the materials of achieving sufficient magnitudes of growth and development are inherent in the Indian economy, the policy makers need to nurture them properly. There might be the balanced growth initiatives by the Government as well as the private sectors in India towards all the three key sectors in the economy. Further, the governments at the centre and state levels along with the private sectors should invest more in order to bring the post-Covid 19 scenario of the farm and non-farm sectors into a positive and forward looking state.

Limitations and Future Scope

In spite of all the good research outcomes the study has some limitations. Primarily it could not examine the interrelations between farm and non-farm sectors in the subnational level and sub-sectoral level. Thus, the study could be carried out to see the similar linkages across different states in India and different sub-sectors under any particular sector to see whether any such key sectors do have the potential in producing the linkage effects for the long and short runs. Besides, the study could have considered the price aspects of the different sectors to see whether the factors, the two types of labour, could have any sort of income or wage disparity due to any disparity in the prices of the sectoral

outputs. The study preserves all these as its future research agenda.

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