ISSN: 0976-5409

Volume: 53 • Issue: 2 • 2021

ODISHA ECONOMIC JOURNAL

(Formerly Orissa Economic Journal)

ORISSA ECONOMICS ASSOCIATION
Bhubaneswar

http://www.odishaeconomicjournal.in/

Odisha Economic Journal **(*OEJ*)** is a peer-reviewed journal published by the Orissa Economics Association (OEA) bearing ISSN 0976-5409. The journal is listed in UGC-CARE. The OEA has been publishing this bi-annual journal since 1968.

The journal considers empirical and theoretical research contributions in the field of economics and development studies under the following categories of manuscript:

- Research Articles
- Book Reviews/Review Articles
- Research Notes/Commentaries
- Latest Issue/Policy Centric Database

Odisha Economic Journal

(Formerly Orissa Economic Journal)

Volume 53 • Issue 2 • 2021

Journal of the Orissa Economics Association

Bhubaneswar

http://www.odishaeconomicjournal.in/

Contents

Referees

Editorial 1

Articles

States' Fiscal Management during COVID-19 4
Deba Prasad Rath, Bichitrananda Seth & Samir Ranjan Behera

Investigating the Agriculture-induced Environmental Kuznets Curve in Indian Context 34
Owais Ibin Hassan & Shahid Ashraf

An Empirical Analysis on Economic Development and Deterioration of Freshwater in India by using Environmental Kuznets Curve 58
R. Manikandan, S. Bhuvanesvari & M. Sangeetha

Impact of Family Wealth on Female Labour Force Participation in Odisha 76
Rajat Singh Yadav & Bharti Kumari

An Analysis of Productivity and Efficiency of Mining Sectors in Odisha 100
Kailash Chandra Pradhan & Harihar Dehury

Growth of Marine Fish Production in Odisha 116
P Sujata & Shibalal Meher

Changes in Production and Labour Regimes in Automobile Industry: A Study from Gurgaon-Manesar Region 140
Amit Chakraborty & Nayanjyoti

Research Note/Commentary

Impact of Income Inequality on Human Development in Emerging Economies: A Panel Data Analysis 163
Bhavya Logar & Nausheen Nizami

Book Review

Some Remedies for Textbook Economic Theory 176
Macroeconomics – An Introduction (By Alex M. Thomas)
Goddanti Omkarnath

Referees

OEJ expresses sincere gratitude to the following experts for their comments, suggestions and recommendations on draft papers.

Vikas Bajpai, Jawaharlal Nehru University, New Delhi

Rahul Gupta Choudhury, International Management Institute, Bhubaneswar

Amarendra Das, National Institute of Science Education and Research, Bhubaneswar

Keshab Das, Gujarat Institute of Development Research, Ahmedabad

Saudamini Das, Institute of Economic Growth, Delhi

Santosh Dash, Gulati Institute of Finance and Taxation, Thiruvananthapuram

Biplab Dhak, A.N. Sinha Institute of Social Studies, Patna

Varinder Jain, Institute of Development Studies, Jaipur

Pratap Ranjan Jena, National Institute of Public Finance and Policy, New Delhi

Amalendu Jyotishi, Azim Premji University, Bangalore

Vinish Kathuria, Indian Institute of Technology-Bombay, Mumbai

Swati Kothary, Nirma University, Ahmedabad

Udaya S. Mishra, Centre for Development Studies, Thiruvananthapuram

Himanshu S. Rout, Utkal University, Bhubaneswar

Partha Pratim Sahu, National Institute of Rural Development & Panchayati Raj, Hyderabad

P.K. Viswanathan, Amrita Viswavidyalam, Kochi

Editorial

This issue starts off with an article providing a detailed analysis of the subnational initiatives at managing the fiscal challenges as aggravated by the unprecedented COVID-19 pandemic. Authors Deba Prasad Rath, Bichitrananda Seth and Samir Ranjan Behera observe that the discrete strategies by individual states were determined by the specific issues as migrant workers, digital development of local bodies, health care system, and demographic features. Nevertheless, the ratio of revenue expenditure to capital outlay remained low. Grants from the upper tier and the accumulate dreserves of urban local bodies had helped reducing dependence on borrowings during the pandemic.

Considering nitrous oxide as aproxy for environmental degradation, the second paper by Owais Ibin Hassan and Shahid Ashraf examines if the Environmental Kuznets Curve (EKC) exists for fertilizer pollution in Indian context using annual frequency data for the period 1970-2018.Applying the ARDL Bounds test approach, findings of the study confirm both a short-run and long-run relationship between farm growth and environmental degradation. The study makes a case for broad-basing green farming practices. Further, pursuing the EKC, another article explores the relationship between fresh water depletion as a serious form of environmental degradation national per capita income. The estimation leads to the conclusion that the EKC for India is upward facing and not in the shape of an inverted-U.

Based on data from the National Family Health Survey (2015-16) the paper by Rajat Singh Yadav and Bharti Kumari explores household level factors in a regional context influencing female labor force participation (FLFP). These include household wealth, access to basic entitlements, social, health and educational attainment education. In the Odisha context, the study finds that with an increase in the share of deprived households in a spatial cluster, the FLFP rises. Female autonomy, education and basic entitlements emerge important determinants in FLFP decision making.

There is a paper analysing the performance of the mining sector in Odisha focusing on the productivity and efficiency aspects. This paper by Kailash Chandra Pradhan and Harihar Dehury suggests rising revenue over almost a four-decade period from 1980 to 2018. However, even when both investment and employment has increased over the years the total turnover has come down. The major concern has been that the technical efficiency has declined sharply with total factor productivity rising mildly. Another paper, focusing on the primary sector again, analyses the performance of the marine fish production in the state of Odisha. As observed by the authors P. Sujata and Shibalal Meher, during the period 1998-99 to 2019-20marine fish production has risen steadily albeit at a slow rate. This sector is in need of state intervention to turn it an economically attractive activity.

The next paper explores recent changes in production and labour regimes in a fast globalising economy. Authors Amit Chakraborty and Nayanjyoti, basing their study on primary field survey undertaken in the automobile industry in the Gurgaon-Manesar-Bawal Region in north India, come up with the observation that both contractualization and informalization of labour have occurred under these new global production regimes. Labour has been adversely affected by a loss of collective bargaining power and poor working conditions including job insecurity. Interests of big capital has dominated both the production and labour processes.

The research note in this issue, authored by Bhavya Logar and Nausheen Nizami, examines the impact of income inequality on development as measured by the HDI in emerging economies. It points to the rather undesirable proposition that inequality had a negative impact on transmission channels as education and health. High economic growth coexists with persistent income inequality raising policy interventions for broad-basing growth.

A perceptive review of the book *(Macroeconomics: An Introduction, by Alex M. Thomas)* in this issue has been presented by Goddanti Omkarnath who both dissects the text and reflects on the content and presentation of this recent textbook in macroeconomics that would be both relevant and

interesting for students trying to understand various challenges facing developing economies.

It is encouraging to note that the number of articles received by this journal has risen notably during the recent months. These have been submitted by scholars from all across the country. While that has been an important development indicating larger visibility and preference by the concerned academia the same has enhanced pressure on quality control and processing taking the help of domain expertise. This has implied both deeper and wider engagement by the Executive Editor to check and balance in order to uphold the quality of scholarship of the material published in the journal. Often times, that is tough but one is not looking for an easier option in fact.

Keshab Das
Executive Editor

Article

States' Fiscal Management during COVID-19

Odisha Economic Journal
Volume 53 • Issue 2 • 2021
pp. 4-33
Journal of the
Orissa Economics Association
OEA

Deba Prasad Rath
Bichitrananda Seth
Samir Ranjan Behera

Abstract

The paper examines the impact of the first and second waves of COVID-19 on sub-national government's finances and how they managed the same. Gross fiscal deficit of States and UTs to GDP ratio increased notably in 2020-21 due to the scissor effect. The fuller impact of the pandemic on State finances was determined by the State-specific factors such as migrant workers, digital development of the local bodies, health care system, and demographic features. The impact in the second wave was relatively slighter than in the first wave. The empirical findings suggest that, despite the fiscal stress, States' revenue expenditure to capital outlay ratio remained below the threshold level. Municipal corporations' (MC) budgets were also affected severally by the pandemic, forcing them to use alternative ways of financing

Deba Prasad Rath, Officer-in-Charge, Department of Economic and Policy Research, Reserve Bank of India, Mumbai. Email: dprathrbi@gmail.com

Bichitrananda Seth, Assistant Adviser, Department of Economic and Policy Research, Reserve Bank of India, Mumbai. Email:bichitranandaseth@rbi.org.in

Samir Ranjan Behera, Director, Department of Economic and Policy Research, Reserve Bank of India, Mumbai. Email: samirrbehera@rbi.org.in

An earlier version of this paper was presented as part of keynote speech by the first author in the 53rd annual conference of the Orissa Economics Association (OEA) during February 12-14, 2021 at NISER, Bhubaneswar covering States' fiscal management during COVID - 19. The analysis in this paper is, thus, largely sourced from the Reserve Bank's reports titled *State Finances: A Study of Budgets 2020-21* and *State Finances: A Study of Budgets 2021-22*. Views expressed in this paper are those of the authors and not of the institution to which they belong. Usual disclaimer applies.

[1] Jammu and Kashmir and Ladakh being the two UTs originated from the State of Jammu and Kashmir, effective from October 31, 2019.

along with reduction of spending. Empirical results indicate that grants from the upper tier and MCs' accumulated reserves helped restrict their borrowing requirement during the pandemic.

Keywords: Fiscal policy, COVID-19, revenue, expenditure, health, borrowing.

Introduction

As per the Indian Constitution, India, that is Bharat, shall be a Union of States, and it shall include (i) the territories of the States, (ii) the Union territories (UTs) specified in the First Schedule and (iii) such other territories as may be acquired. Currently, while there are 28 States and 9 UTs, 28 States and 3 UTs with legislative assemblies present their respective budgets. These States and UTs with legislature constitute more than 60 per cent of the expenditure of the general government (States, UTs and the Centre), and their share has been increasing. These reflect the role of States and UTs in the general government finances. However, their finances are characterised by lower revenue generation capacity and higher responsibility of spending towards social welfare. Furthermore, state-wise variations are also witnessed as all States are not the same in terms of revenue generation capacity and hence, in discharging their social-welfare function. To correct these vertical and horizontal imbalances, the Finance Commission - a constitutional body - is entrusted with recommending methods to share Central taxes and grants with States.

Despite these provisions, States' finances are not immune to endogenous and exogenous shocks. During the early 2000s, States witnessed a vicious circle of high gross fiscal deficit (GFD), debt and interest payments. As a result, GFD, debt and interest payments were 4.4 per cent, 32.9 per cent and 2.9 per cent of the GDP, respectively, in 2003-04. To consolidate their finances, States adopted fiscal responsibility legislations (FRLs) at different times. Most of the States made the rule to eliminate revenue deficit by 2008-09 and reduce their GFD to 3 per cent of the GDP. The majority of States successfully achieved these targets by 2007-08 - the consolidated revenue deficit (RD) was in surplus, and GFD was reduced to 1.6 per cent of the GDP. These achievements were, however, short-lived. During 2008-09, the GFD increased to 2.5 per cent and further to 3.0 per cent in 2009-10 due to the global financial crisis. After that, States have been keeping their GFD-

GDP ratio below the 3.0 per cent threshold, except for 2014-15 and 2015-16, due to Ujwal DISCOM Assurance Yojana (UDAY).

While State finances were affected by the slowdown in economic activity in 2019-20, they witnessed a historic exogenous shock in the form of COVID-19. The shock deteriorated state finances and forced them to concentrate on thehealth sector. Against this backdrop, this paper examines the impact of COVID-19 on sub-national government finances (including local government) and how they fought against this unprecedented shock.

The remaining part of the paper is structured as follows: Section II briefly reviews the origination of COVID-19 and cross-country experience with the disease. The impact of COVID-19 on state finances along with an empirical result on States' quality of expenditure is provided in Section III. COVID-19 and its spatial dimensions are analysed for States in Section IV. Section V discusses the impact of COVID-19 on municipal finances and examines their fight against the impact along with the factors that determine the borrowing of municipal corporations. Concluding observations are set out in Section VI.

Section II

COVID-19 and Cross-Country Experiences

Cross-Country Experiences

By January 7, 2022, 44 cases of COVID-19 were identified in Wuhan (Allam, 2020). As the cases in China steeply increased, the government imposed strict lockdowns and travel restrictions. Countries worldwide started imposing border and travel restrictions, and eventually, North America and some countries in Europe and Asia suspended flights to China (Allam, 2020). By the end of February, COVID-19 was found in over 54 countries with total cases of more than 85,403 and around 3,000 deaths. On March 11, 2020, as COVID-19 spread at a meteoric pace, WHO declared COVID-19 to be a pandemic.

As the virus unrelentingly gained momentum across the world, the disease's epicentre shifted from Wuhan to Europe. Initially, Italy was the worst-hit

country, with over sixty-nine thousand cases and the maximum number of deaths by March 25, 2020. With no vaccination or medication available and social distancing and proper maintenance of self as the only treatment methods, COVID-19continued to mushroom across the globe (Niermann and Pitterle, 2021). Due to its geographical advantage and strict control of in and outbound travel, New Zealand, Australia, and Japan were able to tame the transmission of the virus in 2020. Africa recorded remarkably low COVID-19 deaths due to many reasons such as early lockdowns, low air travel from Asia, success in leveraging the resources for fighting HIV and Tuberculosis, lower global integration and a younger population (Niermann and Pitterle, 2021).

Though many East Asian countries were faced with a high rise in cases in the early days of the pandemic, they were able to bring down the transmission of the virus and fatalities. This is attributed to their stronger crisis management system, the experience of managing previous endemics, and the government's swift response (Niermann and Pitterle, 2021). China also successfully attained an impressive decline in COVID-19 positive cases (Saxena, 2020). The first wave of COVID-19 peaked in Europe between March-April 2020, and the fatality rates flattened in the later months.

The second wave spurred by the new variant-Delta led to soaring cases again in Europe in late 2020 and early 2021 and became the dominant variant by mid-April in UK. This mutation of the virus was more infectious and posed a higher risk of hospitalization in United States, Latin America, and the Caribbean (Niermann and Pitterle, 2021).By June 2021, the second wave flattened in Western Europe and North America, but the COVID-19 case load continued to surge in Eastern Europe, South America, India, Iran, Tunisia and Turkey. During the second half of 2021, Asian countries such as Malaysia, Bangladesh, Vietnam, Thailand, Japan, and China witnessed a sharp rise in COVID-19 cases, spurred dominantly by the Delta variant (BBC News, 2021). African continent witnessed a similar onslaught brought by the Delta variant, with caseload crossing the previous peaks in July 2020, making situation dire for the region which already was struggling with low vaccination rate (Mendez, 2021). As per WHO, the Delta strain became the most prominent strain of COVID-19 around the globe by November 2021.

India's Experience

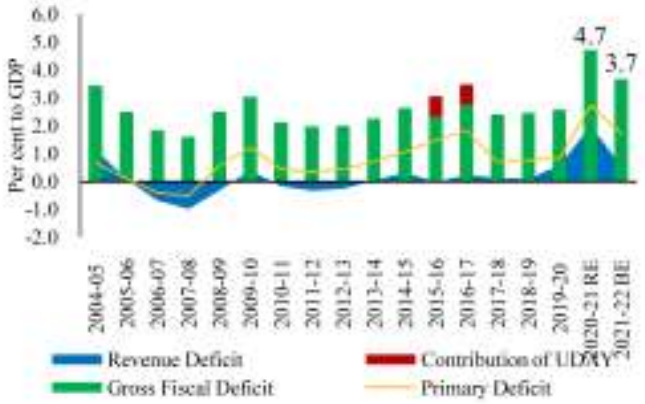
Kerala was the first State to confirm COVID-19 infection on January 30, 2020. The infection was found in 15 States and UTs by the day of the first nationwide lockdown. It reached lower point in mid-February 2021 after peaking around mid-September 2020. Another (second) wave started around mid-March 2021 and peaked on May 6, 2021. In terms of the steepness of rise in new cases and peaks, the second wave was stronger than the first one due to the significantly higher viral load of the Delta variant. The decline was equally sharp as cases reached about one-eighth of the peak by June 30, 2021. The share of the top 20 districts in new cases was high in lean periods of low infections compared to phases in which cases were spiking at the all-India level. Reflecting the steep rise in new cases, the doubling rate declined sharply during the second wave as against a consistent increase during the first wave. While the sharp rise in new cases during the second wave significantly increased the caseload, the case fatality rate remained stable (RBI, 2020). While the most urbanised States in India tend to have a higher number of COVID-19 cases per million, the case fatality rate does not show any clear association between infections and urbanisation.

Section III

State Finances during the Pandemic

Since the pandemic-related lockdown was imposed in India on March 24, 2020, many States had already presented their budget in their respective legislative assembly. These States along with States who presented budgets post-lockdown pegged their consolidated GFD at 3.2 per cent of GDP for 2020-21 (Chart 1). However, the pandemic's impact on State finances turned out to be more severe than anticipated, and the GFD-GDP ratio increased to 4.7 per cent (as per revised estimates) . Both revenue and primary deficits increased sharply, indicating a sharp deterioration in state finances.

Chart 1: Major Deficit Indicators of States and UTs



Source: Budget documents of States.

Hit hard by the nationwide lockdown, revenue receipts contracted during the initial months of the pandemic led by own tax, non-tax and tax devolution, while growth in grants was positive, partly offsetting the revenue fall. State goods and services tax (SGST) plunged sharply than the overall GST decline, with variations contingent upon state-specific spatial features. Stamp duties, which are a major source of revenue under States' direct taxes, also plunged due to contraction in construction activity, reverse migration of labourers and social distancing norms.Some revenue-specific measures, viz., extension of deadlines for payment of taxes to provide relief to businesses and citizens had contributed further in worsening revenue situation of States.

All categories of taxes started recovering from the second half of the year as economic activity resumed (Charts 2a and b). Consequently, contractions in own tax revenue and other revenue receipts started becoming smaller. Own non-tax revenues, with a small share in total revenue receipts relative to own tax revenue, continued to lag behind. In order to garner some additional revenues, 22 States/UTs have hiked their duties on petrol and

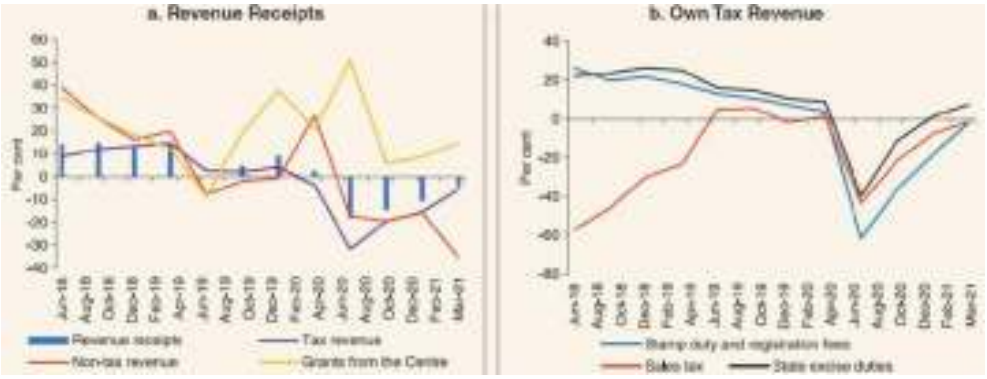
---

[2] The GFD-GDP ratio as per budgeted GDP was 2.8 per cent as published in *State Finances: A Study of Budgets 2020-21* by the RBI.

[3] The figure is likely to change when it becomes account. The provisional data on 26 States from the Comptroller and Auditor General of India (CAG) and budget estimates of the remaining five States and UTs indicate that the GFD-GDP ratio would be lower than the revised estimates.

diesel in the range of 60 to 80 paisa, while 25 States/UTs have hiked duties on alcohol in the range of 10-120 per cent, on an average basis (RBI, 2020). Transfer in the form of tax devolution also fell short of expectation as a result of contraction in the Centre's gross tax revenue due to pandemic-related lockdown. Only offsetting factor in revenue fall was the grants from the Centre.

Chart 2: Revenue Collection Growth*



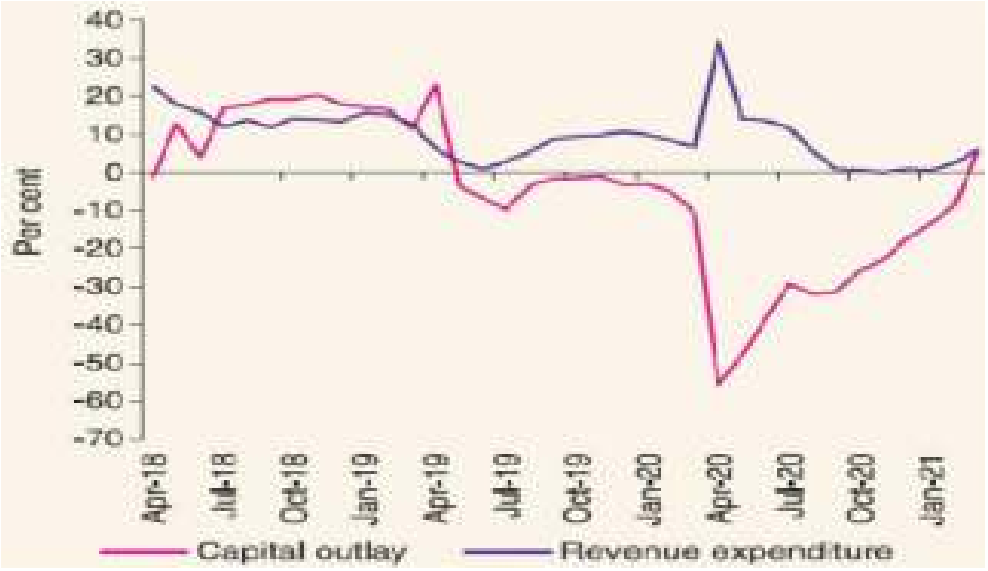
*The growth rates are on y-o-y basis and are calculated on cumulative revenue figures.
Sources: RBI; and CAG.

The pandemic necessitated fiscal policy actions to boost aggregate demand. State governments have been proactive in undertaking policy measures to contain the impact of the pandemic. As a result, revenue spending increased sharply in April 2020 (Chart 3). The financial supports were in the form of insurance cover for doctors and nurses; purchase of medical equipment and tools; hospital arrangements with a sufficient number of beds for COVID-19 patients; providing food free of cost; cash for those who are not availing of any government schemes; cash for registered construction workers; remitting a fixed sum for those trapped abroad in other States; and advance salary and pension payments (RBI, 2020). States also re-prioritised expenditure by curtailing some revenue expenditure allocations viz., dearness allowance (DA) freeze; deferment of part or full salaries and wages and deduction from salary to accommodate expenditure on health and social welfare.

After a dip in April 2020, capex growth recovered swiftly in the second half of the year, which augured well for the economy in the medium-term. To boost capital expenditure by the States, the Centre announced the scheme

of "Special Assistance to States for Capital Expenditure" on October 12, 2020 as part of the *Aatma Nirbhar Bharat* package. Capital expenditure proposals of Rs. 11,912 crore for 27 States were approved under this scheme by the Centre to fund projects in sectors like health, rural development, water supply, irrigation, power, transport, education and urban development.

Chart 3: Growth in Expenditure



Sources: RBI; and CAG.

The pandemic-related uncertainty around revenue collections and higher government expenditure led to a sharp rise in gross market borrowing of States/ UTs by 25.9 per cent to Rs. 7.99 lakh crore in 2020-21 (Chart 4). Correspondingly, the net market borrowing also increased by 33.7 per cent with concentration in a few States like Assam, Bihar, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Nagaland, Sikkim, Uttar Pradesh and West Bengal. At the beginning of Q1:2020-21, the State development loans (SDLs) yields traded with a softening bias. From end-June 2020, various developments, viz., a downgrade of India's sovereign credit rating outlook by Fitch Ratings coupled with higher supply kept SDL yields firm till September (RBI, 2021). Thereafter, yields softened as the Reserve Bank increased the limit of SLR securities kept under the held to maturity (HTM) category by 2.5 per cent of NDTL - from 19.5 per cent to 22 per cent. During February 2021, SDL yields were additionally impacted by international factors, viz., rise in US yields and crude oil prices. Overall, the weighted

average (cut-off) yield (WAY) of SDLs issued during 2020-21 stood at 6.55 per cent, compared with 7.24 per cent a year ago. The weighted average spread of SDL issuances over corresponding tenor of Union Government G-Sec stood at 52.72 basis points (bps) in 2020-21 as compared with 55.02 bps in the previous year. The average inter-State spread during 2020-21 stood at 10 bps as against 6 bps a year ago.

Chart 4: Gross Market Borrowing

Source: RBI.

Given the additional expenditure requirements for coping with the pandemic, the Centre allowed States additional borrowing of up to 2 per cent of GSDP for the year 2020-21 on May 17, 2020. Within this additional borrowing limit, 0.5 per cent was kept unconditional; 1 per cent was linked to four citizen-centric areas of reforms: (i) implementation of One Nation One Ration Card System, (ii) ease of doing business reform, (iii) urban local body/ utility reforms and (iv) power sector reforms; and the remaining 0.5 per cent was initially linked to the completion of at least 3 reforms mentioned above and the conditionality was waived later and become unconditional. The ways and means advances (WMA) limit of States/ UTs was increased by 60 per cent on April 17, 2020 (to Rs. 51,560 crore) over the level of Rs. 32,225 crore prevailing on March 31, 2020. In order to provide greater flexibility to State governments to tide over their cash-flow mismatches, the overdraft (OD) scheme for State governments was relaxed on April 7, 2020, whereby the number of days a State can continue to be in OD was increased from 14 to 21 consecutive working days and from 36 to 50 working days in a quarter. These interim measures were initially valid until September 30, 2020 and were later extended till March 31, 2021. Subsequently, the

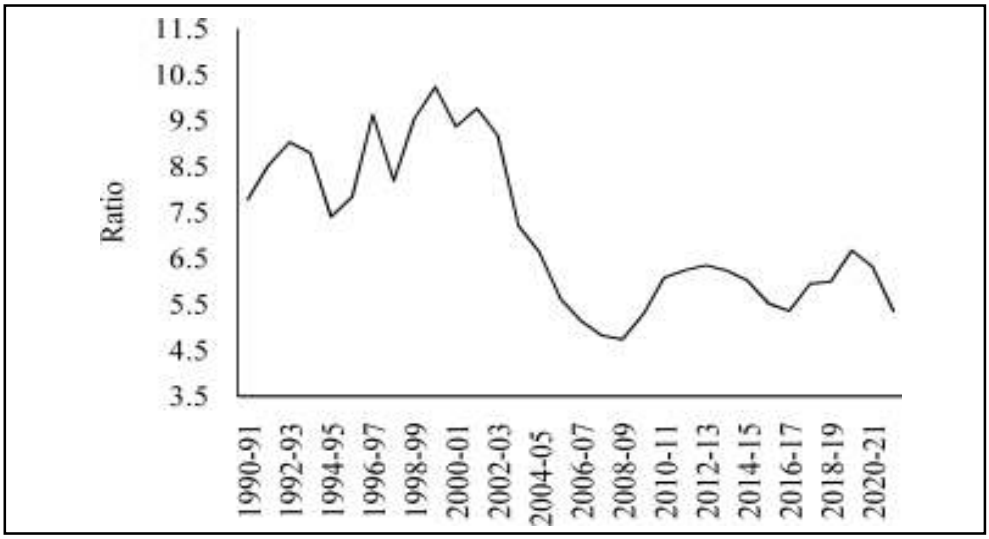
Advisory Committee on Ways and Means Advances to State Governments (Chairman: Shri Sudhir Shrivastava) reviewed the WMA limits. Considering the uncertainties related to the ongoing pandemic, the Reserve Bank decided to continue with the enhanced WMA limits up to March 31, 2022.

In the second half of 2020-21, the Centre came out with an innovative idea to meet the GST compensation requirement stipulated in GST Compensation Act, 2017. Apart from the regular compensation of Rs. 0.91 lakh crore given from compensation cess collection, the Centre provided Rs. 1.1 lakh crore as back-to-back loans to 26 States in tranches. The Centre borrowed this amount from the market and the repayment of loans will be done by itself from the compensation funds, once the compensation payment to State cease to exist from July 2022 onwards, till the full amount is repaid.The accounting treatment of the loans raised can have an impact on the GFD and liabilities of States. If the entire amount of cess would have been given in the form of grants, it would have improved the revenue receipts position of States to that order. Given that part of it is provided as loans, a corresponding reduction in receipts has increased the States' GFD in 2020-21 (RE) to that extent. Given that neither principal nor interest will be paid by States on these loans, they do not have to bear any associated costs. Concomitantly, while the increment in GFD will be added to outstanding liabilities (debt) of States, there is no servicing involved (RBI, 2021). So, strictly speaking, it should not add to the liabilities of the States.On the whole, States' fiscal position during 2020-21 was largely influenced by revenue shortfall along with a net result of higher pandemic-related spending and expenditure re-prioritisation.

The impact of revenue and capital spending on economic activity are different in terms of their magnitude and duration. The effect of revenue expenditure on growth lasts for about a year, while that of capital outlay is stronger and longer, with a peak effect after two to three years. Nonetheless, revenue expenditure has a useful role to play in short-term demand management. Therefore, an optimal mixof both revenue and capital spending is important. At the current juncture, while the economy has surpassed its pre-pandemic level, sustaining growth requires a higher capital outlay. In this direction, RECO - a ratio of revenue expenditure to capital outlay - serves as a good indicator to evaluate growth-promoting policy through a mix of revenue and capital spending.
The ratio of revenue spending to capital outlay declined from a peak of

around 10.2 in 1999-00 to 4.7 in 2008-09 as a result of strict adhere to FRL Act where States reduced unnecessary revenue expenditure, while maintaining capex trend (Chart 5). It increased to 6.7 in 2019-20 and declined to 5.4 in 2021-22 (budget estimates).

Chart 5: RECO Ratio



Source: Budget documents of state governments.

An empirical exercise is carried out using OLS regression framework for examining the linkage between 5-year forward moving average growth in real per-capita gross domestic product (PCGDPG) and the ratio of revenue expenditure to capital outlay (RECO) for the States in India. Control variables used for this regression exercise are the size of India's international trade (export plus import as a per cent to GDP) (TRDGDP), adult literacy rate (ALR) and total expenditure to GDP ratio (TEGDP) as a proxy for the size of the expenditure. Using different threshold levels for RECO ratio (from 6.0 to 7.5), the results indicate that a positive and significant impact is particularly visible at a threshold of 7.0 beyond which it loses significance (Table 1). In 2021-22 (BE), this ratio is placed at 5.4, well below the threshold.

Table 1: Ordinary Least-Square Results

Dependent Variable: Five-year Forward Moving Average Per-capita GDP Growth of States

Variable	Eqn. 1	Eqn. 2	Eqn. 3	Eqn.4	Eqn. 5
PCGDPG (-1)	0.55***	0.63***	0.54***	0.67***	0.59***
TRDGDP	-0.02	0.002	0.03	0.04	-0.01
RECO	0.12				
RECO (>6.0)		0.45*			
RECO(>6.5)			0.87*		
RECO (>7.0)				1.27***	
RECO(>7.5)					-0.01
ALR	0.03	0.03	0.04	0.03	0.03
TEGDP	-0.15	0.01	-0.05	-0.00	-0.13
DUM1	-2.02***	-2.2.30***	-2.74***	-1.61**	-2.01**
DUM2	1.29**				
Constant	1.24	-0.54	-0.61	-2.26	2.26
Adjusted R^2	0.75	0.71	0.72	0.76	0.67
LM Test for Serial Correlation	0.35	0.33	0.26	0.60	0.48
Heteroskedasticity Test:					
Breusch-Pagan-Godfrey	0.18	0.73	0.68	0.72	0.54

Notes: ***,** and * refers to 1%, 5% and 10 % level of significance.

Source: RBI staff estimates.

[4] Traditionally, the mortality from a disease is measured as a ratio of total number of deaths and total number of cases (case fatality rate). However, in case of a new disease like COVID-19, whose epidemiology is still at an

Section IV

Spatial and Structural Dimensions of the Pandemic

The pandemic has taken its toll on many States. A heartening feature is that the fatality rate in all the States, except two, has been below the global average. COVID-19 spread to all States and UTs (except Lakshadweep) and started flattening in September 2020. Maharashtra had accounted for the highest share of new cases throughout the pandemic. The cumulative case fatality rate (CFR) for closed cases (deceased and recovered) was at a lower level across all States on September 30, 2020, than on May 31, 2020. Also, most States had registered a decline in the CFR measured for all cases. An improvement in the ratio of recovered cases to total cases explained this divergence.

Demographics and Epidemiology

Demography played a key role in defining vulnerability to COVID-19 and, hence, in the population's healthcare needs. COVID-19 has shown properties like a higher mortality risk among older people and those with chronic degenerative conditions such as hypertension, diabetes, cardiovascular disease, chronic respiratory disease and cancer (United States Centre for Disease Control, 2020). India fares better than the world average in both the share and population growth in the 60+ age cohort, signifying lower vulnerability to COVID-19. Demographic transition at the State level shows significant heterogeneity and, barring a few exceptions, a strong correlation with GSDP per capita of the State. Among the richer States, Kerala, Tamil Nadu, and Himachal Pradesh have a significantly higher proportion of the population in the 60+ age cohort compared to the national average. This could potentially impact their ability to keep their economies open, as recurrent outbreaks will require them to impose strict isolation policies to protect their vulnerable population. In contrast, the low-income States of Bihar, Uttar Pradesh and Jharkhand have a meagre share of their population in the 60+ age cohort, making them less vulnerable to pandemics (Table 2).

---

exponential growth stage, calculation of case fatality rate based on closed cases (deceased plus recovered) could be a more appropriate measure of mortality from the disease.

Table 2: Demographic Transition across States

State	GSDP per Capita (2018-19)	2011-15 Vital Rates						Population in 60+ Age Cohort		
		Crude Birth Rate	Crude Death Rate	Infant Mortality Rate	Under-5 Mortality	Life Expectancy	Total Fertility Rate	2011	2021	2031
Unit	₹	Per 1000 Population	Per 1000 Population	Per 1000 Live Births	Per 1,000 Live Births	Years	Average Number of Children per Woman	Per cent	Per cent	Per cent
Delhi	3,84,219	15.4	4.8	27.0	29.0	73.8	1.8	8.8	9.3	12.5
Haryana	2,60,286	19.2	6.9	42.0	52.0	69.2	2.3	8.0	9.8	12.5
Karnataka	2,32,874	16.6	7.6	35.0	44.0	69.0	1.9	9.8	11.5	15.0
Kerala	2,25,484	14.8	7.6	11.0	12.0	75.8	1.8	12.7	16.6	20.0
Telangana	2,25,047	16.7	7.3	39.0	43.0	69.1	1.7	9.2	11.0	14.5
Gujarat	2,24,896	19.1	6.7	40.0	50.0	69.1	2.3	8.8	10.2	13.6
Uttarakhand	2,20,257	17.0	6.1	34.0	39.0	71.8	2.0	9.8	10.8	13.2
Maharashtra	2,19,169	15.2	6.6	25.0	27.0	72.0	1.9	9.8	11.7	15.0
Tamil Nadu	2,15,048	14.5	7.6	22.0	26.0	71.1	1.7	10.6	13.6	18.2
Himachal Pradesh	2,11,205	14.8	6.9	37.0	41.0	72.1	1.7	10.4	13.1	17.1
Punjab	1,72,149	14.7	6.8	28.0	35.0	72.1	1.7	10.0	12.6	16.0
Andhra Pradesh	1,64,083	16.3	7.6	33.0	43.0	69.1	1.7	10.1	12.4	16.4
NE states (excluding Assam)	1,27,234	15.8	5.6	31.6	40.1	72.2	1.8	8.7	9.8	12.7
Rajasthan	1,21,343	24.3	7.6	55.0	73.0	69.0	3.0	7.1	8.8	11.2
West Bengal	1,16,837	15.2	6.7	30.0	35.0	70.6	1.7	8.8	11.3	15.7
Jammu and Kashmir	1,06,769	16.1	4.2	20.0	41.0	73.8	1.9	7.8	9.5	13.2
Odisha	1,06,416	16.1	8.0	53.0	66.0	68.9	2.1	9.3	11.9	15.4
Chhattisgarh	1,06,009	22.3	8.1	47.0	63.0	65.2	2.6	7.9	9.8	11.7
Madhya Pradesh	89,025	26.9	8.2	58.0	80.0	64.8	3.0	7.8	8.5	11.1
Assam	84,388	20.8	7.5	51.4	72.0	64.8	2.3	8.4	8.2	11.6
Jharkhand	82,430	22.1	5.8	34.0	49.0	68.7	2.6	8.5	8.4	15.8
Uttar Pradesh	74,409	25.8	8.2	57.0	84.0	64.5	3.0	7.4	8.1	10.1
Bihar	47,541	27.5	5.8	42.0	57.0	69.4	3.0	6.8	7.7	9.8
All India		19.8	6.8	42.9	56.7	68.4	2.2	8.8	10.1	13.1

Sources: RBI, Report of the Technical Group on Population Projections (GoI,2019e); and Ministry of Statistics and Programme Implementation (MoSPI).

State-level mortality and disease burden shows a significant compositional variation between communicable, maternal, neonatal, and nutritional diseases (CMNNDs) and non-communicable diseases (NCDs), with an overall negative correlation across States. Corrected for age disparities, however, there is a positive correlation between mortality and disease burden from NCDs and CMNNDs. Kerala, Goa, Jammu and Kashmir and Punjab stand out as States with the lowest age-standardised mortality and morbidity, whereas Chhattisgarh, Assam, Madhya Pradesh and Uttar Pradesh were characterised by the dual burden of disease with high mortality and morbidity from both CMNNDs and NCDs.Thus, significant differences exist between States, with high-income States more advanced

in the ageing process and with a higher disease burden from non-communicable diseases than their poorer counterparts. A similar pattern is seen in the incidence of co-morbidity conditions linked to higher mortality risk from COVID-19 infections.

Healthcare and Fiscal Implications for States

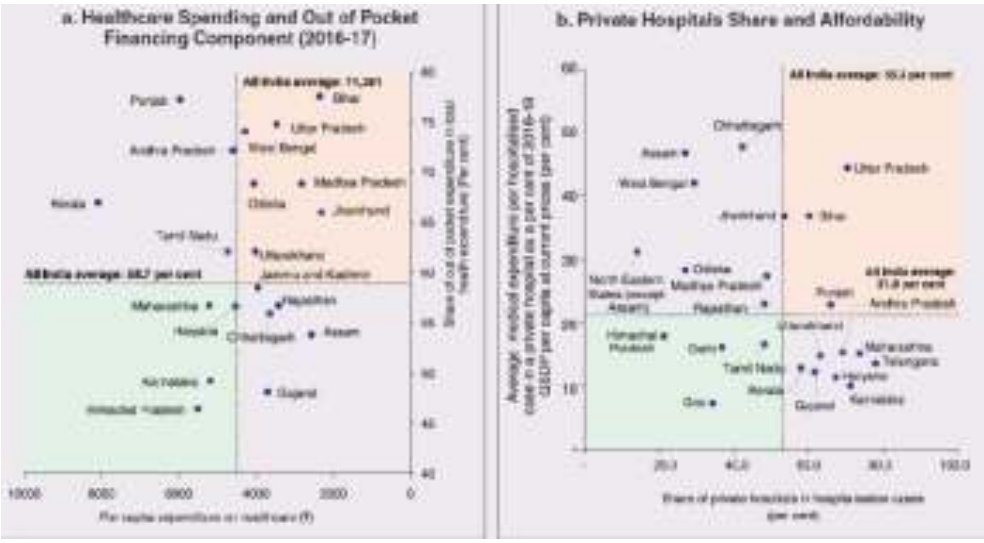
COVID-19 has set off a considerable debate on the importance of health while framing long-term policies for public transport, urban development, workforce mobility and migration - areas in which it has traditionally been at the periphery.

In the Indian federal structure, although the Centre and States share differentiated responsibilities in the healthcare system management, the States' role is larger. The seventh schedule of the Indian Constitution puts public health and sanitation, hospitals and dispensaries under entry 6 of the States' List. Furthermore, law and order (entry 1 and entry 2 of the States' List) and local government (entry 5 of the States' List) also puts the onus of containment on the States. The Centre has specific responsibilities in managing disease outbreaks under the Epidemic Diseases Act, 1897 and the Disaster Management Act, 2005, which can and were invoked during the current pandemic. Also, successive central governments have undertaken various Centrally Sponsored Schemes (CSS) in public health and sanitation (subjects in the State's List), which are routed through the treasuries of state governments and are contributory. From the perspective of management of the COVID-19 health crisis, while significant aspects of healthcare, particularly in health research (including testing and development of therapeutics and vaccines) and international collaboration, are in the primary domain of the Central government, State governments will have to take on the mantle of leadership in healthcare delivery. This pandemic presents an opportunity for States to bring about structural changes to improve healthcare quality, accessibility, and affordability.

In terms of per capita healthcare expenditure (Chart 6a), States in the top right corner of the matrix (shaded red) performed poorly on healthcare spending, which is funded by a high out of pocket component share, suggesting that they have the lowest government spending on healthcare on a per capita basis. Conversely, States in the bottom left corner (shaded green) are the best performing on both these metrics, highlighting the key

role of government finance in these States' healthcare. Kerala is the exception, with significantly higher healthcare spending per capita than all other States, driven by higher-than-average government spending and out-of-pocket spending. Regarding the share of private hospitals in hospitalised cases and their affordability (Chart 6b), States in the top right corner of the matrix (shaded red) have a higher reliance on private hospitals. At the same time, the cost of hospitalisation in these facilities (relative to their GSDP per capita) is higher than the all-India average. At the other end of the spectrum are States in the bottom left corner (shaded green) where the reliance on private hospitals is low and relatively more affordable.

Chart 6: Healthcare in States: Expenditure and Private Hospitals' Share and Affordability



Sources: RBI; National Health Accounts Estimates of India, 2016-17(GoI, 2019d); and NSS 75th Round(GoI, 2019b).

Thus, significant inter-state disparities exist in access to and affordability of healthcare. Himachal Pradesh acquits itself well in providing government healthcare and keeping private healthcare affordable, while Uttar Pradesh, Bihar and Jharkhand will need some catching up. Individuals' spending on healthcare is low in these States, financed mainly from out of pocket, with high reliance on private facilities for hospitalisation that is prohibitively expensive and crowds out medical access to the poor. This requires urgent attention from State governments to prepare their States to meet the healthcare challenges from future pandemics.

In terms of human healthcare resources, there are significant State-level differences. Southern States (except Telangana) have significantly better coverage of medical doctors, while the coverage in low-income States of Uttar Pradesh, Bihar and Jharkhand is among the lowest in the country. These States also have an abysmally low number of registered nurses and midwives vis-à-vis their population size.

Regarding hospital infrastructure in terms of the number of beds available- (a critical variable during COVID-19) - on a standardised measure of government hospital beds availability - per 10,000 population, Himachal Pradesh and Delhi were the best-placed States, while Bihar and Jharkhand lagged. The pivotal role played by the private sector in in-hospital care is a guiding proxy variable. States that have a high share of private-sector hospitalised cases, as well as high availability of government beds (shaded green), appear to be best placed in terms of overall hospital infrastructure, while States that are on the lower end of both these measures (shaded red) are likely to be deficient.

The government has a key role in providing and financing healthcare in India. Despite hospitalisation being prohibitively more expensive in private than a public hospital, the former commands a predominant share, reflecting a conscious choice made by individuals based on quality and accessibility considerations (real or perceived). At the same time, high out of pocket expenses with limited coverage of contributory and employer-based insurance raises concerns about affordability and equity in healthcare access, especially against the backdrop of COVID-19 and the vulnerability of low-income segments of society.

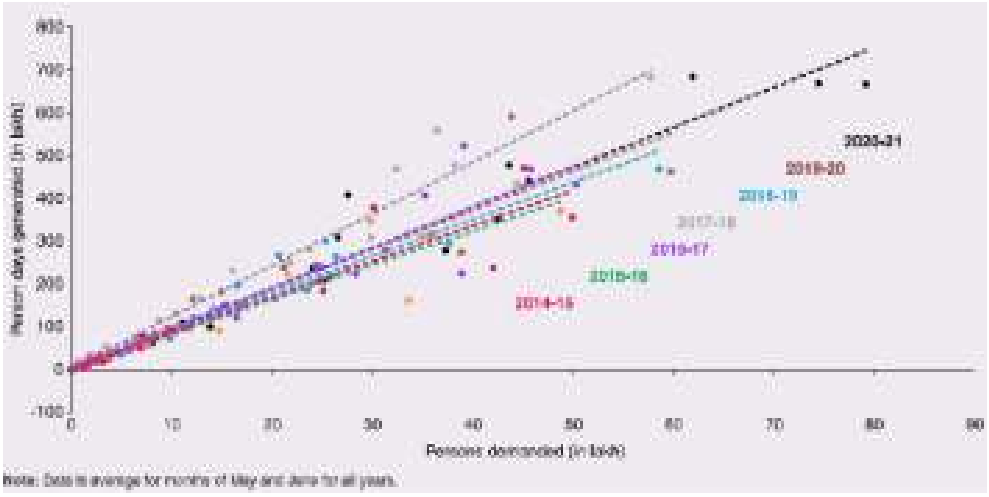
States have the overwhelming share (87.5 per cent in 2019-20) in government spending on healthcare, which is partially financed through transfers by the Centre for CSS. Total healthcare spending by health ministries of the Centre and States was 1.1 per cent of the GDP in 2019-20 (RE), up from 0.9 per cent of the GDP in 2015-16. There is significant heterogeneity in State healthcare spending per capita across States owing to their varying revenue-raising capacity.

Reverse Migration, Employment and MSMEs

COVID-19 led to large migrations during 2020, establishing a link with

epidemiology. The imposition of nationwide lockdown led to job losses, prompting migrant labourers to return from cities to their native places. The resulting transmission of the virus to rural areas added to transitory rural unemployment, besides causing labour shortages in urban areas (Singh et al., 2020). Over the decades, Uttar Pradesh (UP) and Bihar have been the significant out-migration States, followed closely by Rajasthan and Odisha. The major in-migration States are Maharashtra, Delhi, Gujarat and West Bengal. COVID-19 switched the sources and destinations of migrant labourers.In the reverse migration experienced during the pandemic, push factors, viz., high costs of living in urban areas; no earnings; loss of employment; uncertainty about the lifting of the lockdown; limited access to social and unemployment benefits, coupled with pull factors, viz.,rabi crop harvesting; seeking other employment opportunities such as Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA); joining their family members in the native place; and the notion of feeling more safe and secure were the major drivers. The dire consequence for employment is reflected through the work demanded and generated under MGNREGA across States, which has been the highest in the past few years, especially in May and June 2020 (Chart 7).

Chart 7: MGNREGA Employment Demanded and Generated



Sources: RBI; and MGNREGA MIS Reports.

Consequent upon reverse migration, a significant decline in employment was witnessed in India, particularly in sectors where physical presence of

workforce is required e.g., in construction - (73 per cent of total rural female workers and 67 per cent of total urban female workers are migrant workers) - and manufacturing sectors (59 per cent of total rural female workers and 51 per cent of total urban female workers) (Estupinan et al., 2020; Papanikolaou and Schmidt, 2020). An analysis of the daily data on unemployment reflects the sharp increase in unemployment during the lockdown.

In countries with a larger share of informal labour force, the stringent lockdown measures have impacted employment to a greater extent than others. In fact, the incidence of informality seems to have been stuck for decades in India, with the demand for labour and quality of labour being two major factors responsible for this persistence (Mehrotra, 2019).

Micro Small and Medium Enterprises (MSMEs)

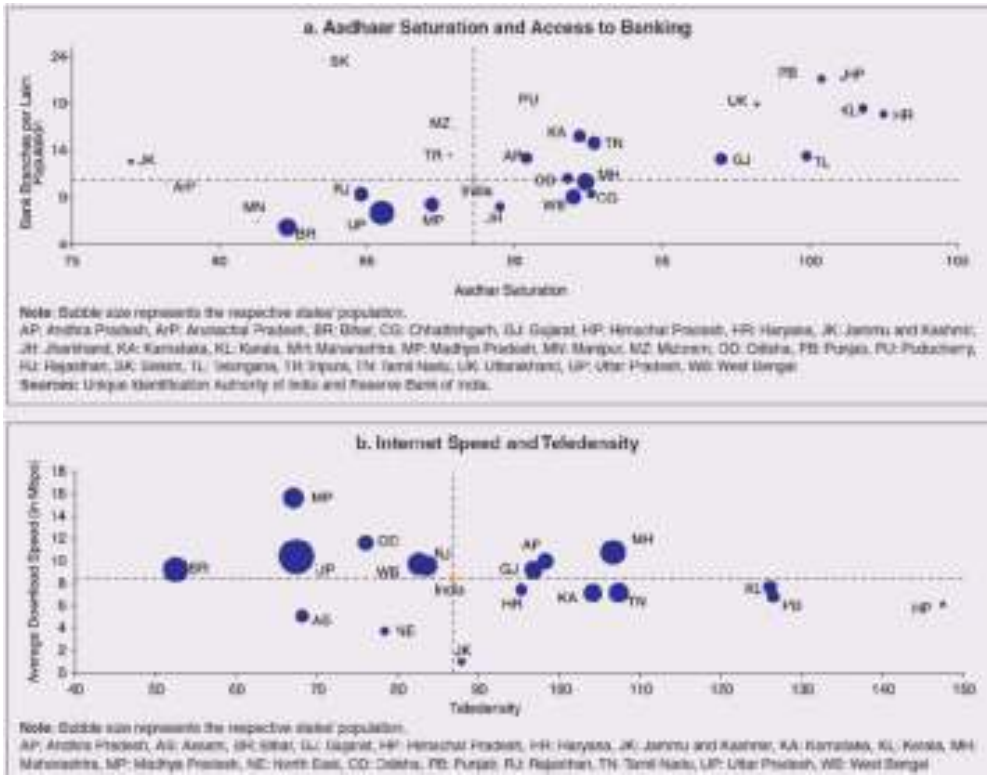
India's 63.4 million MSMEs contribute significantly to the country's economy. The sector accounts for 45 per cent of manufacturing output, more than 40 per cent of exports and employs about 120 million people. MSMEs have taken a bigger hit than other sectors, particularly because of the spatial distribution of the pandemic that is skewed towards States with a higher share of MSMEs, more so micro and small enterprises.The lockdown was a triple whammy for the MSME sector in India - supply disruption; domestic demand shock; and external demand decline (Sahoo and Ashwani, 2020). MSMEs also employ a large share of informal labourers. Consequently, the lockdown and reverse migration impacted MSME productivity, with severe implications for the States with MSME concentration. State-wise data reveal that the top 11 States accounting for around 82 per cent of employment in 2019-20 also have a high incidence of COVID-19 cases and had witnessed the brunt of reverse migration (Dev and Sengupta, 2020; CRISIL, 2020).The Government of India had announced special measures for MSMEs under Aatma Nirbhar Bharat Abhiyan to enhance their capability to withstand the economic fallout of COVID-19.

Digitalisation and Banking

Digital technologies offer immense scope to mobilise resources and for provision of public goods and services, especially during situation like pandemics. The Direct Benefit Transfer (DBT) system, launched by the Union

Government in January 2013, was developed to transfer subsidies/benefits directly to Aadhaar linked bank accounts of the identified beneficiaries. Subsequently, State governments were nudged by the Centre to move their welfare schemes to the Aadhaar-based DBT platform, which curbs leakages and ensures timely transfer of benefits directly to the beneficiaries without any need of paperwork. The success of DBT depends, inter alia, on Aadhaar saturation, availability of banking services and high-speed internet as these are instrumental in minimising inclusion and exclusion errors. More populous States like Bihar, Uttar Pradesh, Rajasthan and Madhya Pradesh lag behind the national average in terms of both Aadhaar saturation and availability of banking services. While there are small variations in average internet download speed, overall teledensity still varies widely amongst States, with Bihar, Uttar Pradesh, Madhya Pradesh, Assam lagging significantly, reporting a teledensity below 70 (Chart 8).

Chart 8: Digital Preparedness of States 2020



Sources: RBI; and Telecom Regulatory Authority of India; and Unique Identification Authority of India.

In COVID-19 times, in India, several State governments had adopted large-scale, technology-enabled, real-time financial support through the direct benefit transfer (DBT) platform in order to provide immediate relief to vulnerable sections of the population like small farmers, migrant labour, women and senior citizens. Out of the States and UTs for which data are available for 2020-21, Goa leads with a per capita DBT of Rs. 4,705. Several digital strategies have also been adopted by States in the COVID-19 period for information dissemination, effective surveillance and citizen services, which was aimedat improving the quality of public services as well as spur innovation by unlocking the power of government data.Public financial management (PFM) systems can also leverage digital solutions for efficient and transparent implementation of government programmes in the COVID-19 and post COVID-19 period.

India has been one of the fastest growing market for digital transactions, with a rich variety of digital payment options. This trend snapped in March 2020 when the COVID-19 pandemic and the associated containment measures brought economic activity to a near standstill. However, as the lockdown was gradually rolled back, digital transactions got a boost since people avoided the usage of cash for the fear of virus transmission through currency notes and preferred online shopping, keeping in view social distancing norms. Thus, digital payments, which were earlier a matter of convenience, became a necessity during the pandemic.

The adverse impact of the COVID-19 pandemic at the regional level is also reflected in state-wise performance of bank branches. Inter-state inequality in banking outreach, in terms of number of credit and deposit accounts, had been narrowing down since 2005 (RBI, 2019). However, credit penetration, as measured by credit to GSDP ratio, in the hilly and less industrialised and urbanised States need to catch up for taking India's financial penetration closer to its emerging market peers.

Exports and Remittances

As a consequence of the pandemic, private transfer receipts, embodying remittances from Indians working overseas, dropped by 8.7 per cent y-o-y in Q1:2020-21. India's exports were weakened by demand and supply-side shocks. The top six States, viz., Maharashtra, Gujarat, Tamil Nadu, Uttar Pradesh, Karnataka and Andhra Pradesh, which reported around 60 per

cent of total confirmed COVID-19 cases, account for nearly two-third of India's merchandise exports. With slowdown in economic activity amid lockdown measures, exports from these States became vulnerable.

Section V

COVID-19 and the Local Government

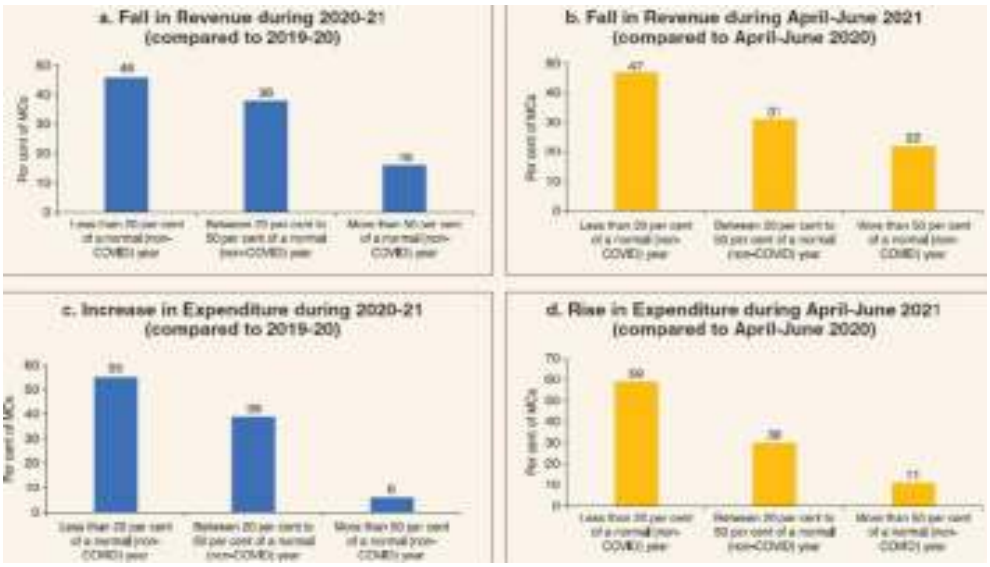
Being the closest to the people, Local governments play a key role in the socio-economic life of the people as they are involved in fighting against the pandemic by containing its spread, mitigating its harmful impact, and stabilising the lives and livelihoods of the people. In this context, it is worth noting that the COVID-19 cases per million people were relatively more in urban areas than in rural.

The Local governments scaled up their functions to provide emergency healthcare facilities, implement and enforce various restrictions on movements of goods and people, and provide nonstop delivery of critical services. The Local governments strengthened the public healthcare facilities by gearing up testing facilities; creation of temporary hospitals and quarantine centres; steering surveillance for tracking and contact-tracing; creating COVID war rooms and 24*7 COVID helplines for providing tele-counselling and tele-medicines; and restricting infections through sanitisation (RBI, 2021). Various local authorities used technology-based smart solutions such as COVID-19 tracking apps, the global positioning system (GPS) and geo-fencing to track the movement of quarantined and health workers. Many cities arranged accommodation and free food for weaker sections of society through community kitchens and food delivery aggregators. The gap in higher demand for and supply of health and quarantine facilities were also bridged with the assistance from the private sector.

Owing to the pandemic, the finances of Local governments deteriorated substantially in 2020-21 and 2021-22. The qualitative survey on municipal corporations (MCs) conducted by the Reserve Bank revealed that their spending increased, and revenue declined apart from the lack (or delayed release) of funds from the State governments during the second wave of the pandemic. MCs' revenue loss has been higher during the second wave as 22 per cent of them incurred a decline in revenue of more than 50 per

cent as against 16 per cent in the first wave (Charts 9 a and b). Similarly, 11 per cent of the MCs surveyed reported spending growth of more than 50 per cent during the second wave as against 6 per cent in the first wave (Charts 9 c and d).

Chart 9: Impact of COVID-19 on the Finances of MCs in India

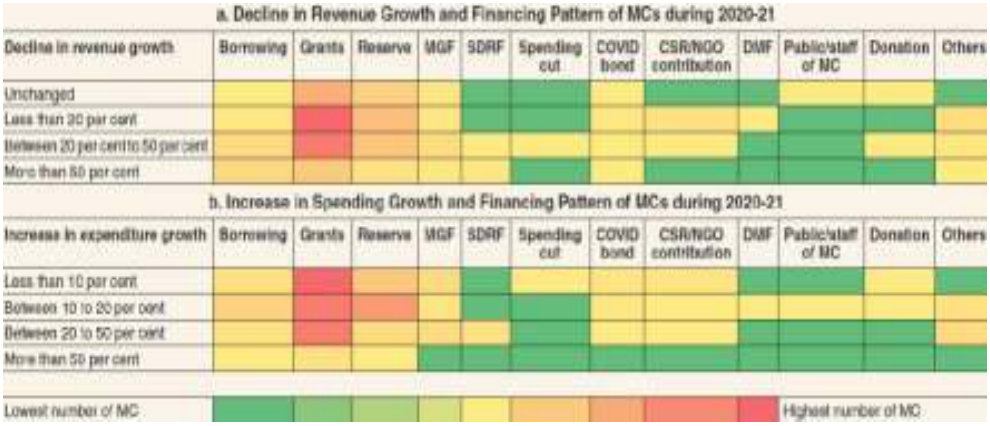


Source: RBI (Online Survey).

Since several MCs recorded either a fall in the revenue surplus or an increase in the revenue deficit , the consolidated revenue surplus declined in 2020-21 (RBI, 2021). They, in fact, reduced their non-essential expenditure and raised additional funds through borrowings, grants from the States and the Centre, reserves, municipal funds, deposits in State Disaster Response Funds (SDRF), issuances of COVID bonds, donations and contributions (Chart 10). While grants were the most significant contributor to the financing of their resource gap (around 43 per cent), the reserve meant for the infrastructure sector or committed liabilities took second place (19 per cent). Borrowing became prominent, though it played a supplemental role. About 6 per cent of surveyed MCs borrowed from State governments. Another 2 per cent borrowed from banks to meet the additional need for funds during the pandemic. Five MCs issued bonds to finance COVID-related expenditure.

[5] Based on data of 14 large MCs.

Chart 10: Financing Pattern of MCs in 2020-21



Source: RBI (Online Survey).

Despite the adverse fiscal situation, only 12 per cent of MCs resorted to borrowing either from financial institutions or State governments. This could be attributable to the adequacy of grants received from States and the Centre or withdrawal from their reserves. It is interesting to examine the association between MCs' borrowing and their reserve and grants situation during the pandemic. The association is estimated using logistic regression. The dependent variable is borrowing in binary form (if borrowed=1, otherwise=0), and independent variables are revenue declined (no decline, less than 20 per cent, 20-50 per cent and more than 50 per cent), increase in spending (less than 10 per cent, 10-20 per cent, 20-50 per cent and more than 50 per cent), grants (if used=1, otherwise=0), reserve (if used =1,otherwise=0), and creation of contingency fund for the third wave (if yes=1, otherwise=0). All the independent variables are categorical. Two models are estimated, using revenue decline and grants as an alternative to each other. The results are placed in Table 3.

Table 3: Logistic Regression Results

Dependent Variable: Borrowing (Yes=1; Otherwise=0)

	1	2	
	Odds ratio	Odds ratio	Reference
Decline in Revenue			
Less than 20 per cent	0.17**	-	No decline
20-50 per cent	0.74	-	No decline
More than 50 per cent	3.66	-	No decline
Increase in Spend ing			
10-20 per cent	1.24	1.03	No decline
20-50 per cent	0.29	0.73	No decline
More than 50 per cent	0.61	1.76	No decline
Grants	-	0.27**	No use of grants
Reserves	0.22*	0.22**	No use of reserve
Contingency funds for 3rd wave	0.26***	0.39**	No creation of funds
Observations	111	111	
Chi-square	34.42***	39.07***	
Goodness-of-fit test (Hosmer-Lemeshow)	12.40	10.38	

Notes: ***, ** and * are statistical significance at the 1, 5 and 10 per cent levels, respectively.

The results indicated that the borrowing behaviour of municipal corporations responded more to their revenue decline than spending increase. This is reflected in an insignificant probability of spending increase. On the other hand, from the revenue side, the probability that an MC will go for borrowing is 0.17 times less when revenue declines by 20 per cent than when there is no decline. It means that the MCs facing a revenue decline of less than 20 per cent are more likely to borrow than the MCs facing no decline in revenue. Similarly, the probability of reserves and creation of contingency funds for the third wave indicated that a MC going for borrowing is 0.22 and 0.26 time more than in the absence of those events.

This implies that MCs using reserves funds or setting up contingency funds for COVID-19 are less likely to borrow than MCs not using the reserve funds or not setting up the contingency funds for COVID-19. The model 2, which uses grants instead of revenues as the indicator of MCs receipts, also validates the result that MCs receiving grants, using reserve funds or setting up contingency funds for COVID-19 are less likely to borrow compared to those not receiving grants, not using reserve funds or not setting up contingency funds. This is reflected in the probability of grants, reserves and creation of contingency funds of 0.27, 0.22 and 0.39, respectively. During the pandemic, grants from the upper tier and their accumulated reserves helped restrict MCs' borrowing.

The MCs have also resorted to expenditure rationalisation measures. Among the surveyed MCs, 18 per cent reported expenditure cuts relating to non-essential areas. Guidelines were issued to the head of departments to restrict expenditure to a certain proportion of budgetary allocations until a specific period or to incur only essential spending like establishment expenses, COVID-19 prevention, electric charges, payment of property tax, water tax, and urgent repair and maintenance works. Discretionary spending like expenditure on renovation and decoration of office premises, purchase and hiring of additional vehicles except for health/sanitation work/carrying emergency staff, and withdrawal from the general provident fund (GPF) except for urgent treatment, education, and marriage-related expenditure were restricted (RBI, 2021).

The pace of vaccination has picked up across various States in India in recent months. As per information available up to November 27, 2021, 31.0 per cent of India's population has been fully vaccinated, while 52.7 per cent received at least the first dose. Local governments played an important role in the vaccination drive by making necessary arrangements and spreading awareness.

Section V

Concluding Observations

Fiscal position of the States of India deteriorated due to outbreak of COVID-19. While the focus during the first few months of 2020-21 has been on managing the health crisis, it is the regional and spatial dimensions of

structural features like demography, health care systems, migrant workers, digitisation and strength of the third tier which played an important role in determining the fuller macroeconomic impact of the pandemic on state finances. In 2020-21, the first wave of the pandemic posed States the critical challenge of declining revenue and the need for higher spending. To partially offset the revenue shortfall, the States hiked their duties on petrol, diesel and alcohol and focused on rationalising non-priority expenditures to make room for higher expenditure on healthcare and social services. While the GFD of the States overshot the 2020-21(BE) by a wide margin, this needs to be seen in the context of the concerted efforts taken by the Centre, States and the Reserve Bank of India to mitigate the impact of the pandemic on human life and the economy. These measures also helped in reducing fiscal stress on States.

The year 2021-22 started on a similar note, with the outbreak of the second wave. However, the impact of the second wave on State finances was less severe than the first wave due to less stringent and localised restrictions imposed this time as opposed to the nationwide lockdown during the first wave of COVID-19. Furthermore, the increased pace of vaccination, waning of the second wave and removal of restrictions are expected to put the economic recovery on a robust and sustainable path, setting the stage for States to map out a credible glide path for fiscal consolidation over the medium term. States are also below the threshold level of revenue expenditure to capital outlay indicating that they are preserving quality of expenditure in the post-COVID year.

The pandemic had changed the landscape of sub-national government functioning and finance. As the public health crisis recedes, the priorities will need to shift to improving the resilience of economic, social and fiscal systems by addressing the stark vulnerabilities exposed by the COVID-19. An unambiguous lesson from the varied experiences of States is the need to step up health care and related expenditure. Yet another important takeaway is boosting investment in basic digital infrastructure so as to sharpen aspects like contact-tracing, targeted public service provisioning amidst social distancing norms and sanitation compulsions. Upgrading the urban infrastructure to improve the resilience of our cities, which were severely hit during the pandemic, also assumes crucial importance. This highlights the role of local governance institutions and the importance of empowering these institutions for effective interventions at the grass-root level.

States need be prepared better to manage migrations and reverse migrations through effective labour law reforms that bring in the flexibility to absorb migrant/informal labour productively and seamlessly. For out-migration States, it may be important to skill more people so that they get absorbed closer to home and contribute to greater regional balance. For in-migration States, gainful employment through state-specific urban schemes must go hand in hand with scaling up health infrastructure and social safety nets for migrant labour. Even as States re-engage in restoring sustainability and quality of their finances especially in respect of capital spending, credibility considerations warrant retracing a glide path back to FRL fiscal targets within a stipulated time frame.

The impact of the pandemic has been heterogeneous across time and space, warranting the adoption of localised approaches for crisis management rather than a centralised response. During the second wave, the third-tier echelons of government became frontline pandemic warriors. Their involvement in the COVID-19 response became the catalyst for forging vistas of cooperation with civil society, NGOs and the private sector in mitigating the pandemic's impact. It is in this context that a key lesson can be derived from the pandemic experience - the importance of strengthening local government finances.Before the pandemic, local governments across the world suffered from insufficient budgets, over reliance on funds from upper tiers of government, lack of access to new sources of revenue, limited autonomy to change/introduce taxes, and low levels of taxpayer compliance. COVID-19 amplified these structural constraints on local government finances and brought to the fore new challenges such as revenue volatility and demand for public services and investments in areas which were not required earlier. In other words, COVID-19 has increased the responsibilities of local governments towards delivery of public services manifold.

In India, the role of MCs in cities that were the hotspots became pivotal. As a consequence, their budgets came under severe strain, forcing them to cut down discretionary spending, use reserves and other contingency funds, including resources from funds linked to the infrastructure sector or committed liabilities. This diversion of funds may have serious consequences for the financial sustainability of cities in the short to medium term. On the positive side, many of the MCs in India have now created special reserve funds to cope with future pandemics. This imparts a degree of resilience to their finances. The empirical findings in this paper indicate thatduring the pandemic, grants from the upper tier and their accumulated reserves helped to restrict their borrowing.

References

Allam, Z. (2020). The First 50 days of COVID-19: A Detailed Chronological Timeline and Extensive Review of Literature Documenting the Pandemic. In *Surveying the COVID-19 Pandemic and its Implications.* (pp. 1–7).

BBC News. (2021).Retrieved from https://www.bbc.com/news/world-asia-53420537.

CRISIL. (2020). *The epicenter of an existential crisis.*

Dev, M., & Sengupta, R. (2020). *COVID-19:Impact on the Indian Economy.*

Estupinan, X., Sharma, M., Gupta, S., Birla, B. (2020). *Impact of COVID-19 Pandemic on Labour Supply and Gross Value Added in India.*

Government of India (GoI). (2019b). *Key Indicators of Social Consumption in India: Health.* National Statistical Office, Ministry of Statistics and Programme Implementation.

Government of India (GoI). (2019d). *National Health Accounts Estimates for India 2016-17.* National Health Systems Resource Centre, Ministry of Health and Family Welfare.

Government of India (GoI).(2019e). *Report of the Technical Group on Population Projections*. National Commission on Population, Ministry of Health and Family Welfare.

Shereen, M.A., Khan,S., Kazmi,A., Bashir, N., & Siddique, R. (2020). COVID-19 infection: emergence, transmission, and characteristics of human coronaviruses.*J. Adv. Res.,24*, (pp. 91-98).

Mehrotra, S. (2019). *Informal Employment Trends in the Indian Economy: Persistent informality, but growing positive development*. Employment Working Paper No. 254, Employment Policy Department, International Labour Organisation.

Lennart, N., and Pitterle, Ingo A. (2021).*The COVID-19 crisis: what explains cross-country differences in the pandemic's short-term economic impact*?. MPRA Paper 107414, University Library of Munich, Germany.

Papanikolaou; D. and Schmidt, L.D.W. (2020). *Working Remotely and the Supply-Side Impact of COVID-19.*

RBI (2019). *Report on Trends and Progress of Banking in India* 2018-19.

RBI (2020). *State Finances: A Study of Budget* 2021-22.

RBI (2021). *State Finances: A Study of Budget* 2021-22.

Mendez, Rich. (2021). Africa suffers worst surge in Covid cases as delta variant spurs third wave of pandemic. *CNBC*. Retrieved from https://www.cnbc.com/2021/07/08/delta-variant-africa-suffers-worst-surge-in-covid-cases-officials-brace-for-third-wave.html

Sahoo, P.,& Ashwani. (2020). *COVID-19 and Indian Economy: Impact on Growth, Manufacturing, Trade and MSME sector*. IEG Working Paper.

Singh, S.K., Patel, V., Chaudhary, A., Mishra, N. (2020). Reverse Migration of Labourers amidst COVID-19, *Economic and Political Weekly, Vol. 55,* Issue No. 32-33, 08 Aug.

Investigating the Existence of Agriculture Induced Environmental Kuznets Curve in the Context of Indian Economy

Odisha Economic Journal
Volume 53 • Issue 2 • 2021
pp. 34-57
Journal of the
Orissa Economics Association
OEA

Owais Ibni Hassan
Shahid Ashraf

Abstract

Agriculture poses high pollution risk, most notably through the unchecked use of fertilizers. This study examines the existence of EKC for fertilizer pollution in Indian context using annual frequency data over the period 1970-2018. EKC is a widely tested hypothesis especially for the pollutant, carbon dioxide. The behaviour of nitrous oxide as a pollutant has been relatively neglected in the EKC literature. Nitrous oxide is an environmental hazard with its 300 times greater warming capability than carbon dioxide. This paper attempts to fill that gap in literature and uses nitrous oxide as a proxy for environmental degradation in the EKC framework. ARDL Bounds test approach is applied to investigate the relationship between pollution and economic growth. Using ARDL Bounds test approach,the results of this study conform a short-run as well as long-run relationship between agricultural growth and environmental degradation thus validating the EKC hypothesis for Indian agriculture sector. However, no significant relationship was found between land use and nitrous oxide emissions. Alternate agricultural practises and use of organic fertilisers and manures

Owais Ibni Hassan, Research Scholar, Department of Economics, Jamia Millia Islamia, New Delhi. Email: owaisibnihassan@gmail.com

Shahid Ashraf, Professor, Department of Economics, Jamia Millia Islamia, New Delhi. Email: sashraf@jmi.ac.in

should replace conventional agricultural practises. The findings underscore urgent need for wider implementation of green farming.

Keywords: Agriculture, ARDL Bounds test, Environmental Kuznets Curve, Greenhouse Gases, Nitrous oxide, Pollution

Introduction

The economy-environment relationship is widely tested within the framework of the environmental Kuznets curve (EKC). The EKC hypothesis models the trade-off between the environment quality and economic growth. The concept of EKC helps us to see and analyse the implications of economic growth on the quality of environment. Thus, this concept becomes very important when the policies are framed related to economic growth. It helps the economies to frame the relevant policies at different stages of economic development. The EKC hypothesis shows nations respond to their respective issues related to environment. It posits that initially economic growth leads to an increase in pollution but after a certain threshold level of growth further economic growth tends to reduce environmental degradation thus yielding and inverted U shaped pathway between pollution and income. This inverted U shape of the EKC is explained by the scale, composition and technique effects (Diao et al., 2009; Al-Mulali et al., 2015; Olale et al., 2018). These are discussed in detail in the next section. Modern economies are characterised by well-developed manufacturing and service sectors yet the primary sector specifically agriculture remains pivotal especially in the Indian context. In India agriculture contributes significantly to employment, exports and GDP. As of 2019 agriculture's share in GDP is 20 per cent , exports 10 per cent and 58 per cent in employment *(Economic Survey of India 2020-2021)*. Moreover, India is the global leader in the production of spices, milk,rice wheat and tea (State of Indian Agriculture 2015-16, Ministry of Agriculture, Government of India). Despite being economically significant, agricultural methods, practises, inputs among other things are an ecological threat. Havemann (2014) reports that agriculture is a source of greenhouse gas emissions. Agricultural induced greenhouse gas emissions need to be adequately addressed to combat air pollution. Agricultural practises like farming and crop burning release nitrous oxide and methane (Cole et al., 1997). Use of chemical fertilisers and livestock rearingcontribute significantly to nitrous oxide

emissions. (Henseler and Dechow, 2014). Nitrous oxide is known to trap heat in the atmosphere and is linked to climate change. Solomon et al (2007) that nitrous oxide is 300 times more harmful than carbon dioxide in trapping heat. Nitrous oxide can remain in the atmosphere for 144 years (Prather et al., 2015) making it an environmental hazard. Nitrous oxide is the primary agent in depleting the ozone layer (Ravishankara et al., 2009). Kang and Bange (2013) claim that nitrous oxide constitutes 6 per centsources of anthropogenic gases.

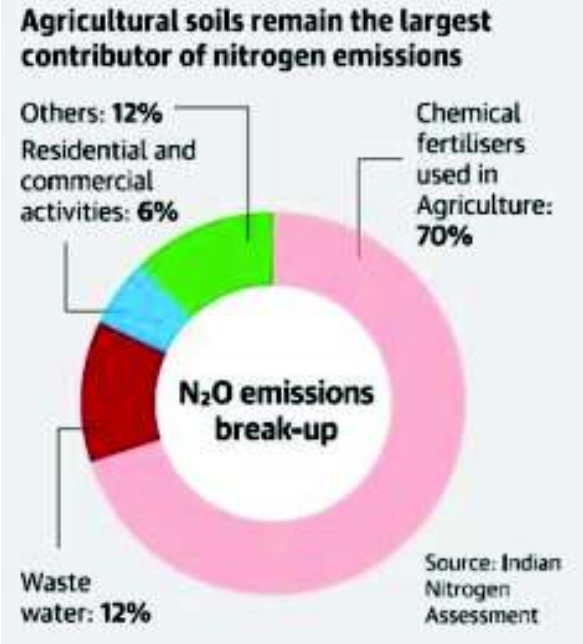
In growth-pollution literature the most widely studied pollutant is carbon dioxide. Given the fact that nitrous oxide is highly hazardous it is not adequately studied in growth literature. This paper attempts to fill the gap in literature and examine the effect of agricultural output on nitrous oxide emissions. Globally agricultural emissions have increased by 14 per cent from 1990 to 2005 (Mannina et al., 2017). About 15-35 per cent of global greenhouse gas emissions can be traced to agricultural practices. (Agriculture Overview, World Bank, 2018). In the year 2005, nitrous oxide emission from agriculture sector was about 82 per cent of the world`s total nitrous oxide emissions (EDGAR, 2009). Anthropogenic activities, in particular the indiscriminate use of nitrogen induced fertilizers and cultivation of nitrogen fixing crops has disturbed the nitrogen cycle (Del Grosso and Parton, 2012).

Nitrous oxide remains a key pollutant in India especially through the overuse of nitrogen based fertilisers in the last three decades (Some et al., 2019). The application of fertilizers accounted for 72 per cent towards nitrous oxide emission in India and manure and crop burning residue accounts for 3 per cent and 11 per cent, respectively (Sharma, 2020). The cropping of rice and wheat are the major source of nitrous oxide emission as both the crops occupy 26 million Ha of productive land in Asia and the fertilizers used are usually nitrogen based (Pathak et al., 2002). According to the President of Indian Nitrogen Group, Mr.Raghuram, nitrous oxide has become the leading greenhouse gas from Indian agriculture since 2002 (Natureasia). The Indian Nitrogen Assessment report of 2010 confirms that nitrous oxide emissions is growing at 6 per cent annually in India. The key contributor to Nitrous oxide emission in India is the burning of the crops. Over 7 million kg of nitrous oxide is emitted by this process per year, reports the Indian Nitrogen Assessment. The report further adds that the agriculture remains the largest contributor to nitrogen emissions. As per the report of Indian Nitrogen Assessment, Nitrous oxide emissions in India grew at a whopping pace of 52 per cent from 1991 to 2001 and 69 per cent from 2001 to 2011.

As per the dean of Indian Nitrogen Assessment, Dr. Raghuram, Nitrogen is the main component of chemical fertilizers used for agricultural purposes and this leads to an immense increase in the soil and water pollution, thereby causing health issues in living beings including humans.
In 2010, over 70 per cent of nitrous oxide is emitted from agricultural soils. Moreover, since 2002, nitrous oxide has become the leading greenhouse gas from Indian agriculture, replacing methane.

77 per cent of all agricultural nitrous oxide emission in India is caused by chemical fertilizers . These fertilizers are mostly consumed in the production of wheat and rice. Figure 1 shows the break-up of nitrous oxide emission in India.

Figure 1: Breakup of Nitrous Oxide Emission in India



The Green Revolution was path breaking for Indian agriculture. It achieved self-sufficiency and surplus from a situation of food deficit. The practises introduced through the Green Revolution continued for many years (Saharawat et al., 2010). In hindsight, the green revolution contributed as significantly to pollution in India as it did to output growth. Leading rice producing States of India such as Punjab, West Bengal and Haryana have been releasing nitrous oxide rampantly. These states have been using nitrous oxide based fertilizers which has led to an increase in nitrous oxide emissions.

According to Indian Nitrogen Assessment's report, chemical fertilizers account for almost 77 per cent of overall nitrous oxide emitted from agriculture.The above mentioned facts pave a path for this study to be undertaken under the framework of EKC hypothesis for Indian economy. The EKC hypothesis has been extensively investigated for India. However, to the best of our knowledge no study has performed an agricultural induced EKC investigation. This study incorporates nitrous oxide as the pollutant used for environmental degradation. This study can provide useful insights by examining the association between nitrous oxide emissions and economic growth using the latest data. It can aid in policymaking by highlighting country specific factors that define the pollution-growth pathway.

2. Literature Review

2.1 Studies about Economic Growth and Environmental Degradation

The EKC hypothesis has been widely tested using an array of variables, time periods and econometric specifications. Results vary widely depending upon the pollutant studied and the econometric techniques used. Broadly there is no consensus in literature about the validity of EKC. Carillo and Maietta (2014) found a negative relationship between economic growth and environmental degradation for Italian regions, from 2000 to 2006, by applying Arellano-Bond two-step dynamic panel data GMM technique. Zhang et al. (2015) tests the relationship between economic growth and environmental degradation from the time period 2004 to 2012 for Chinese cities and he finds a negative correlation between economic growth and environmental quality. The same results have been found by Valadez and Hu (2016) by examining the impact of growth and trade on the quality of environment. Exports and GDP were taken as dependent variables, and air pollution, water pollution and industrial solid waste were taken as independent variables in this study. A section of literature confirms that pollution increases with economic growth. Shafik and Bandyopadhyay (1992) also conducted an investigation of testing the existence of the EKC hypothesis for countries at different levels of income. They analysed the behaviour of eight different indicators of environmental degradation and their study also validates EKC hypothesis. Panayotou (1993) investigated the economic growth and environmental degradation nexus by using the cross-section data on deforestation and air pollution for some selected sample developed and developing nations. Nitrous oxide and sulphur dioxide are used

as the indicators of environmental pollution for this study. The results show a positive relationship between economic growth and environmental pollution. De Bruyan et al. (1998) investigated the pollution and income relationship for four countries and they found a positive relationship between economic growth and environmental degradation. Deyong et al. (2011) investigate the EKC hypothesis for China from 1990 to 2007 using the panel cointegration tests. The research results found a positive relationship between carbon emission and economic growth. Tamang (2013) investigated the EKC hypothesis for a panel of 8 low-income nations and a panel of 11 high-income nations using nitrous oxide, carbon dioxide and methane as pollution indicators. The study did not find any support for the EKC hypothesis.Fakher and Abedi (2017) try to establish a relationship between economic growth and pollution in some developing countries and they find out that the economic growth impacts the environment quality in a positive manner. Awad (2017) also studies a panel of Sub-Saharan countries from 1990 to 2014 and found a positive relationship between pollution and economic growth. Churchill et al. (2018) conducted a study on EKC hypothesis for 20 OECD nations from the period 1870-2014. The study uses carbon dioxide emissions as the proxy for environmental degradation and employs the Westerlund panel cointegration technique. The results validated the EKC hypothesis for the whole group of OECD countries.

Raggad (2018) tested the EKC hypothesis between carbon emissions, economic growth and energy consumption and urbanization from 1971 to 2014 in Saudi Arabia and he also found a positive impact of income increase on co2 emissions using the ARDL technique. Hao et al. (2018) studied the relationship between environmental quality and per capita income for China. They found N-shaped EKC which implies that before the environment quality improves, as the economy grows, it actually worsens first. The time period used in this study is from 2006 to 2015 for the panel of 30 provinces of China. Spatial Durbin Model is used for testing the EKC hypothesis in this study. Shuja ur Rehman et al. (2019) also tried to investigate the EKC hypothesis from the time period 1970-2016 for Pakistan. The results show a negative impact of financial development on the environmental degradation and thus supports the EKC hypothesis by taking carbon dioxide emissions as the dependent variable. Mahmood et al. (2020) also tested the EKC hypothesis for six East Asian countries by investigating the nexus between globalization and carbon dioxide emissions for the time period 1972-2013 and they validated the EKC hypothesis for the selected sample time period.

2.2 Studies Related to Nitrous Oxide

Carbon dioxide is the most studied pollutant in the EKC literature. Studies that have used nitrous oxide as the pollutant in EKC are few are far in between. Some of them are reviewed here. Cole et al. (1997) tested the EKC hypothesis for 11 OECD countries from 1970 to 1992, using the nitrous oxide as the pollution proxy. The study employs Random and fixed effects regression for estimations. and they found an inverted U-shaped EKC. Och (2017) tested the EKC hypothesis for nitrous oxide emissions for Mongolia from the time period 1981 to 2012. The study estimates the long-run relationship between nitrous oxide emissions, exports, urbanization and income. The results show a long-run relationship between the variables used. Zambrono-Monseratte and Fernandez (2017) investigated the EKC hypothesis for Germany from the time period 1970 to 2012 using the ARDL technique. Nitrous oxide has been used as the proxy for environmental degradation and the repressors include economic growth, agricultural land use and exports. They found the evidence in support of EKC hypothesis.

Wang et al. (2017) give a different insight into the EKC by providing microeconomic verification of the hypothesis for the USA. They used nitrous oxide as a proxy for environmental quality and GDP as the economic growth indicator for the period 1980-2009, methane from 1990 to 2009 and carbon dioxide emission from 1960 to 2010. They concluded that there exists a long-run relationship between economic growth and nitrous oxide emissions using Correlation and cointegration methods. Nassiani et al. (2017) used the nitrous oxide as the dependent variable and GDP, financial development and energy consumption as independent variables using the EKC framework from the period 1990 to 2015 for BRICS nations and they found the evidence in support of EKC hypothesis using Panel fixed effect regression. Sinha and Sengupta (2019) also tested the EKC hypothesis for nitrous oxide and renewable and fossil fuel energy consumption for the period 1990-2015 for a panel of APEC countries. They found a two-way causality between nitrous oxide emissions, renewable and fossil fuel energy consumption. They found N-shaped EKC. Haider et al. (2020) investigated the EKC hypothesis for a group of countries raked on their nitrous oxide emission. The results show that the economic growth and nitrous oxide emission are positively correlated from the period 1980 to 2012. The other regressors included in the study are agricultural land use and exports. The technique used is the Pooled Mean Group.

2.3 Studies for Agriculture as a Dependent Variable

In the EKC literature, the most common proxy for income is GDP. A host of additional variables have been incorporated in the EKC models, ranging from foreign direct investment, education, financial development, urbanization to name a few. However agricultural induced environmental degradation has not been adequately addressed in literature. Since agricultural emissions are posing an increasingly alarming environmental threat this study aims to fill the gap in literature and examine the impact of agriculture on nitrous oxide emissions. Coderoni and Esposti (2011) took agricultural data for Italy and fitted it into the EKC framework for agricultural emissions such as nitrous oxide and methane for the time periods 1951-2008 and 1980-2008. Their results did not support the existence of EKC hypothesis for agricultural co2 emission. The study employs GMM technique for estimations. Havemann (2014) noted that one of the main source of greenhouse gases is agriculture, thus it needs to be addressed before it further disrupts the environment. Leitao (2014) also investigated the relationship between the agriculture productivity and co2 emissions for Portugal from 1960 to 2015 using OLS and GMM techniques. The results show that agricultural productivity impacted the co2 emission positively.

Alamdarlo (2016) investigated the EKC hypothesis for agricultural sector of Iran from 2001 to 2013 and they found that EKC is validated for the observed variables i.e. water consumption, agriculture value added and carbon emissions.Dogan (2017) has investigated the agriculture induced degradation for China from the period 1971 to 2010 using ARDL Bounds test approach and FMOLS. The results validate the existence of agriculture-induced EKC hypothesis. Liu et al. (2017) tested the relationship between agricultural value added and the CO2 emission from the period 1992 to 2013 for North African countries. The results of Granger causality test shows that agriculture causes co2 emissions. Ullah et al. (2018) tested the agriculture -induced EKC for Pakistan for a period of 1972-2014 using the ARDL and Granger causality techniques. Their results show that there is relationship between agriculture and CO2 emission. The variables used in the study are agricultural ecosystem and carbon dioxide emissions. Gokmenoglu and Taspinar (2018) investigated the agriculture-induced EKC for Turkey for the period 1960-2013. The study considers energy consumption, urbanization, trade and financial development for testing the hypothesis by employing ARDL technique. Their results validate the

EKC hypothesis for agriculture. Chandio et al. (2019) investigated if there is any impact of agriculture and financial development on co2 emissions in Pakistan for the period 1980-2016 and they found positive relationship between the examined variables.

Despite the fact that agriculture and nitrous oxide impacts the environment in a bad manner, very few studies have been dedicated to these two parameters. The aim of our study is to incorporate both these parameters and fill the gap in the existing literature. Moreover, to our knowledge, no study is conducted to investigate the agriculture-induced EKC for India and thus our study is designed to fill this gap as well.

3. Data and Methodology

3.1 Variables Used

The variables used in this study include Agricultural Nitrous oxide emission (N), agricultural land use (LU), agricultural value added (A), and the square term of agricultural value added (AS).

3.2 Data Source

For the empirical analysis of this study, we use the annual data from the year 1970 to 2018. The data for all the variables were sourced from the World Development Indicators. The sample period choice was made on the basis of the availability of the data.

3.3 Model Estimation

The functional form for the estimation of EKC hypothesis has been drawn from the path breaking study of Grossman and Krueger (1991) and more recently after the studies of Shahbaz et al.(2013) and Gokmenoglu and Taspinarr(2018).

The agriculture-induced EKC model can be modelled as:

$$N = F(A, AS, LU) \quad (1)$$

Where N is the Nitrous oxide emissions from agriculture sector (Proxy for environmental degradation), A is the agricultural value added (Proxy for

agricultural growth), AS is the square term of agricultural value added (Used to test for the existence of EKC), and L is agricultural land use which is used as a control variable so as to avoid the variable omission bias.

To estimate the elasticity and to capture the growth impacts in the long-run, the variables are transformed into their logarithmic forms. Shahbaz et al.(2012) argue that using the log linear models are useful in terms of efficiency and thus the model is expressed as:

$$LN_t = \beta o + \beta_1 LA_t + \beta_2 LAS_t + \beta_3 LLU_t + u_t (2)$$

Where at period t, LN is the natural log of the Nitrous oxide emission from agriculture, LA is the natural log of the agricultural value added, LAS is the natural log of the square term of agriculture value added, LLU is the natural log of the agriculture land use, and u is the error term.

3.4 Estimation Procedures

So as to ensure the reliability of the model to test the relationship between the agricultural growth and environmental degradation, we employ the following procedures, i.e., unit root tests, the ARDL Bounds test, and the Error Correction Form (ECM).

3.5 Unit Root Test

In order to carry forward further econometric analysis, it is mandatory to test for the stationary qualities of the variables. This is very helpful to avoid the spurious results. The current study employs the Augmented Dickey Fuller (Dickey and Fuller 1979) and Phillip Peron (Phillips and Peron 1986) unit root tests. The ADF unit root test is applied to know the stationary traits of the variables and to cross check the results, we employ the PP unit root test as it is superior to the ADF test. PP is a non-parametric test and moreover it does not need to select the serial correlation levels as is done in the ADF test.

3.6 ARDL Bounds Test

IN order to estimate the short run and the long run coefficients, we employ ARDL bounds test which was developed by Pesaran and Shin (1995) and

Pesaran et al. (2001). The reason for choosing ARDL for cointegration analysis is that it is suitable for small sample size and it can be applied on the mixed order of integration, i.e., I(0) or I(1). Moreover, it can choose different optimum lag lengths thus it helps in saving the degree of freedom. ARDL provides an unbiased estimate if there is any endogineity in the independent variables (Odhiambo, 2009; Pesaran et al., 2001). For our model, the linear ARDL form of equations is as follows:

$$\Delta LN_t = \beta_0 + \beta_1 LA_{t-1} + \beta_2 LA_{t-1} + \beta_3 LAS_{t-1} + \beta_4 LLU_{t-1} + \sum_{i=1}^{p} \alpha_{1i}\, \Delta LN_{t-1} + \sum_{i=1}^{q} \alpha_{2i}\, LA_{t-1} \sum_{i=1}^{r} \alpha_{3i}\, LS_{t-1} + \sum_{i=1}^{s} \alpha_{4i}\, LLU_{t-1} + u_t \quad (3)$$

Where Δ is the difference operator; β_0 is the intercept term; ut is the error term; p, q, r and s are the optimal lag lengths; i represent the value of optimal lag; β_1 , β_2 , β_3 and β_4 are the long run coefficients.

Equation 3 is used to test the null hypothesis of no cointegration among the given variables. The existence of null hypothesis that there is no long run relationship, is tested by the following equation: $H_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ The existence of a long run cointegration is determined by the means of F-Statistics. A long run relationship can be claimed only if the estimated value of F-Statistics from the Bounds tests is greater than upper critical value. The null hypothesis of no cointegration is accepted when the F-value falls below the lower critical bound value.

Once the cointegration among the variables is confirmed, the long run coefficients of the ARDL model are estimated by using the below equation:

$$LN_t = C1 + \sum_{i=1}^{p} \alpha_{1i}\, \Delta LN_{t-1} + \sum_{i=1}^{q} \alpha_{2i}\, LA_{t-1} \sum_{i=1}^{r} \alpha_{3i}\, LS_{t-1} + \sum_{i=1}^{s} \alpha_{4i}\, LLU_{t-1} + u_t \quad (4)$$

After estimating the long-run coefficients, the next step is to estimate the short-run coefficients by estimating the Error Correction Model (ECM). It is argued that in order to confirm the short run relationship among the variables, the value of lagged error correction term has to bear a negative sign and should be statistically significant. The below equation shows the Error Correction Model:

$$\Delta LN_t = C1 + \sum_{i=1}^{p} \alpha_{1i}\, \Delta LN_{t-1} + \sum_{i=1}^{q} \alpha_{2i}\, LA_{t-1} \sum_{i=1}^{r} \alpha_{3i}\, LS_{t-1} + \sum_{i=1}^{s} \alpha_{4i}\, LLU_{t-1} + \Omega ECT_{t-1} + u_t \quad (5)$$

Where ECT_{t-1} is the lagged value of error correction term. This term represents the speed at which a short run disequilibrium is restored after a short-run shock. Ω is the coefficient of the error correction term.

4 Estimation Results

4.1 Unit Root Tests

The results of the ADF and PP unit root tests is presented in the table 1. It shows that the variables Nitrous oxide emissions from agriculture sector, agricultural value added (A), and the square term of agricultural value added (AS) are stationary at first difference and the agricultural land use is stationary at level.

Table 1: Unit Root Results

	ADF		PP	
Variables	T-Statistic	P-Value	T-Statistic	P-Value
LN	1.76	0.39	0.50	0.97
LA	0.73	0.99	1.42	0.99
LAS	0.84	0.99	1.56	0.99
LLU	3.14	0.03	2.98	0.04
Δ LN	2.94	0.04	7.29	0.00
Δ LA	11.47	0.00	16.52	0.00
Δ LAS	11.42	0.00	15.61	0.00
Δ LLU	7.66	0.00	7.62	0.00

Source: Authors' own calculations

4.2 Cointegration Test

From the stationarity results, it is evident that the variables are integrated of mixed order, i.e., they follow the I(0) and I(1) processes, thus ARDL is the suitable technique to use for checking the long-rung cointegration. The

optimal lag length has also been selected so as to carry forward the ARDL Bounds test.

The result of the Bounds test is given in Table 2. The dependent variable is the Nitrous oxide emissions from agriculture sector and the explanatory variables are the agricultural value added, the square term of agricultural value added and the agricultural land use. After estimating the model, the calculated F-Statistic is 6.35, which is higher than the critical value of upper bound I(1) at the 5 per cent significance level. This reveals that cointegration exists when agricultural value added, the square term of agricultural value added and the agricultural land use are the independent variables.

Table 2: Bounds Test Results

Test Statistic	Value	Significance	I(0)	I(1)
F-Statistic	6.35	10 %	2.37	3.2
		5 %	2.79	3.67
		1 %	3.65	4.66

Source: Authors' own calculations

4.3 Short-run and Long-run estimates

Table 3 shows the long-run coefficient estimations of the ARDL model. The long run coefficients of LA is having a positive sign and is statistically significant, which implies that growth in agriculture positively impacts the agricultural nitrous oxide emissions, and a per cent increase in agricultural economic growth will cause a 26.81 per cent increase in agricultural nitrous oxide emissions. The square term of the agricultural value added is also statistically significant and is having a negative sign which indicates a necessary condition for EKC existence, hence it proves the existence of EKC hypothesis. The quadratic term of the agricultural value added reduces the agricultural nitrous oxide, and a percentage increase in the agricultural value added is going to reduce the emissions by 0.49 percentage. Subsequently, the coefficient of Agricultural value added is positive ($\beta_0 > 0$) and the coefficient of the square of agricultural value-added id negative ($\beta_2 < 0$), this validates the presence of an inverted U-shaped curve for

agriculture sector during the period 1970-2018. This finding is similar to those of Najafi Alamdarlo (2016), Dogan (2016), Gokmenolu and Taspinar (2018), in Pakistan, Turkey and China. Moreover, Zafeiriou and Azam (2017) also confirm the existence of an inverted U-Shaped curve for agricultural sector in Spain, France and Portugal.

In the case of the agricultural land use, the long run results are positive but slightly insignificant. Thus, the impact of agricultural land use on the agricultural nitrous oxide emissions is not very much and hence, there is a scope for India to increase the land use ratio for agricultural purposes.

Table 3: Long-run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	P-value
LA	26.81	5.50	4.86	0.00
LAS	-0.49	0.10	-4.68	0.00
LLU	4.19	3.82	1.09	0.28

Source: Authors' own calculations

4.4 Error Correction Model

An error correction model is introduced based on the ARDL Bounds test taking the log of the agricultural nitrous oxide emissions as the dependent variable. Table 4 shows the results of the Error correction model. The ECT shows the short run coefficients. The ECT is statistically significant and has a negative sign. The coefficient of ECT is -0.36 and is significant which indicates that agricultural nitrous oxides converges to its long-run equilibrium at 36 per cent speed of adjustment.

Table 4: Error Correction Term

Variable	Coefficient	Std. Error	t-Statistic	P-value
CointEq(-1)	-0.36	0.06	-5.95	0.00

Source: Authors' own calculations

4.5 Diagnostic Tests

Table 5 shows the result of diagnostic tests. The selected data has been tested for various econometric diagnostic tests to carry out the analysis. The tests include Serial correlation test, Data stability test, Heteroscedasticity test, Normality test and stationary test. The diagnostic tests show that the data is suitable for conducting the necessary econometric analysis. The CUSUSM (Fig. 1) and CUSUMQ (Fig. 2) tests for stability are also carried out and the dotted line has been found inside the boundary interval at the 5 per cent significance level. This implies that the data is stable for the chosen period of time.

Table 5: Diagnostic Test Results

Diagnostic test	F-statistic	Prob.
Serial correlation	1.40	0.25
Normality		
Heteroscedasticity	0.73	0.59

Source: Authors' own calculations

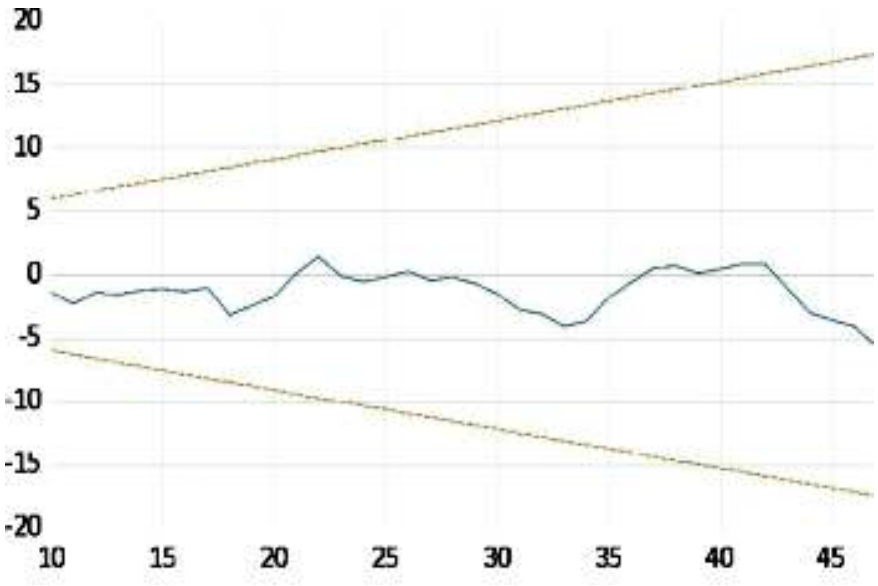


Figure 2: CUSUM

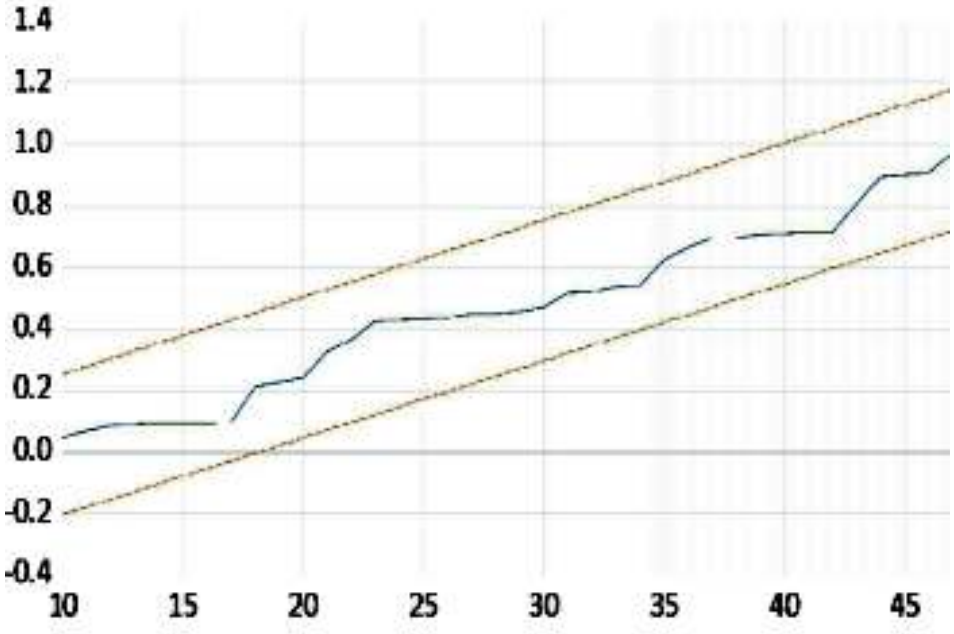


Figure 3: CUSUMSQ

5. Conclusion and Policy Implications

Despite its importance in environmental degradation, very few studies are available using nitrous oxide as the proxy for environmental degradation. This study explores the relationship between agriculture induced nitrous oxide and the economic growth using the EKC framework for India from 1970 to 2018. The hypothesis of agriculture being an important determining factor of environmental degradation in India is tested. The hypothesis was tested using the ARDL Bounds test (For long run coefficients) and Error Correction Model (for short run coefficients. The data was found suitable for further econometric analysis.

The results of the analysis have shown that there is a long run and short run relationship between agriculture induced nitrous oxide and agricultural economic growth. The inclusion of agricultural value added and the square term of it has allowed us to analysed the EKC hypothesis and the positive and negative signs of the agricultural value added has validated the Agriculture-induced EKC for India. The results of the Bounds test confirms a long run relationship between agriculture induced nitrous oxide and agriculture economic growth. Moreover, according to the results of short

run relationship estimation, the value of the Error correction term is 0.36, that allows us to infer that in India about 36 per cent of nitrous oxide emissions disequilibrium in the short run is rectified. However, agricultural land use does not have a significant impact on the agriculture induced nitrous oxide. Thus India has the scope to increase its area under agriculture usage.

Further studies should aim at testing the cubic form of the EKC framework and should investigate if the nitrous oxide emission is rising again after a dip or not. Moreover, different studies need to be conducted in Indian context on different kinds of GHG emission from the agriculture using wider ranged and updated datasets.

References

Akbostancý, Elif & Tunç, Gül & Türüt-Aþýk, Serap. (2017). Drivers of fuel based carbon dioxide emissions: The case of Turkey. *Renewable and Sustainable Energy Reviews*. 81. 10.1016/j.rser.2017.06.066.

Al -Mulali, U., Weng -Wai, C., Sheau -Ting, L., Mohammed, A.H. (2015). Investigating the environmental Kuznets curve (EKC) hypothesis by utilizing the ecological footprint as an indicator of environmental degradation. *Ecological Indicators* 48, 315-323.

Alege, Philip, Ogundipe & Adeyemi. (2013). Environmental quality and economic growth in Nigeria: A fractional cointegration analysis. *International Journal of Development and Sustainability.* 2. 2168-8662.

Amowine., Nelson, Ma., Zhiqiang, Li., Mingxing, Zhou., Zhixiang, Asunka., Benjamin, Amowine., James. (2019). Energy Efficiency Improvement Assessment in Africa: An Integrated Dynamic DEA Approach. *Energies.* 12. 3915. 10.3390/en12203915

Apergis, Nicholas. (2015). Environmental Kuznets curves: New evidence on both panel and country-level CO2 emissions. *Energy Economics.* 54. 10.1016/j.eneco.2015.12.007

Awaworyi ,Churchill., Sefa ., Inekwe., John, Ivanovski., Kris & Smyth., Russell. (2018). The environmental Kuznets curve in the OECD: 1870–2014. *Energy Economics*. 75. 389-399. 10.1016/j.eneco.2018.09.004

Bruyn, S. M. d. (1998). Economic growth and emissions: Reconsidering the empirical basis of environmental Kuznets curves. *Ecological economics: the transdisciplinary journal of the International Society for Ecological Economics, 25*(2).

Carillo, Felicetta & Maietta, Ornella. (2014). The relationship between economic growth and environmental quality: the contributions of economic structure and agricultural policies. *New Medit.* 13. 15-21.

Chandio, Abbas , Jiang,.et.al. (2019). Does Energy-Growth and Environment Quality Matter for Agriculture Sector in Pakistan or not? An Application of Cointegration Approach. *Energies.* 12. 10.3390/en12101879

Coderoni, S., Esposti, R. (2011). Long-Term Agricultural GHG Emissions and Economic Growth: The cointegration and Granger causality. *Renewable and Sustainable Energy Reviews* 16(5), 2947-2953.

Cole CV, Duxbury J, Freney J, Heinemeyer O, Minami K, Mosier A. et al. (1997). Global estimates of potential mitigation of greenhouse gas emissions by agriculture. *Nutr Cycl Agroecosyst49*(1-3): 221–228.

Cole MA, Rayner AJ, Bates JM. (1997). The environmental Kuznets curve: an empirical analysis. *Environ Dev Econ2*(4): 401 –416.

Grosso, del, S. J., & Parton, W. J. (2012). Climate change increases soil nitrous oxide emissions. *The New phytologist*, *196*(2), 327–328.

Zeng., S.X., Xu., X.D., Dong., Z.Y., Xu., W.Y. (2009). EKC analysis for studying economic growth and environmental quality: a case study in China. *Journal of Cleaner Production 17*(5), 541 -548.

Dickey., D.A, Fuller., W.A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *J. Am. Stat. Assoc.* 74:427–431.

Dinda., Soumyananda. (2004). Environmental Kuznets Curve Hypothesis: A Survey. *Ecological Economics*. 49. 431-455. 10.1016/j.ecolecon.2004.02.011

Dogan., E, Turkekul., B. (2016). CO2 emissions, real output, energy consumption, trade, urbanization, and financial development: testing the EKC hypothesis for the USA. *Environ Sci Pollut Res* 23(2):1203–1213.

Economic Survey. (2020). https://www.indiabudget.gov.in/economicsurvey/

EDGAR, (2009). *Emission Database for Global Atmospheric Research, release version* 4.2.Available at: http://edgar.jrc.ec.europa.eu (accessed 24.1.18).

Fakher, H., Abedi, Z. (2017). Relationship between Environmental Quality and Economic Growth in Developing Countries (based on Environmental Performance Index). *Environmental Energy and Economic Research*, *1*(3), 299-310. doi: 10.22097/eeer.2017.86464.1001

Gokmenoglu., K.K, Taspinar., N. (2018). Testing the agriculture-induced EKC hypothesis: the case of Pakistan. *Environ Sci Pollut Res* 25(23):1–13

Gokmenoglu, K. K & Taspinar, N. (2018). Testing the agriculture-induced EKC hypothesis: the case of Pakistan. *Environmental science and pollution research international*, *25*(23), 22829–22841. https://doi.org/10.1007/s11356-018-2330-6

Grossman., G.M, Krueger., A.B. (1991). Environmental impacts of a North American free trade agreement (No. w3914). *National Bureau of Economic Research, Cambridge*

Guangyue, Xu & Deyong, Song. (2013). An Empirical Study on the Environmental Kuznets Curve for China's Carbon Emissions: Based on Provincial Panel Data. *Chinese Journal of Population Resources and Environment.* 9. 66-76. 10.1080/10042857.2011.10685040.

Haider., Azad , Bashir., Arooj, & Husnain., Muhammad. (2020). Impact of agricultural land use and economic growth on nitrous oxide emissions: Evidence from developed and developing countries. *Science of The Total Environment*. 741. 140421. 10.1016/j.scitotenv.2020.140421.

Hao, Y., Wu, Y., Wang, L., & Huang, J. (2018). *Re-examine environmental Kuznets curve in China*:

Hassan, Syeda & Nosheen., Misbah. (2019). Estimating the Railways Kuznets Curve for high income nations—A GMM approach for three pollution indicators. *Energy Reports.* 5. 170-186. 10.1016/j.egyr.2019.01.001.

Havemann, T., 2014. Investing in Agriculture: Jumping Kuznets' Curve. *Clarmondial GmbH, Weinrebenstrasse* 20 8708 Mannedorf Switzerland

Havemann, Tanja & Muccione.,Veruska. (2011). *Mechanisms for agricultural climate change mitigation incentives for smallholders*. 6.

Henseler, Martin & Dechow, Rene. (2013). Simulation of regional nitrous oxide emissions from German agricultural mineral soils: A linkage between an agro-economic model and an empirical emission model. *Agricultural Systems*. 10.1016/j.agsy.2013.10.005.

IPCC. (2005). *Fifth Assesment Report*. https://www.ipcc.ch/assessment-report/ar5/

Kang, W., Pei, X., Yue, W., Bange, A., Heineman, W. R., & Papautsky, I. (2013). Lab-on-a-Chip Sensor with Evaporated Bismuth Film Electrode for Anodic Stripping Voltammetry of Zinc. *Electroanalysis*, *25*(12), 2586–2594. https://doi.org/10.1002/elan.201300349

Kucuk., Dogan, Nezahat. (2017). The impact of agriculture on CO2 emissions in China. *Panoeconomicus*. 66. 30-30. 10.2298/PAN160504030D.

Kuznets Curve (EKC) and an Empirical Investigation. *Polish Journal of Environmental Studies* 26(4)

Leitão, Nuno, Carlos. (2014). Economic Growth, Carbon Dioxide Emissions, Renewable Energy and Globalization. *International Journal of Energy Economics and Policy*. 4. 391-399.

Liu, X., Zhang, S., Bae, J. (2017), The impact of renewable energy and agriculture on carbon dioxide emissions : Investigating the environmental Kuznets curve in four selected ASEAN countries. *Journal of Cleaner Production*, 164, 1239-1247.

Mannina, G., Capodici, M., Cosenza, A., Di Trapani, D., van Loosdrecht, M.C.J.J.o.c.p. (2017). *Nitrous oxide emission in a University of Cape Town membrane bioreactor: the effect of carbon to nitrogen ratio*. 149, 180 -190

Mehmood., Usman & Tariq., Salman. (2020). Globalization and CO2 emissions nexus: Evidence from the EKC hypothesis in South Asian countries. *Environmental Science and Pollution Research.* 27. 10.1007/s11356-020-09774-1.

Moheeldeen, Atif. (2017). Climate Changes in Africa: Does Economic Growth Matter? A Semi-parametric Approach. *International Journal of Energy Economics and Policy*. 7. 1-8.

Najafi, Alamdarlo, Hamed. (2016). Water consumption, agriculture value added and carbon dioxide emission in Iran, environmental Kuznets curve hypothesis. *International Journal of Environmental Science and Technology.* 13. 10.1007/s13762-016-1005-4.

Nassani, A.A., Aldakhil, A.M., Abro, M.M.Q., Zaman, K. Environmental Kuznets curve among BRICS countries: Spot lightening finance, transport, energy and growth factors. *J. Clean. Prod.* 2017, 154, 474–487

Och, M., (2017). Empirical Investigation of the Environmental Kuznets Curve Hypothesis for Nitrous Oxide Emissions for Mongolia. *International Journal of Energy Economics and Policy* 7(1).

Odhiambo, Nicholas, (2009). Energy consumption and economic growth nexus in Tanzania: An ARDL bounds testing approach, *Energy Policy*, 37, issue 2, p. 617-622

Olale, E., Ochuodho, T.O., Lantz, V., El Armali, J. (2018). The environmental Kuznets curve model for greenhouse gas emissions in Canada. *Journal of Cleaner Production* 184, 859 -868.

Panayotou, T. (1993). Empirical Tests and Policy Analysis of Environmental Degradation at Different Stages of Economic Development. Working Paper, Technology and Employment Programme, *International Labor Office, Geneva*.

Pathak, Himanshu & Bhatia, Arti & Prasad, Shiv & Singh, Shalini & Kumar, Shukal & Jain, Manish & Kumar, Upendra. (2002). Emission of Nitrous Oxide from Rice-Wheat Systems of Indo-Gangetic Plains of India. *Environmental monitoring and assessment*. 77. 163-78. 10.1023/A:1015823919405.

Pesaran, M. H., & Shin, Y. (1995). *An autoregressive distributed lag modelling approach to cointegration analysis*.

Pesaran, m. H., Shin, Y., & Smith, R. J. (2001). Bounds Tesing Approcahes to the Analysis of Level Relationships. *Journal of Aapplied Econometrics*, 16, 289- 326.

Phillips, Peter, Perron & Pierre. (1986). *Testing for a Unit Root in Time Series Regression*. Cowles Foundation, Yale University, Cowles Foundation Discussion Papers. 75. 10.1093/biomet/75.2.335.

Prather, Michael & Holmes, Christopher & Hsu, Juno. (2012). Reactive greenhouse gas scenarios: Systematic exploration of uncertainties and the role of atmospheric chemistry. *Geophysical Research Letters*. 39. 9803-. 10.1029/2012GL051440.

Raggad, Bechir. (2018). Carbon dioxide emissions, economic growth, energy use, and urbanization in Saudi Arabia: evidence from the ARDL approach and impulse saturation break tests. *Environmental Science and Pollution Research*. 25. 10.1007/s11356-018-1698-7.

Ravishankara, A. R., Daniel, J. S., & Portmann, R. W. (2009). Nitrous oxide (N2O): the dominant ozone-depleting substance emitted in the 21st century. *Science (New York, N.Y.)*, *326*(5949), 123–125. https://doi.org/10.1126/science.1176985

Reay, Dave. et.al. (2012). Global agriculture and nitrous oxide emissions. *Nature Climate Change*. 2. 410-416. 10.1038/nclimate1458.

Saharawat,et.al. (2010). Evaluation of alternative tillage and crop establishment methods in a rice-wheat rotation in North Western IGP. *Field Crops Research*. 116. 260-267. 10.1016/j.fcr.2010.01.003.

Saleem, Nyla et.al. (2019). The Impact of Human Capital and Biocapacity on Environment, Environmental Quality Measure through Ecological

Footprint and Greenhouse Gases.*Journal of Pollution Effects & Control.* 7. 237. 10.35248/2375-4397.19.7.237.

Selden, T.M., Song, D. (1994). Environmental quality and development: is there a Kuznets curve for air pollution emissions? *Journal of Environmental Economics and Management* 27(2), 147 -162.

Shafik., N, Bandyopadhyay., S. (1992). Economic growth and environmental quality: Time-series and cross-country evidence, vol *904. World Bank Publications*

Shahbaz, M., Lean, H.H., Shabbir, M.S.(2012). Environmental Kuznets curve hypothesis in Pakistan:

Shahbaz, M., Mutascu, M., Azim, P. (2013) Environmental Kuznets curve in Romania and the role of energy consumption. *Renewable and Sustainable Energy Reviews* 18, 165 -173.

Sinha, A., & Sengupta, T. (2019). Impact of energy mix on nitrous oxide emissions: an environmental Kuznets curve approach for APEC countries. *Environmental Science and Pollution Research,26*(3), 2613-2622

Solomon, S. et.al. (2007) . Contribution of working group I to the *fourth assessment report* of the intergovernmental panel on climate change, 2007. Cambridge University Press, Cambridge.

Solomon, S. et al. (2007). Contribution of working group I to the *fourth assessment report* of the intergovernmental panel on climate change, 2007. Cambridge University Press, Cambridge.

Some, Shreya & Roy, Joyashree & Ghose, Arpita. (2019). Non-CO2 emission from cropland based agricultural activities in India: A decomposition analysis and policy link. *Journal of Cleaner Production*. 225. 10.1016/ j.jclepro.2019.04.017.

Spatial estimations using environmental quality index. *Sustainable Cities and Society,* 42, 498-511.

Tamang, P., (2013). Re-examining the Environmental Kuznets Curve: Evidence from Time Series. *Financial and Quantitative Analysis1* (2), 30-42.

U. C. Sharma. (2020). Methane and Nitrous Oxide Emissions from Livestock in India: Impact of Land Use Change. *Journal of Agriculture and Aquaculture*.

Ullah, A., Khan, D., Khan, I., & Zheng, S. (2018). Does agricultural ecosystem cause environmental pollution in Pakistan? Promise and menace. *Environmental Science and Pollution Research,25*(14), 13938-13955.

Valadez, Guillermo & Hu, Jiaqi. (2016). Relationship between the Environment and Economic Growth in China via Exports: A Perspective of Ecological Impact (2000-2014). *Journal of Environmental Protection*. 07. 1670-1692. 10.4236/jep.2016.711136

Wang, Q., Jiang, R., & Zhan, L., (2019 b) . Is decoupling economic growth from fuel consumption possible in developing countries? –A comparison of China and India. *Journal of Cleaner Production,* 229, 806 -817

Wang, S., Yang, F., Wang, X.E., Song, J. (2017). A Microeconomics Explanation of the Environmental Kuznets Curve (EKC) and an Empirical Investigation. *Polish Journal of Environmental Studies* 26(4)

WorldBank.(2008).*AgricultureOverview*.https://www.worldbank.org/en/topic/agriculture/overview

Zafeiriou, Eleni & Azam Khan, Muhammad. (2017). CO2 emissions and economic performance in EU agriculture: Some evidence from Mediterranean countries.. *Ecological Indicators*. 81. 104-114.

Zambrano, Monserrate, M.A., Fernandez, M.A. (2017). An Environmental Kuznets Curve for N2O emissions in Germany: an ARDL approach, *Natural Resources Forum*. Wiley Online Library.

Zhang., T., Wooster, M.,J., Green, D.,C., Main B. (2015). New field-based agricultural biomass burning trace gas, PM2.5, and black carbon emission ratios and factors measured in situ at crop residue fires in Eastern China. *Atmos Environ* 121:22–34.

Article

An Empirical Analysis on Economic Development and Deterioration of Freshwater in India by using Environmental Kuznets Curve

Odisha Economic Journal
Volume 53 • Issue 2 • 2021
pp. 58-75
Journal of the
Orissa Economics Association
OEA

R. Manikandan
S. Bhuvanesvari
M. Sangeetha

Abstract

India is the second-most populous country in the world and it has largest blue water footprint within its territory and also receives an average of 4,000 billion cubic meters of rainfall per annum. So, India had naturally replenished its water resource country but last few decades per capita availability of water has continuously declined due to the over-extraction of freshwater for agriculture and industrial activities. Although these sectors are contributed around 47 percent of GDP and the increasing growth of population substantially increases the domestic water consumption and domestic untreated wastewater polluted the available freshwater bodies consequently, it becomes a finite source. The main focus of the study is to know the relationship between Environmental degradation (freshwater depletion) and GDP per capita at National level by using the Environmental Kuznets Curve. Chiefly correlation and regression was used for data analysis. The correlation test shows that there is a negative correlation between two variables and linear regression estimates revealed that R2 is 80 and negative relationship between GDP per capita and per capita water availability in India. It was confirmed that India is in initial stage of economic development therefore, India's Environmental Kuznets curve is upward not inverted U Shape.

R. Manikandan, Assistant Professor, Department of Economics, Bharathiar University, Coimbatore, Tamil Nadu. Email: manikandan@buc.edu.in

S. Bhuvanesvari, Ph.D. Scholar, Department of Economics, Bharathiar University, Coimbatore, Tamil Nadu. Email: sbhuvanesvari2906@gmail.com

M. Sangeetha, Ph. D. Research scholar, CSRD/SSS, Jawaharlal Nehru University, New Delhi. Email: saneco2005@gmail.com

Keywords: Fresh water, GDP per capita, Wastewater, Environmental Kuznets curve.

Acknowledgement : S. Bhuvanesvari expresses her genuine thanks to Dr. Ambedkar International Centre for being granted Dr. Ambedkar Doctoral fellowship for her research work.

1. Introduction

The Environmental Kuznets Curve (EKC) explains the relationship between Economic development and Environmental quality as an inverted U shape curve *(World Development Report 1992, Grossman and Krueger 1995; Saboori et al. 2012; Liu et al. 2007; Shahpouri et al. 2016).* India is a developing nation and the largest freshwater consumer in the world (*Hoekstra and Chapagain 2007*). The developing countries are in the initial stage of economic development, therefore with an only concentration on economic growth, it increases the environmental degradation, in this stage Environmental Kuznets Curve will be upward and after the economic growth of the country will be continuing and reach the maximum level and environmental degradation also reach to the maximum level. The maximum level means the threat worsens to environmental quality it is referred to as a turning point mentioned in EKC after that country gains adequate resources to protect the environment. Article 51(A) of Constitution of India, the Duty of every citizen is "to protect and improve the natural environment including forest, lakes, rivers, and wildlife and to have compassion for living creatures". However, the deterioration of freshwater resources is mainly due to high population growth and their activities, contamination of water bodies, high dependency on groundwater, and urbanization. The consumptive uses of water for agriculture, industries, and domestic sectors create more pressure on freshwater resources (*WWAP report 2006, 2009*).

Agriculture and industrial sectoral development contribute to GDP growth of the country as while in India 90 percent of fresh water is used for agricultural activities alone (*Dhawan, GFFA, 2017*). Every year India withdrawal a large amount of freshwater from ground and surface water sources, to fulfill the water demand for human consumption like drinking, cooking, and other domestic purposes and various sectoral activities. According to *Census 2011 and the Ministry of Urban Development report*, 80 percent of surface water is polluted in India due to domestic sewerage. In recent decades, freshwater availability in India was rapidly declining. This

indicates that India should concentrate on conserving freshwater resources and increasing the availability of freshwater for future generations.

1.1 Empirical relationship between the GDP per capita and Freshwater degradation in India

India is a developing nation. So, the country requires more resources for their economic development, especially water required for Agriculture, Industrial activities, and domestic purpose but the excessive extraction of freshwater leads to a decline and shortage of freshwater, worsening the environment quality. In the initial stage of economic development, the Environmental Kuznets curve is upwards in future, the country will achieve high economic growth but environmental resources will very poor. It was a turning point cited in the Environmental Kuznets curve but before the turning point country should make efforts to protect the freshwater resources (environmental quality) otherwise the country reach zero or poor environmental resources and faces more environmental cost. It directly hit the GDP of India. According to *World Bank report*, water scarcity and exacerbated climate change could cost 6 percent of GDP for some regions. The *NITI Aayog Report* on *Water Management Index* reveals that India will lose 6 per cent of GDP by 2030 due to an extreme water crisis. Therefore this paper mainly focuses on analyse the empirical relationship between Economic development as GDP per capita and Environmental degradation as per capita water availability; per capita renewable freshwater resources and population growth effect on water availability; requirement of freshwater in India.

2. Review of Literature

Indian regions are faces serious environmental degradation owing to high population growth and continuous economic development. In India, the main problem in the Central and East regions was high population growth but in the west and south region economic development was the main reason for environmental damage and the northern regions have various causes of natural resources degradation such as population, economic development, urbanization effect and pollution (Lakshmana 2013). High-income people are less affected by the increase in water prices than low-income people and point out that more water is consumed by low-income people for domestic purposes. Highlighted the different class lifestyles that

influence water bills and domestic water consumption (Justes *et al.* 2014). The water crisis in India is due to the disputation between demand and supply of water. Water requirement has multiple owing to agricultural activities, industrialization, urbanization, and rapid population growth. So, water plays a major role in socio and economic development. While mismanagement of water resources, over pumping and depletion of groundwater, and pollution affected water supply. More water demand coupled with economic development is critical for available freshwater (Ahmad 2014). Analyzed the relationship between GDP per capita and water pollution in developed and developing countries, the result proved that inverted U shape EKC. In developed countries, the EKC reached the turning point after that downward curve shape and developing countries faced an upwards slope (Shahpouri *et al.* 2016). Water was once considered to be a renewable resource but gradually became a non-renewable resource, water pollution control measures high abatement cost creates a trade-off between water conservation and economic development (Balooni and Venkatachalam 2016). The study found out the relationship between the per capita industrial water consumption and the economic growth of China has inverted U shape EKC (Zhang Yue et al. 2017). The study analysed the relationship between the decoupling of water consumption and economic growth in Jiangxi province China. The results reveal that the effect of water consumption on economic development was positive and technology was negative drivers of water consumption changes(Mianhao Hu et al.2018). The water consumption was positively associated with metropolitan economic performance of Guangzhou, China (He and Gao, 2021). These literatures are supporting evidence for while Nation's GDP per capita increased with a gradual decline in environmental resources.

3. Objectives

To examine the relationship between GDP per capita and per capita water availability in India,and per capita renewable freshwater resourcesby using EKC.

4. Methodology

For this research paper, Secondary data has been collected from World Bank, Central water commission, Ministry of Jal Shakti reports, Central

pollution control board CPCB, Ministry of Environment & Forests, CSE Report, AQUASTAT (Food and Agriculture Organization), Census reports. The research paper is based on analytical and comparative methodology. By using Environmental Kuznets curve hypothesis to understand link between India's GDP per capita and per capita water availability. Statistical tools such as Correlation,Regression,Compound Growth rate (CGR) and percentage change over the previous year wereused for data analysis.

5. Results and Discussion

Table 1. Freshwater Withdrawals for Agriculture, Industrial Activities and Domestic Sector in India (in billion m^3/year)

Year	Agriculture	% change over previous year	Industrial	% change over previous year	Municipal and Domestic purpose	% change over previous year
1980	411.7	-	12.6	-	14.05	-
1990	460	11.73	15	19.05	25	77.94
2000	558.4	21.39	10	-33.33	42	68.00
2010	688	23.21	17	70	56	33.33
2010% of total freshwater withdrawals	90.41%		2.23%		7.36%	

Source: AQUASTAT (FAO), World Bank, 2015.

In India, the demand for freshwater is very high and people are facing water scarcity, due to the extraction of more fresh water for agricultural, and industrial activities. Economic development mainly depends on the agriculture, industrial sector, and service sector of the country. Table 1 clearly shows that every decade fresh water requires for agriculture activities tremendously increases and over the 3 decades agriculture alone extracted more freshwater proved in percentage change over the previous year 11.73 per cent in 1990, freshwater extraction vastly increase over the previous year it was 21.39 per cent in 2000, central water commission stated 85.3 per cent of water consumed for agriculture in 2000 and 23.21 per cent in 2010. In India, agricultural activities alone required 90 per cent of freshwater for irrigation purposes (FAO 2017) due to water-intensive irrigation and crop pattern. Industrial sector water withdrawal increased to 19.05 per cent change over the previous year in 1990 and -33.33 per cent in 2000 because world bank data mention only 10 billion cubic meters of process

water as consumptive uses of water (CPCB 2000) an additional reason is the share of industrial contribution in GDP was 24 per cent in 1990 after 10 years only 1 per cent increased with gradual economic output contributed 25 per cent in 2000 (World Development Indicators 2002). After 10 years water demand for the industrial sector was increase 70 percent over the previous year. The freshwater resource depletion highly affected agriculture activities, indirectly effect on GDP contribution. An increase in population with changes in the water consumption pattern of the people leads to water required for the domestic sector also increasing. It represents that freshwater consumption of the domestic sector increasing every year and compare to the previous year demand for domestic water consumption was 77.94 per cent, in 1990; compare with 1990, 68 per cent in 2000, and 33.33 per cent in 2010. It indicates the public and Government should concentrate to increase the storage of water resources. In 2010 data indicates that 90.41 per cent of water was withdrawn for agriculture, 2.23 per cent for the industrial sector, and 7.36 per cent of freshwater for domestic consumption. Hence, the table concluded that Indian Agriculture activities require more fresh water which was confirmed by the commission on sustainable development report, agriculture alone withdraws 70 per cent of freshwater from lakes, rivers, and underground sources, and also increasing population growth will sustainably increase the water demand for domestic purposes.

Table 2. Population Growth, GDP and Freshwater Withdrawals in India

Year	Total Population (in Crores)	% change over previous year	GDP (in dollar)	% change over previous year	Fresh Water Withdrawals (in billion cubic meters BCM)	% change over previous year
1980	69.9	-	186.33	-	438.3	-
1990	87.33	24.94	320.98	72.26	500	14.08
2000	105.66	20.99	468.40	45.93	610.4	22.08
2010	123.43	16.82	1,675.62	257.73	761	24.67
CGR	**20.88**		**100.72**		**20.38**	

Source: AQUASTAT (FAO), World Bank, 2014.

The Table 2 analyse the population growth, GDP, and freshwater withdrawal for the last 4 decade. The gross domestic product registered the highest compound growth rate of 100.72 per cent and also identified a positive growth rate through percentage change over the previous year in 1990 GDP was 72.26 per cent and it increased to 257.73 per cent in 2010 simultaneously population growth supported to GDP growth in India. Over 4 decades, India's population growth was increasing confirmed by the

percentage change over the previous year and 20.88 per cent was compound growth rate (CGR) of the total population. In 1990 India's total population growth was 24.94 per cent compared with the previous year and after a decade increased to 20.99 per cent then in 2010 population was 16.82 per cent increase over the previous year. It's evident that, India faces an alarming population growth rate and also it helps to improve the economic development of the country. At the same time increase the freshwater withdrawals from surface water sources like lakes & rivers for Agriculture, Industrial activities, and also for domestic purposes. The population growth was a negative impact on freshwater withdrawals in India. The compound growth rate of freshwater withdrawals was 20.38 per cent and freshwater requirements are increases recognized by percentage change over the previous year. Compare with previous year withdrawal of freshwater rise to 14.08 percent in 1990, 22.08 per cent in 2000, and 24.67 per cent of freshwater extraction increased in 2010. The table ascertained that the Indian economy is in the development process with a high population growth rate and more freshwater withdrawals for the domestic sector, agriculture, and industrial activities. These activities are supported to the GDP growth rate and positive growth in economic development but annihilate the environment. The over-extraction, over usage of freshwater, leads to water scarcity, and waste from sectoral activities polluted the available fresh water. (Theodore Panayotou 1993) pointed out the low levels of economic development give low environmental impacts but intensified agriculture and industrialization accelerated the economic development with over-extraction of resources and the rate of resource depletion exceeds the rate of resource regeneration. The same condition is replicable in India, freshwater is extremely depleted it was an intimation to the restoration of freshwater sources.

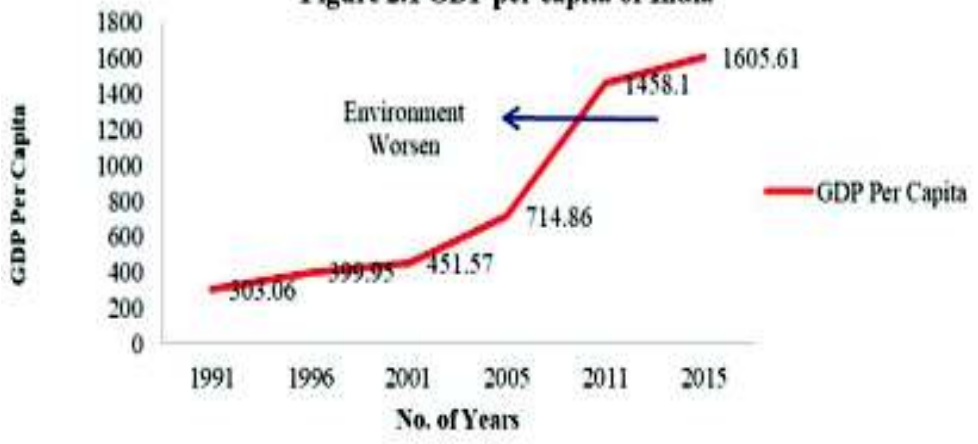
Table 3. GDP Per Capita and per capita Water Availability in India

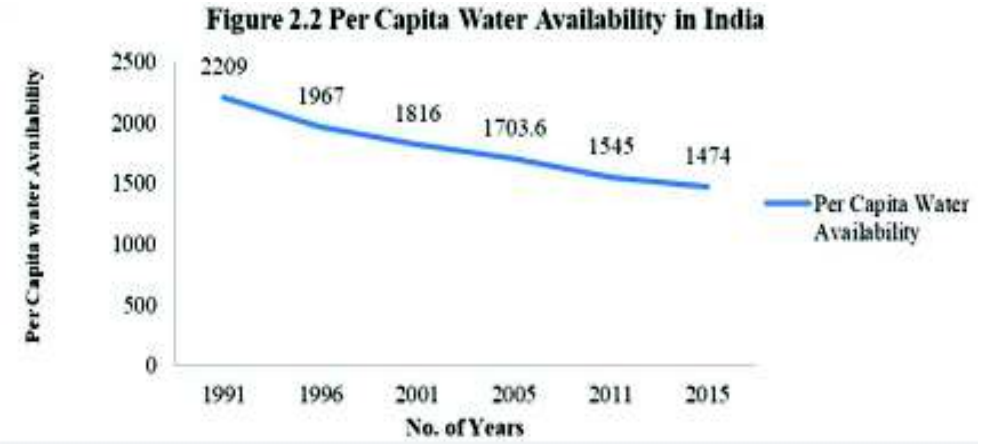
Year	GDP Per Capita (in dollar)	**% change over previous year**	Per Capita Water Availability (Cubic meters)	**% change over previous year**
1991	303.06	-	2209	-
1996	399.95	31.97	1967	-10.96
2001	451.57	12.91	1816	-7.68
2005	714.86	58.31	1703.6	-6.19
2011	1458.1	103.97	1545	-9.31
2015	1605.61	10.12	1474	-4.60

Sources: World Bank 2015, Central Water Commission, Ministry of Jal Shakti reports

The data presented in Table 3 was divided into 5 years of GDP per capita and per capita water availability in India from 1991 to 2015 and its percentage change over the previous year. India's GDP per capita unceasingly increases, with positive growth in percentage change over the previous year but per capita, water availability substantially decreases, and percentage change over the previous year decline negatively. The per capita GDP was 31.97 per cent, and per capita availability of water fell to -10.96 per cent in 1996; compare with the previous year 12.91 per cent of the growth in GDP per capita but water availability per capita was -7.68 per cent in 2001; 58.31 per cent of GDP per capita was increased, -6.19 per cent of per capita water availability reduced in 2005; GDP per capita was raised double, compared to previous year 103.97 percent, but per capita, water availability decreased to -9.31 per cent in 2011; GDP per capita growth 10.12 per cent and per capita water availability declined to -4.60 per cent in 2015. The table results confirm that developing country concentrate on improving their economic development so, the GDP per capita of India unceasingly increase due to the contribution of the agricultural and industrial sector. These sectors are required more freshwater for the production process and expansion of population growth with raise in domestic water consumption cited in table 1 by this reason per capita water availability gradually declines. This is more relevant to the Ministry of Jal Shakti report 2020, India's per capita availability of water is reduced by an increase in population**.** It expresses that at present water availability is also exhaustible sooner before that make an appropriate step for water management and restoration of water bodies.

Figure 2.1 GDP per capita of India





The figures represent that as India is a developing country the curve expresses an inverse relation between GDP per capita and per capita water availability, India's GDP per capita was an upward curve and per capita water availability downwards curve because of economic activity and population growth. The result finally supports the EKC.

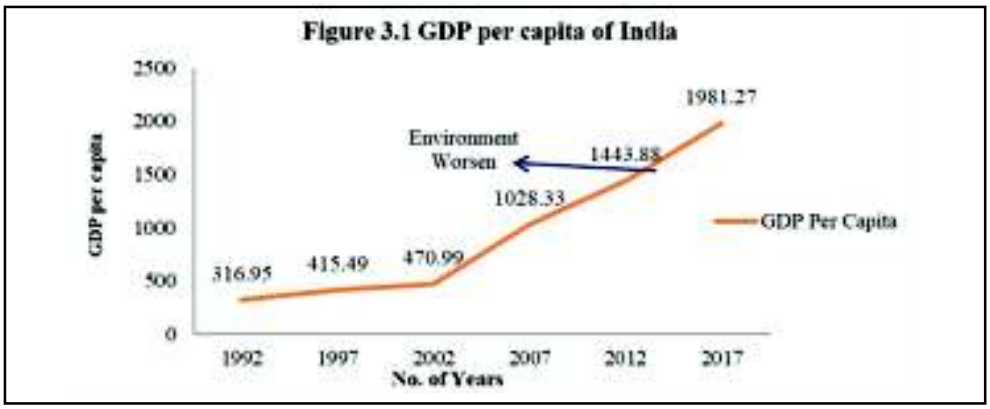
Table 4. GDP Per Capita and Per Capita Renewable Internal Freshwater Resources in India

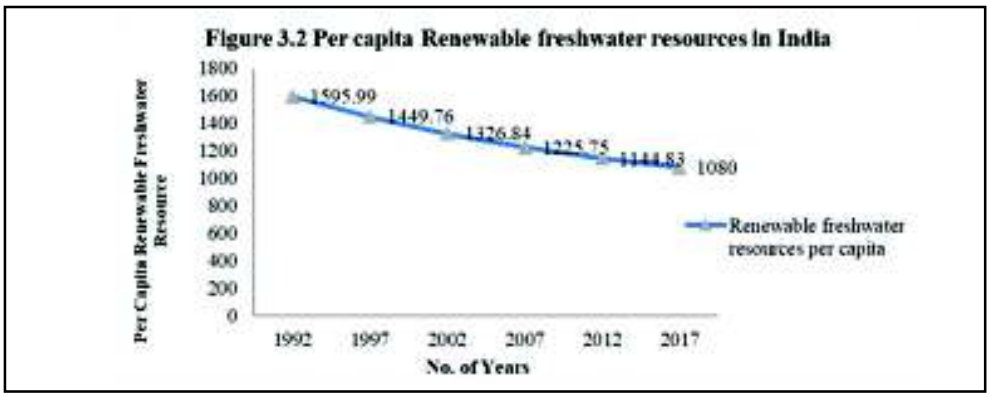
Year	GDP Per Capita (in dollar)	% change over previous year	Per capita renewable freshwater resources (in cubic meters)	% change over previous year
1992	316.95	-	1595.99	-
1997	415.49	31.09	1449.76	-9.16
2002	470.99	13.36	1326.84	-8.48
2007	1028.33	118.33	1225.75	-7.62
2012	1443.88	40.41	1144.83	-6.60
2017	1981.27	37.22	1080.00	-5.66

Source: AQUASTAT (FAO) 2017, World Bank 2017.

Table 4 reveals that data was divided into 6 years due to data availability. GDP per capita and per capita renewable freshwater resources in India and its percentage change over the previous year. It represents that GDP per capita continuously increase and had positive growth compared to the

previous year, renewable freshwater resources available per person significantly reduce and its percentage change over the previous year was negative. The per capita GDP was 31.09 per cent, per capita renewable freshwater resources decrease to -9.16 per cent in 1997; 13.36 percent of the growth in GDP per capita, but renewable freshwater resources availability of each person was -8.48 per cent in 2002; compare with the previous year's registered highest growth of GDP per capita was 118.33 percent and, -7.62 per cent of per capita renewable water resource decline in 2007; GDP per capita was raised compared to previous year 40.41 percent, but per capita renewable freshwater resources was -6.60 percent in 2012; GDP per capita growth was 37.22 per cent and per capita renewable freshwater resources decrease to -5.66 per cent in 2017. The table determined that renewable freshwater resources are gradually reduced due to economic development. It indicates that at present as well as in future, India will going to face a high level of water scarcity problem. Currently, India is in 13th position as the world's most water-stressed country and 54 per cent of the country face extremely high - water stress (World Resources Institute 2014, 2019).





The figures indicate that India concentrates on over-exploitation of environmental resources for economic activities. The curve expresses an inverse relationship between GDP per capita and per capita renewable freshwater resources, India's GDP per capita has an upward curve and per capita renewable freshwater resources has a downward curve.

5 (a) Correlations result : GDP Per Capita and Per Capita Water Availability in India

		GDP per capita	Per capita water availability
GDP per capita	Pearson Correlation	1	- .895*
	Sig. (2-tailed)		.016
Per capita water	Pearson Correlation	-.895*	1
availability	Sig. (2-tailed)	.016	
*. Correlation is significant at the 0.05 level (2-tailed).			

Table 5 (a) displays a negative correlation or inverse relationship between GDP per capita and per capita freshwater availability in India, when increasing the GDP per capita of India at the same time the per capita availability of water in India decreases. Both variables are significant at the 5 per cent level. The reason behind this GDP per capita of the country arose mainly due to agricultural and industrial activities and their contribution but these activities required more freshwater which is already discussed in tables 1 & 3 together reinforcing to correlation relationship. It implicates the 'trade-off situation' between economic growth and water sustainability.

5 (b) Correlations result : GDP Per Capita and Per capita Renewable Freshwater Resources in India

		GDP Per capita	Per capita renewable Freshwater resources
GDP Per capita	Pearson Correlation Sig. (2-tailed)	1	-.909* .012
Per capita renewable Freshwater resources	Pearson Correlation Sig. (2-tailed)	-.909* .012	1
*. Correlation is significant at the 0.05 level (2-tailed).			

Table 5 (b) shows the negative correlation between GDP per capita andper capita renewable freshwater resources in India. According to the world bank, a renewable freshwater resource refers to internal river flows and groundwater from rainfall in the country. when GDP per capita of India was upsurge but the per capita renewable freshwater resources in India consecutively decreases verified through correlation both the variables are significant at 5 per cent level. It will impact the degradation of groundwater and surface water in India. It specifies the future generation of India will face water insecurity because India is the largest freshwater consumer, population density, urbanization create more pressure on freshwater resources, and untreated wastewater is mixed into freshwater resources. Tables 5 (a) and (b) strongly support the EKC as the variables show a negative correlation. When India's GDP increased, per capita water availability and per capita renewable freshwater resources declined.

Linear Regression Analysis

The linear regression was used to test the EKC hypothesis, to know the relationship between GDP per capita and per capita water availability in India, and per capita renewable freshwater resources. The dependent variable is per capita water availability in India and the independent variable is GDP per capita of India.

Hypothesis 1:

- GDP per capita is the key determinant of per capita of water availability in India.

Table 6: Linear Regression of GDP Per Capita and Per Capita Water Availability in India.

Per capita water availability as the dependent variable				
	Estimate	**Std error**	**t- value**	**Significance**
(Intercept)	2140.131	104.647	20.451	0.000**
GDP per capita	-0.431	0.108	-4.004	0.016**
R squared	0.800			
Adjusted R Square	0.750			

Note: ** 1% level of Significance

Quadratic Function: $Y= a \pm b_x$

$$Y= 2140.131 - 0.431_{(GDP\ per\ capita)} + \mu$$

Where Y= per capita water availability; a = Constant, x = GDP per capita μ = Error term.

The table 6 represents the linear regression of GDP per capita and per capita water availability in India. The R2 value is 0.80. This shows that 80 percent of the variation in per capita water availability in India was explained by GDP per capita and it is statistically significant at 1 % level. There is a negative relationship between the variables. Therefore, India should take preventive measures to avoid water scarcity.

Hypothesis 2:

- GDP per capita is the key determinant of per capita renewable freshwater resources in India.

Table 7: Linear Regression of GDP Per Capita and Per Capita Renewable Freshwater Resources in India.

Per capita renewable freshwater resourcesas the dependent variable				
	Estimate	**Std error**	**t- value**	**Significance**
(Intercept)	1553.166	68.088	22.811	0.000**
GDP per capita	-0.264	0.061	-4.360	0.012**
R squared	0.826			
Adjusted R Square	0.783			
Note: ** 1% level of Significance				

Quadratic Function: $Y= a \pm b_x$

$$Y= 1553.166 - 0.264_{(GDP\ per\ capita)} + \mu$$

Where Y= Per capita renewable freshwater resources; a = Constant, x = GDP per capita = Error term

Table 7 shows the linear regression of GDP per capita and per capita renewable freshwater resources in India. The results confirmed that 82 percent of the variation in the dependent variable is explained by the independent variable (GDP per capita) and it is statistically significant at 1 % level. There is a negative relationship between the GDP per capita and per capita renewable freshwater resources in India, affirming an upward EKC.

6. Conclusion

The result of the study confirms that with an upward EKC India is in the take-off stage or initial stage of economic development. India's GDP per capita increased as freshwater availability gradually declined. The rapid population growth, water-intensive lifestyle, and economic activities are the rootcauses for declining per capita water availability and freshwater resources in India. The study stresses restoration of water bodies.

References

Ahmad T.B., (2014). An Analysis of Demand and Supply of Water in India.*Journal of Environment and Earth Science* 4 (11), 67-72. https://www.researchgate.net/publication334807513_An_Analysis_of_Demand_and_upply_of_Water_in_India

Balooni. K, Venkatachalam. L. (2016). Managing water for Sustainable development: An Indian prespective. *IIM Kozhikode Society & Management Review, sage publication* 5 (1), vii -xii.https://doi.org/10.1177%2F227797 5215 625500

Central pollution control Board Annual reports. Ministry of Environment, Forest and climate change, Govt of India. www.cpcb.nic.in.

Central pollution control Board CPCB Bulletin. (2016). https://cpcb.nic.in / / openpdffile.php?id=TGF0ZXN0RmlsZS9M YXRlc 3RfMTIzX1 NVTU1BUllfQk9PS19GUy5wZGY=

Centre for Science and Environment and DTE staff. (2016). 78% of sewage generated in India remains untreated. *Down to Earth,* April 06, 2016.https://www.downtoearth.org.in/news/waste/-78-of-sewage-generated-in-india-remains-untreated—53444.

Centre for Science and Environment CSE. (2004). 'It isn't agriculture, *Down to Earth*, 12(19), February15, 2004. CSE: Down to Earth Supplement on water use in industry (rainwaterharvesting.org)

Dhawan, V. (2017). Water and Agriculture in India. Background paper for the South Asia expert panel during the Global Forum for Food and Agriculture (GFFA). *OAV – German Asia-Pacific Business Association*. Asia.

Down to Earth. (2016). Water scarcity may cause upto 6% loss in GDP: World Bank. *Down to Earth,* May 3, 2018. https://www.downtoearth.org.in /news/water/water-scarcity-may-cause-upto-6-loss-in-gdp-world-bank-53816

FAO, (2017). *The future of food and agriculture – Trends and challenges*. Rome http://www.fao.org/3/i6583e/i6583e.pdf

Grossman G. and Krueger A. E. (1995). Economic growth and the environment. *Quarterly Journal of Economics* 110 (2), 353-377. https://doi.org/10.2307/2118443

He, Y., Gao, S. (2021). Electricity Water Consumption and Metropolitan Economic Growth: An Empirical Dual Sectors Dynamic Equilibrium Model. Front. Energy Res. 9:795413. Doi: 10.3389/fenrg.2021.795413

Hoekstra, A.Y., Chapagain, A.K. (2007). Water footprints of nations: water use by people as a function of their consumption pattern. *Water resources management Springer* 21, 35-48. http://dx.doi.org/10.1007/978-1-4020-5591-1_3

India.com (2018). NITI Aayog's Water Management report Warms of 'Extreme water crisis', 6 per cent loss in country's GDP. *India.com*, June 21, 2018. https://www.india.com/news/india/niti-aayogs-water-management-report-warns-of-extreme-water-crisis-6-per-cent-loss-in-countrys-gdp-3122657/

Justes, A., Barberan, R., & Farizo, B. A. (2014). Economic valuation of domestic water uses. *Science of the Total Environment* 472, 712–718. http://dx.doi.org/10.1016/j.scitotenv.2013.11.113.

Lakshmana, C.M. (2013). Population, development, and environment in India.*Chinese Journal of Population Resources and Environment* 11 (4), 367-374. http://dx.doi.org/10.1080/10042857.2013.874517

Liu, X., Heilig, G.K., Chen, J.M., Heino, M. (2007). Interactions between economic growth and environmental quality in Shenzhen, China's first special economic zone. *Ecological Economics* 62, 559-570. https://doi.org/10.1016/j.ecolecon.2006.07.020

Matto, M. (2019). India's water crisis: The clock is ticking. *Down to Earth,* June 21, 2019. https://www.downtoearth.org.in/blog/water/india-s-water-crisis-the-clock-is-ticking-65217

Mianhao, Hu., Yunlin, Hu., Juhong, Yuan., Fucai, Lu. (2018). Decomposing the decoupling of water consumption and economic growth in Jiangxi, China. *Journal of Water Reuse and Desalination* 1, 94-104.

Ministry of Jal Shakthi. (2020). Per Capita Availability of Water.https://pib.gov.in/PressReleasePage.aspx?PRID=1604871

Panayotou, T. (1993). Empirical Tests and Policy Analysis of Environmental Degradation at Different Stages of Economic Development. Technology and Employment Programme, Working Paper 238, Geneva: International Labour Office.

Ritchie, H., Roser, Max. (2017).Water Use and Stress. *Published online at OurWorldInData.org*.https://ourworldindata.org/water-use-stress (Online Resource)

Saboori, B., Sulaiman, J., Mohd, S. (2012). Economic growth and CO2 emissions in Malaysia: A cointegration analysis of the environmental Kuznets curve.*Energy Policy* 51, 184-191. https://doi.org/10.1016/j.enpol.2012.08.065

Sengupta, S. (2018). Polluted surface and groundwater could cause a Cape Town-like situation. *Down to Earth*, December 3, 2018. https://www.downtoearth.org.in/news/water/polluted-surface-and-groundwater-could-cause-a-cape-town-like-situation-62365

Shahpouri. A., Biabi.H., Abolhassani.L. (2016). Economic development and Environmental quality: The environmental Kuznets curve for water pollution. *J. Appl. Sci. Environ. Manage* 20 (1), 161-169. http://dx.doi.org/10.4314/jasem.v20i1.19.

Shiao, T., Maddocks, A., Carson, C., Loizeaux, E. (2015). 3 Maps Explain India's Growing Water Risks. *World Resources Institute*.https://www.wri.org/insights/3-maps-explain-indias-growing-water-risks

Tripathi, B., (2019). Despite plentiful rains and rivers, why does India rank among world's most water-stressed nations? *India spend.com*, August 08, 2019.

UNDESA and UN Water. International Decade for Action Water for life 2005–2015. https://www.un.org/waterforlifedecade/water_and_sustainable_development.shtml

World Development Report. (1992). Development and the Environment. New York: *Oxford University Press*. World Bank.

World Resources Institute. (2019). Adequate Water Risk Atlas. https://www.wri.org/news/release-updated-global-water-risk-atlas-reveals-top-water-stressed-countries-and-states

World Water Assessment Programme WWAP. (2006). The United Nations World Water Development Report 2: Water a shared responsibility. New York: *UNESCO Publishing, Paris andBerghahn Books*.

World Water Assessment Programme WWAP. (2009). The United Nations World Water Development Report 3: Water in a changing world. *UNESCO Publishing*, Paris and *Earthscan,* London.

Zhang Yue., Alun, G., Bolin, P. (2017). Relationship between Industrial Water Consumption and Economic Growth in China Based on Environmental Kuznets Curve. *Energy Procedia* 105, 3557 – 3564. https://doi.org/10.1016/j.egypro.2017.03.818

Article

Impact of Family Wealth on Female Labour Force Participation in Odisha

Odisha Economic Journal
Volume 53 • Issue 2 • 2021
pp. 76-99
Journal of the
Orissa Economics Association
OEA

Rajat Singh Yadav
Bharti Kumari

Abstract

Using the National Family Health Survey (2015-16), this paper explores female labor force par-ticipation mediated by household wealth in their cluster space, household deprivation with basic entitlements, respondent education, caste, region-specific dummies and along with some controls like language, poor health, and age. We saw that the behavior of female labor supply decision varies according to the regions, with the proportion of deprived or richest households in a cluster changes. With increase in the proportion of deprived households in a cluster, the Female Labor Force Participation Rate (FLFPR) is also increasing in Kalahandi-Balangir-Koraput (KBK) and Inland Central/Northern regions whereas, with increase in the proportion of prosperous households in a cluster, the FLFPR is decreasing in Inland Central/Northern and Eastern/Coastal regions. We find that the female labour force participation rate by educa-tion follows a U-shape in both urban and rural area of Odisha s,tate but it does not hold across castes. Regression results show that female autonomy through decision making power, control over assets, and freedom of movement has significant positive impact on the decision of female labor supply outcome at the individual level as well as the district level. House-hold deprivation with basic entitlements emerge as important variables that explain decreasing women's workforce participation, and the interaction effect of poor space

Rajat Singh Yadav, PhD/JRF Scholar, Gokhale Institute of Politics and Economics, Pune.
Email: rajatsingh.yadav@gipe.ac.in

Bharti Kumari, PhD/JRF Scholar, Indian Institute of Technology, Delhi.
Email: bhartigupta1602@gmail.com

and non-deprived household is critical in understanding women's work participation. We find that there is a non-linear impact of education, age and family wealth on female LFPR in the state of Odisha.

Keywords: district, female labor force participation, female autonomy, income effect, substi-tution effect, wealth effect.

1. Introduction

The world has witnessed significant positive breakthroughs in various facets of socio-economic lives of people over the last few decades. Tremendous strides in R&D, engineering, software, medicine, and many other scientific and technological spheres along with developments in social sciences have led to expansion of numerous opportunities for females to join the labor force. However, an increase in the number of opportunities has not overruled some of the important factors that are considered in the decision-making process of a female labor supply. In the case of India, there are several multi-faceted factors which affect decisions taken by females in the context of working or not. Furthermore, the impact of these socio-economic factors various across regions in India. Under this backdrop, in this paper, we look at the impact of the household wealth in a deprived or prosper space on the FLFPR in Odisha. As per the Census of India 2011, the Odisha population is nearly 4.2 crore (please follow Indian numerical system throughout the text) with a heterogeneous geographic distribution. Out of 30 districts, six districts have a population of over 20,00,000 and 14 districts have a population of 10,00,000 and above. Therefore, nearly 84 percent of the total Odisha population are living in 20 districts of the state.

Since Odisha is geographically small region and 83 percent population is rural population (Census of India, 2011), so the districts are not divided traditionally into East, West, North and South regions. However, for our study we have considered three regions, namely the Koraput-Bolangir-Kalahandi (KBK) region, Eastern/Coastal region and Inland/Northern region which have been detailed below. The KBK region consists of eight districts namely, undivided Koraput (Koraput, Nabarangpur, Rayagada and Malkangiri), undivided Bolangir (Subarnapur and Bolangir) and undivided Kalahandi (Kalahandi and Nuapada). The mapping of the three regions is provided in Figure 1. The KBK region with high concentration of

Scheduled Castes and Scheduled Tribes (SC/ST) population was considered,by the Planning Commission of India as far back as 2003, as an extremely backward region with high degree of morbidity, low level of literacy, and acute poverty (Agarwal, et al., 2003). Recent studies also highlight KBK region to be suffering from acute socio-economic disparities and remains one of the most backward regions in the country (Priyambada, 2012). In KBK region, with increase in female educational attainment there is a decreasing slope for FLFPR and only 10.74 per cent females have attained high education whereas, Eastern/Coastal region and Inland/Northern region both has an increasing participation rate after passing the threshold in education years (Figure 2). Thus, the KBK region has been considered separately for our study along with other two above mentioned regions of Odisha. According to the NSSO 64th round, migration of households was largely confined within the state: 10.4 million people moved within Odisha out of 11.4 million had a migratory status. Most migrated individuals find the coastal region (38 per cent) and northern regions (33 per cent) of Odisha as a favourable location for mobility. This clustering of people in some districts is motivated due to lack of employment opportunities in the area where they are residing or in the hope of finding better opportunities elsewhere. For instance, 46.68 per cent of the households in rural areas and 83.68 percent of the households in the urban areas had migrated for employment related reasons.

Despite many policies and programs for improving women participation in labour market, female labour participation has stagnated at a lower level in India. There is a rural-urban divide in female labor market, and it appears that female labour force participation rate in urban India remained stagnant at 18 per cent since 1980s despite rising education levels (Klasen and Pieters, 2013). However, in urban area of Odisha, 18.82 per cent of females are employed, whereas in rural area 21.60 per cent of females are in labor force. It was also pointed out that women with low education appeared to be obliged to work if her household income was very low, whereas highly educated women seemed less necessitated. In the context of Odisha State, 18.13 per cent females are having higher education in urban area which is quite higher than the percentage of higher educated females in rural area,i.e., 4.66 per cent. Though only 22.72 per cent females out of higher educated females are going to work whereas, in rural 20.68 per cent of higher educated females are working. Increasing educational attainment has been associated with stronger preferences for white-collar jobs (Desai

et al., 2010), while these jobs tend to become scarce relative to the rapidly growing supply of educated workers.

The main supply side factors are household wealth, rising husband's income, stigmas against educated women engaging in menial work, and education ofwomen (Chatterjee, Desai & Vanneman, 2018). On the demand side, employment in sectors appropriate for educated women grew less than the supply of educated workers, leading many women to withdraw from the labor force. Even though, one would expect a rising share of women to enter the labor force, especially in urban Odisha where women have gotten much more educated (Figure 2). This is termed as 'Income Effect'. But as education levels of females rise, they move back into the labour force as shown by the rising part of the U-curve. This entire development reflects an initial high-income effect which reduced women's participation and then a slow increase in substitution effect which raised her participation (Goldin, 1994).

The behaviour of female labor force participation is the basic static labor supply model, in which an increase in the wage rate reduces demand for leisure as its opportunity cost rises, increasing labor supply. If leisure is a normal good, an increase in a person's income will increase the demand for leisure and thus reduce labor supply (Blundell and MaCurdy, 1999). These are the well-known substitution and income effects. For a person currently not working, an increase in the wage rate only has a substitution effect, increasing her incentive to work (i.e., one would always expect a positive own wage effect at the extensive margin). An increase in unearned income (non-labor income or labor income earned by household wealth, husband's job) reduces the marginal utility of the woman's earnings and therefore reduces labor force participation in Eastern/Coastal region and Inland/Northern region whereas, in KBK it remained constant (Figure 3). This is mainly due to social stigma against women working in paid employment outside the house and also the increased wealth of the household.

In Odisha, proportion of tribals has the largest population in the country. The national average for scheduled tribe is 8.6 percent and schedule caste is 16.6 percent whereas in the state, the scheduled tribe is 22.9 per cent and the scheduled caste population is 17.2 per cent. Participation decision may also often depend on caste membership. Among the SC, ST and OBC,

Schedule Caste women's participation is decreasing in urban area as the educational attainment increases whereas, in rural area, Schedule Tribe women has the same downward slopping curve and Schedule Caste women has U-shape curve (Figure 5).

Literature Review

The FLFPR, especially for married women, tends to decline and then rise along with the economy growth of a country, thus following a U-shaped curve (Goldin, 1994). The decline in the initial stage arises due to the income effect where there is a transition from family farms/shops towards higher paying jobs, thus excluding less educated or illiterate female workforce from the wider market. However, over the years the substitution effect shows stronger impact, where increase in education levels provides higher opportunities for female workforce rather than only manual work.

Bhalla & Kaur (2011) analyse the NSS surveys undertaken in 1983, 1993/94, 1999/2000 and 2004/05 to study the reasons for low female LFPR. The authors show that LFPR has been consistently higher in rural areas compared to urban areas. The authors also point out the fact that females working in family farms/shops are categorised under unpaid jobs, however, NSS surveys show little difference between the paid and unpaid nature of jobs between male and female workforce.

Klasen & Pieters (2012) analyse the factors affecting female labour force participation during India's 1991 economic reforms. Using unit level estimation for the time period 1987 to 2004, the results show that labour force participation of poorly educated women is primarily driven by economic push factors and social status effects. On the other hand, women with high education levels were impacted by pull factors such as attractive employment opportunities and pay conditions, however, this section constitutes a very minor share of the total women labour force in India during the given period. Thus, the authors conclude that 1991 reforms, though led to tremendous economic growth contributed minimally towards female labour force participation.

Lack of access to water and basic entitlements like toilet, water quality, education, cooking fuel, floor and roof of the households can be a source of detrimental effect on human health and hence restricts females from

participating in the labor market (Coffey et. al., 2013). This leads to the queries of all the factors which not just affect female labor force participation rate linearly but also non-linearl. According to the World Bank (2012), labor force participation of women is associated with the health and well-being of women.

Afridi, Mukhopadhyay & Sahoo (2012) study the impact of the National Rural Employment Guarantee Scheme (NREGA) on FLFPR in India. NREGA is one of the largest rural employment programmes in the world and since large percentage of population in India resides in the rural sector, the impact on female labour force participation in rural areas provides better policy insights. Using econometric techniques, the results show that greater participation of mothers leads to better educational outcomes of their children. This again reiterates the importance of female labour force participation for the wellbeing of the entire household. Furthermore, the authors also mention that increased participation by females/mothers in their occupations will lead to improved position in household decision-making which also contributes towards poverty alleviation in rural areas.

Kapsos, Silberman & Bourmpoula, (2014) also point out the changing NSS methodologies as one of the problems in identifying female employment. For instance, contributing family workers are classified as employed, whereas family persons engaged in domestic care work are categorised as economically inactive. As a result, this bias will affect the documenting of female workforce more than men.

Verick (2014) highlights the point that though female labour force participation rate is low in the formal sector, the contribution of females in the economy remains remarkably high but is not reported in official statistics. A vast majority of women report their activity status as 'attending to domestic duties', which is considered as non-SNA (System of National

[1] The System of National Accounts (SNA) is the internationally agreed-upon standard set of recommendations on how to compile measures of economic activity in accordance with strict accounting conventions based on economic principles (UN 2008). This document defines the "production boundary," which determines what goods and services must be included in national income accounts. This boundary is also known as the boundary of SNA. Non-SNA work is defined as all work carried out outside the production boundary that can be delegated to others

Accounts) because of which their contribution towards the estimation of the Gross Domestic Product remains under-valued.

There is a trend of declining female labour force participation when a country transitions from an agrarian based economy to industry-based economy. Sanghi, Srija & Shirke (2015) studies the trends in female labour workforce participation from 1993-2012 where it is observed that majority of women workforce participate in agricultural activities and the transition towards industrialization leads to less educated or illiterate female workforce unemployed. Nevertheless, increase in family income and education levels over the years has increased to a small extent the female labour force participation in India over the years.

Sorsa, et al. (2015) highlight the importance of female labour force participation for inclusive growth and wellbeing of the household as well as the society. Using data from the International Labour Organisation (ILO), the authors look at the impact of various socio-economic variables on the female labour force participation rates using econometric techniques. The results show that education, income levels, labour market regulations and various social and cultural factors are negatively correlated with female labour force participation. On the other hand, financial inclusion, financial development, rural employment programmes such as MNREGA and improved infrastructure show positive impact on female labour force participation. At the regional level, Orissa shows similar trend to the national level. Furthermore, the share of female labor force is higher in rural areas vis-à-vis urban areas.

Naidu (2016) finds that even with increasing economic activity in India, the FLFPR keeps declining which remains contradictory to the U-shaped curve hypothesis. NSS surveys show that women workforce opts for 'domestic activities'. Women workforce with lower income and fewer assets are opting out of the wider market, which again is surprising. The authors attribute this trend to rising gender wage gap and shrinking employment opportunities for women workforce.

Mehrotra & Parida (2017) study the U-shaped curve by identifying the macro-level and NSS (household) data and identify income effect has remained stronger than the substitution effect due to mechanization of not

only the industrial sectors but of agricultural activities and increasing capital intensity and increase in real wages in rural areas as well.

As seen above, there have been many studies conducted to study the factors affecting FLFPR in India. However, the impact of family wealth/assets has largely been overlooked or under utilised in literature. Moreover, due to the regional disparity in demographic and socio-economic conditions in India, studies at sub-national level have shown growing importance. In our study we consider the state of Odisha where the impact of family wealth on FLFPR is observed and contribute in the literature by finding the probability of females joining the labor force at individual level and analysis leads to district level to see whether the individual effort gets converted to the aggregate level if these factors affects districts with low FLFPR differently from the districts with high level of FLFPR.

2. Methodology

In this paper, we use cross-sectional data from National Family Health Survey (NFHS-4) which was carried out in the year 2015-16. NFHS is a large-scale, multi-round survey conducted in a representative sample of individuals, households, childbirth, couple records throughout India. An individual ever-married women sample comprising of all women in the reproductive age from 15 to 49 years. It is used to collect information from the perception of women on household member's composition and household's basic entitlements. The focused state of the analysis is Odisha.

Individual Level Analysis

The main dependent variable is a binary variable assuming 1 for working female and 0 for not working. Logistic regression is used and analyses the relationship between multiple independent variables and a categorical dependent variable, and estimates the probability of an event occurring is p, the probability of the event not occurring is (1-p), then the corresponding odds is a value given by: Odds [of event] = $\frac{p}{1-p}$

Logistic regression takes a log transformation of the odds and model that as a linear function of the explanatory variables.

Logit (y) = ln (odds)=ln ($\frac{p}{1-p}$)= ? +xβ

where p is the probability of interested outcome and x is the explanatory variable.

p=P (Y=interested outcome | X= x, a specific value) = $\frac{e^{\sigma}+x^{\beta}}{1+e^{\sigma}+x^{\beta}}$

The predicted probabilities are limited between 0 and 1. The exponential function of the regression coefficient is the odds ratio associated with a one unit increase in the independent variable.
For the current paper we estimate the following equation at the individual level in both rural and urban area:

Working female = household deprivation[2] (dummy) +β_2 head of household +β_3 various indices +β_4 household wealth +β_6 female autonomy + control variables

District Level Female Labor Force Participation Rate: OLS Estimates

To capture the individual heterogeneity in the female labor force participation in their cluster space and therefore in the level of FLFPR across different districts. Our hypothesis is that role of household deprivation or family wealth in the space in increasing female labor supply decision may be more prominent in districts with higher level of female labor force participation rate than in districts which are performing poorly.

$\alpha+\beta_1$

The OLS regression equation is modelled, where FLFPR is modelled in the following form:

$$FLFPR = \alpha+\beta_1 X_1 +\beta_2 X_2 +.... \beta_n X_2 +\varepsilon \text{ ..... Equation 1}$$

Where;
FLFPR is the percentage of working female at the district level α is a district specific,

[2] To measure deprivation an index is created using dimensions like toilet and water facility at home or uses open space or field, water quality, cooking fuel, type of floor, roof and wall material as given in the NFHS unit level dataset. According to the availability of these basic facility, a deprivation score is given. If the household didn't have any facility among these then score of 1 is given

β_1, β_2 , β_n and so on are the parameters to be estimated from the data, X_1, X_2, and so on are explanatory variables,

ε is the error term following classical OLS assumptions

The rate of change of Y with respect to a unit change in the variable X_i will be given by the derivative of y with respect to X_i. The coefficients of the explanatory variables describe the mathematical relationship between each independent variable and dependent variable. The p-values for the coefficient indicate whether these relations are statistically significant.

Variables

It is well documented that there is wide-spread disparity in terms of working females between urban and rural areas. Thus, we should construct different models for both rural and urban area by incorporating the same set of independent variables and the working female as a dependent variable.

1. *Working Female:* A working woman is defined to be an eligible woman who gets remunerated for her work in the form of either cash or kind or both. It is a dependent variable with dichotomous category 'not working' or 'working'.

2. *Household Wealth:* For the purpose of quantifying the proportion of richest household in space that determine development in a space, an index is constructed. This index attempts to serve as a proxy for wealth and is constructed in a manner such that higher values are indicative of higher levels of wealth in the state.

3. *Household Deprivation:* Apart from individual characteristics, household characteristics serve as an important variable for capturing the local level deprivation with multi dimensions like toilet and water facility at

[3] The wealth index is a composite measure of a household's cumulative living standard which is given by NFHS dataset. The wealth index is calculated using easy-to-collect data on a household's ownership of selected assets, such as televisions and bicycles; materials used for housing construction; and types of water access and sanita-tion facilities.

[4] Ownership is captured in the NFHS by asking who owns the house/land or if the house/land is owned jointly or by men or by women.

home or uses open space or field, water quality, cooking fuel, type of floor, roof and wall material.

4. *Property Right:* Economic theory purports that ownership of assets/ financial autonomy increases the bargaining power of women in the household which, allows them to take more control over decisions that impact their lives (Anderson et. al., 2009). We check the ownership of formal land titles and house rights by looking at the variable which records if the land or property of the household is on the name of women in the age group of 15-49.

5. *Bank Usage:* Merely opening an account is not enough to utilize the benefits of banking facilities (Beck et. al, 2011). An active operating account is must to become the beneficiary of the certain government schemes and directly receiving the money in the bank account.

6. *Female Autonomy:* The variables consist of two components: (1) Decision-making authority on the woman's de-facto power to guide construction decisions in the household like health, economic, visiting decisions. (2) Domestic-violence- men resort to violence when their position of dominance is under threat. Thus, spousal violence follows as a logical conclusion (beating justified) to the patriarchal assumption that women are subordinate to men. It is through spousal violence that men exert dominance, control and fear. Thus, these variables, even though are pathways and necessary conditions to achieving female empowerment, are not necessarily reflective of empowerment or conversely the extent of patriarchy per se.

7. *Children under five:* Household with children is another important characteristic of the household which we control for. The time investment in care economy restricts the female's mobility for work outside the home.

8. *Education of Women:* To capture the non-linear impact of education on FLFPR, we incorporate education as highest level of education along with square of education.

4. Regression Results and Discussions

Individual level Analysis

The individual level analysis is undertaken to understand if high household wealth can influence the females in participating the labor market. For this, the dependent variable is a binary variable assuming 1 for working and 0 for not working. Since the dependent variable is dichotomous, a logistics regression framework was utilised. The odds ratios from the individual-level logistic regression are outlined in Table 3.

Urban and Rural Model

Amongst, the main variables of interest, the own wealth index category, and the proportion of richest household in the cluster space is coming out to be significant, but the probability of participation in the labor market increases with the development of space. For instance, the space in which greater proportion of richest households reside have less stigma (positive association sign) are 1.04 times more likely to go for work than the space with high stigma (negative association sign). This is consistent with the findings of the previous studies which suggests that own household wealth motivates the females to substitute their decision of participation in labor market. Whereas, in the rural area, both the standardised component i.e., own wealth and proportion of richest household in the cluster space is coming out to be significant with negative association sign and the likelihood ratio is 0.96 and 0.98, respectively. It means that high economic status of households in rural area pull out the females from participation in the labor market.

On account of high degree of correlation among the output variables quantifying wealth (Figure 7), principal component analysis technique is used for creation of the index. PCA best captures the variance in the data and prescribes weights to the variables, which are then not left to the discretion of the researcher. While specifying the PCA, correlation matrix is used as opposed to covariance matrix since the variables are non-standardized. The principal component transforms the set of the three correlated variables (Wealth index of urban/rural, wealth in cluster of urban/rural, household wealth) used for the construction of the index into linear combination of the set of three uncorrelated principal

components. The components are constructed in such a manner that the first component explains the maximum variation in the data and the consequent components are constructed so as to explain the largest amount of the remaining variance. As can be seen Table 1 and 2, the first two components explain 91.06 and 90.37 per cent of the total variance and have an eigenvalue of more than 1. The factor scores from the first component, which captures maximum amount of variance in the data (68.07 and 75.98 per cent), are used as weights to compute the 'Wealth Index'.

Borough as a separate variable incorporated in the model to capture the behaviour of richest household clusters in the both rural and urban space. In both the modelling, borough is a significant variable with negative association signs in urban area and positive sign in rural which means that theodd ratio of Labor Force Participation of females for urban rich clusters is 0.16 times lower and 2.71 higher for rural rich clusters.

In addition to this, control over assets implies that the woman owns either land or house in her own name, it can be argued that more than ownership of assets, 'access-to assets, knowledge, social relations and political processes' leads to empowerment (Goldman et. al., 2016). The property rights might influence females to participate in the labor market and hence, we find that house right has a negative association whereas land right has a positive association with 1.03 times more likely to join labor market in urban area but due to a smaller number of females has the property right, these variables are not significant. Whereas, in rural area, house right has a positive association with 1.18 times likelihood ratio and land right has a negative association, though they are not significant.

In addition to the property rights, active usage of bank account is very helpful for getting the benefits of state as well as central government flagship schemes for direct benefit transfer to motivate females to work. Our results tell us that those females actively use the banking facilities are 2.3 times more likely to participate in labor market with high level of significance in urban whereas in rural area, this likelihood ratio is 1.77. Female relationship with household head is a proxy for culture and social norms. The odd of working female is reducing in both urban and rural modelling with 0.72 times likelihood ratio.

Highest level of education is an influential factor behind the female mobility

in the employment sector but in this study results states that education is an significant variable but it comes up with negative association whereas square of education has a positive association which confirms that there exists a non-linear impact of education on the behavior of female labor supply decision. As the educational attainment increases 1.01 times more likely to have working women in urban area whereas in rural, 1.00 times more likely to work with high significance. The same kind of non-linear impact, we can see with age as well with high significance.

Household deprivation in both urban and rural area restrict females from joining the workforce. However, the space in which household resides might be an important variable to capture the stigma of the society, but the health of the female as an individual and non-deprived household is also considerable. So, the interaction of poor space and non-deprived households has positive association with 1.53 likelihood ratio in urban area whereas in rural, it is 1.6. On the other hand, interaction of poor space and unhealthy individual has a negative association. Unhealthy includes the disease of BP, asthma, diabetes, thyroid, heart, cancer.

The odds of working female in KBK region and inland central/northern with reference to coastal region is 0.77 and 0.48, respectively in urban area with negative association sign whereas in the rural area, the odds ratio is 1.51 and 1.31, respectively with positive association sign.

Scheduled Castes, Scheduled tribes and Other Backward Castes with reference to others, OBC is significant in urban area and ST is significant in rural area to increase the chance of females to participate in labor market.

Language is not a barrier in Odisha State as 96.92 percent in our dataset speaks Oriya and hence, the odd likelihood ratio is 3.38 in urban area with high significance level whereas, in rural area, it is 1.38. Children at home demands the time of mother and this is not significant in both urban and rural area, but the association sign is negative in both the cases.

District Level Analysis

To overcome the individual level heterogeneity, here we are focusing on the communities at an aggregate level would perform to push the females in participating labor market. However, there are possibilities of some

influence or inspiration from the neighbors or from the local administration that can get reflected in the performance of the districts. For instance, high female autonomy in the district will put high impact on the behavior of females to join labor force. To get a better performance at an aggregate level we need to have better awareness among all the individuals at the community or say, village level. The local Government can actually play an important role here as most of the Government policies are targeted at the district level and a district administration van take up incentive schemes to improve the FLFPR. Like, the high percentage of multi-dimensional deprivation households push the females to the labor market whereas the proportion of richest households in their cluster space act as the pull factor for the females in labor market in some districts than the others. It can be due to more house or land property rights to the female or higher educational attainment of women. Other factors like average number of children at home, speaking language, urban-rural composition of population can have impact of different level at different districts.

This brings us to the next analysis where we estimate Ordinary Least Square (OLS) estimates at the district level and the results are reported in Table 4. At this stage, it is worthwhile to note that a community or village level analysis could have been a better source of insight, however, due to data constraints; this study has focused on the next level of aggregation, namely the district. There are 30 districts in Odisha and the percentage of females as an individual working in each of these districts has been taken as the dependent variable in the analysis. Majority of the independent variables are the categorical variables at the individual level are converted to district level continuous variables. The OLS regression provides a unique coefficient for all the districts by taking out the conditional expectations. In our analysis, the wealth of the household is significantly restricting (negative coefficient sign) the female labor force participation in rural area whereas, in urban, the coefficient sign is positive without any significant probability value. The percentage of multidimensional deprived households in the districts is significantly decreasing FLFPR in rural area with 41.78 per cent coefficient value whereas, in urban, the coefficient value is 10.24 per cent but it is not significant. The demand side variables like financial autonomy which is the combination of decision-making power and say against domestic violence is highly significant in urban area with a positive impact of 35.93 per cent whereas, in rural area, the variable is not significant. House or land right is taken as a proxy for property rights with the females and in our model,

house right is highly significant in both rural and urban with a positive impact of 27.26 per cent and 30.80 per cent, respectively. However, land right is not significant, but the coefficient sign is negative in both the cases. In addition to this, bank usage has a significant positive impact in rural area with 38.10 per cent coefficient value, whereas in urban, this is not significant. Highest level of education of females in the district space is highly significant in both rural and urban area with negative impact of 4.2 per cent and 3.6 per cent, respectively. Children at home are significant in urban area in decreasing FLFPR.

Conclusion

The effect of wealth on female labor force participation rate is non-linear. As wealth increases, economic status of the households also increases, which restricts females from participating in labor market. This non-linearity is more visible in rural area of Odisha. In other words, working women who are not exposed to any kind of education are actually coming from poor economic status and are forced to join the workforce to supplement the family income. At the aggregate level, the supply side issues matter more than the demand side issues as district administration is expected to play bigger role in terms of providing services and incentivizing the female labor supply decision. Institutional failures in providing toilet facility at home, access to safe drinking water and pucca house are making the femalesvulnerable to join labor force.

To sum up, our findings show that financial autonomy has a great role to play and multidimensional deprived households in the districts is significantly decreasing FLFPR in rural area compared to urban area. Presence of children in households lead to decrease in FLPR, which suggest that there is a need of comprehensive care economy.

References

Afridi, F., Mukhopadhyay, A., & Sahoo, S. (2012). *Female labour force participation and child education in India: the effect of the national rural employment guarantee scheme*, https://niti.gov.in/planningcommission.gov.in/docs/reports/sereport/ser /st_rltapkbk.pdf

Bhalla, S., & Kaur, R. (2011). *Labour force participation of women in India: some facts, some queries.*

Chatterjee, E., Desai, S., & Vanneman, R. (2018). Indian paradox: rising education, declining
womens' employment. *Demographic research*, *38*, 855.

Chaudhary, R., & Verick, S. (2014). *Female labour force participation in India and beyond*. New Delhi: ILO.

Coffey, D., Khera, R., & Spears, D. (2013). Women's status and children's height in India: Evidence from joint rural households. *Unpublished, Office of Population Research, Wallace
Hall, Princeton University, Princeton, NJ*, *8540*.

Goldin, C. (1994). *The U-shaped female labor force function in economic development and economic history*.

Kapsos, S., Bourmpoula, E., & Silberman, A. (2014). *Why is female labour force participation declining so sharply in India*? (No. 994949190702676). International Labour Organization.

Klasen, S., & Pieters, J. (2012). Push or pull? Drivers of female labor force participation during India's economic boom. *Drivers of Female Labor Force Participation During India's Economic Boom*.

Mehrotra, S., & Parida, J., K. (2017). Why is the labour force participation of women declining in India?. *World Development*, *98*, 360-380.

Naidu, S., C. (2016). Domestic labour and female labour force participation: Adding a piece to the puzzle. *Economic and Political Weekly*, 101-108.

Parida, S., P. (2010). Poverty and inequality of KBK region of rural Odisha: a comparative analysis. *International Journal of Social Science Tomorrow*, *1*(4), 1-8.

Sanghi, S., Srija, A., & Vijay, S. S. (2015). Decline in rural female labour force participation in India: A relook into the causes. *Vikalpa*, *40*(3), 255-268.

Sorsa, P., Mares, J., Didier, M., Guimaraes, C., Rabate, M., Tang, G., & Tuske, A. (2015). *Determinants of the low female labour force participation in India.*

World Bank. (2012). World Development Report , 2012 . *Gender Equality and Development*. World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/4391 License: CC BY 3.0 IGO

1.0. Appendix

Figure 1: Area of Research study is Odisha State

Figure 2: Regional Variation in Female Labor Force Participation with Education

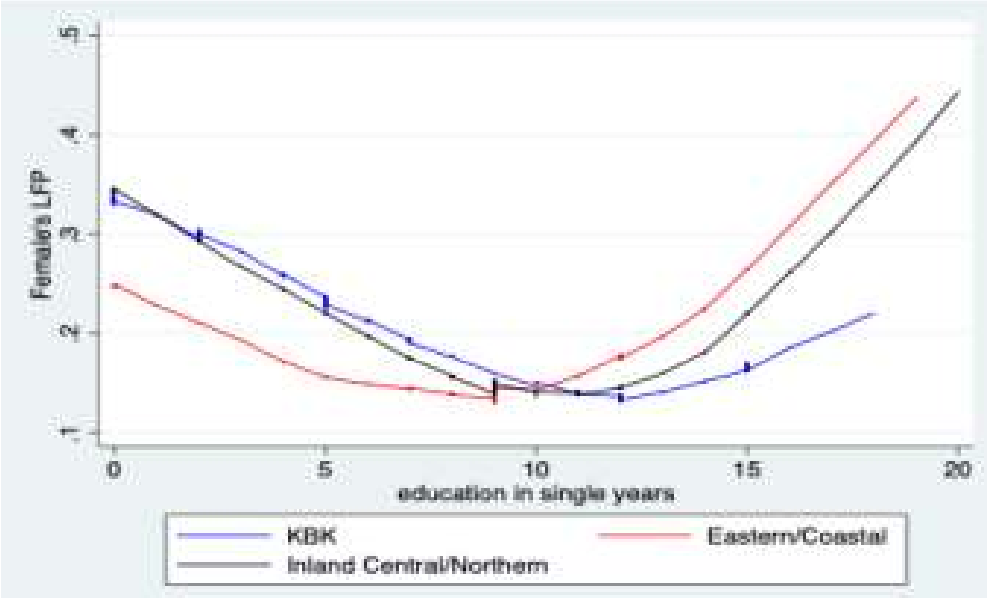


Figure 3: Increasing Female Labor Force Participation with Education

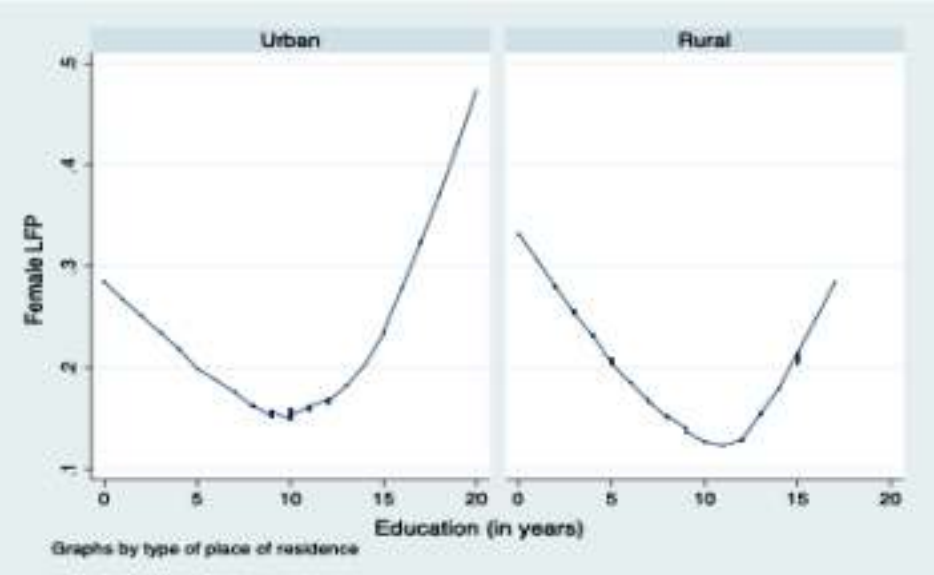


Figure 4: Impact of Education on Female Labor Force Participation Rate in Various Caste Groups.

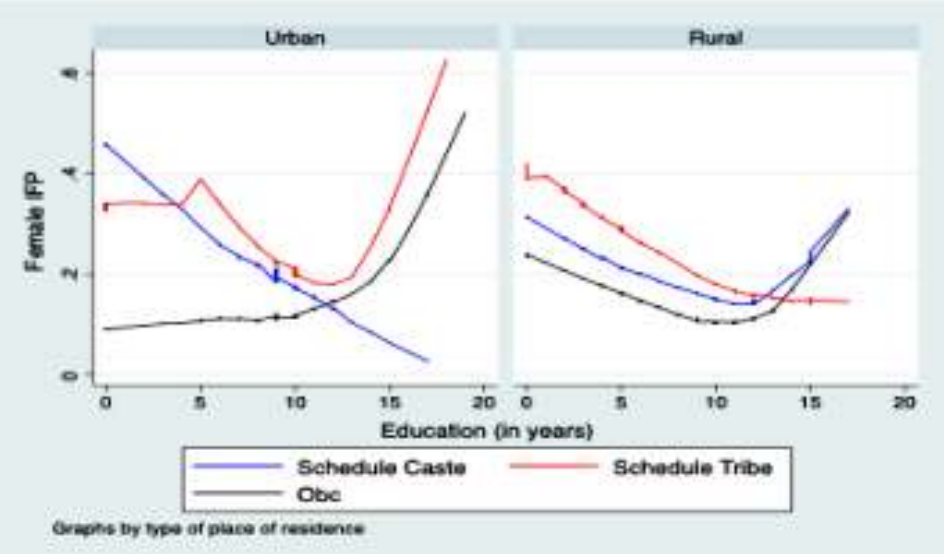


Figure 5: Non-Linear relationship between household wealth and Female Labor Force Participation Rate

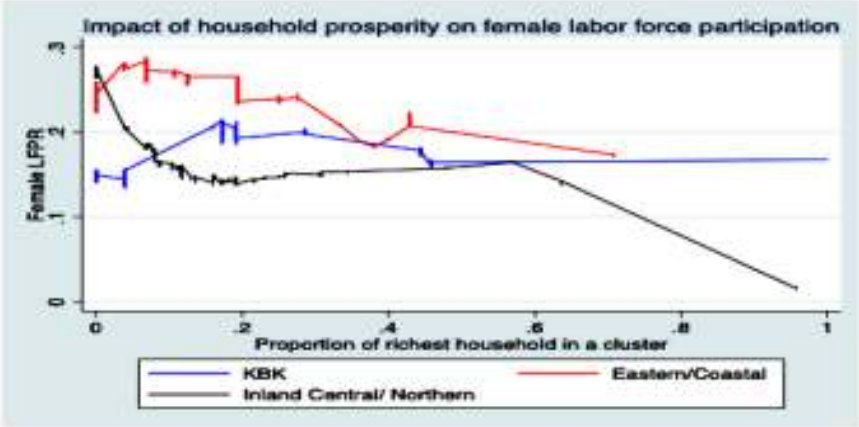


Figure 6: Non-Linear relationship between household deprivation and Female Labor Force Participation Rate

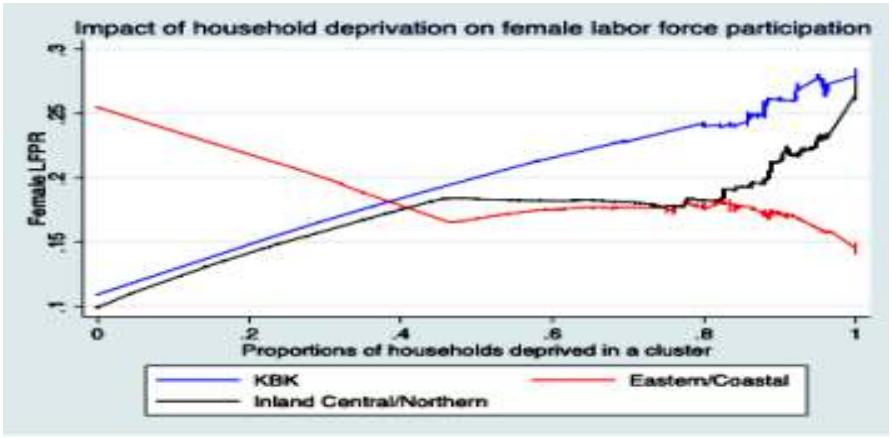


Figure 7: Correlation between Output Variables that Define the Wealth Index (a) Urban (b) Rural

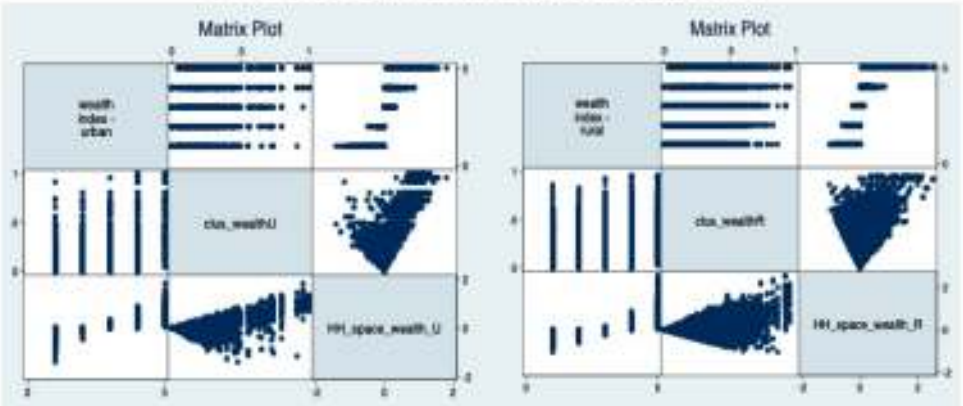


Table 1: Principal Component Analysis between the Output Variables that Quantify Wealth in Rural Odisha

Variables			
Own Wealth	0.6358	-0.1872	-0.7488
Proportion of richest in a space	0.4927	0.8452	0.2071
Household wealth in the locality	0.5941	-0.5006	0.6296
Cumulative variance	0.6807	0.9106	1.000
Eigenvalues	2.04196	0.689908	0.268128

Table 2: Principal Component Analysis between the Output Variables that Quantify Wealth in Urban Odisha

Variables			
Own Wealth	0.5899	-0.3585	-0.7235
Proportion of richest in a space	0.5547	0.8311	0.0405
Household wealth in the locality	0.5868	-0.4252	0.6891
Cumulative variance	0.7598	0.9037	1.000
Eigen values	2.27948	0.431716	0.288801

Table 3: Results of Individual level Analysis (With Dependent Variable FLFPR)

Variables	Odds Ratio - Urban (Z statistics)	Odds Ratio-Rural (Z statistics)
Own wealth	0.956 (-2.68**)	0.967 (-5.08***)
Wealth in cluster space	1.022 (1.09)	0.987 (-1.49)
Borough	0.168 (-1.47**)	2.372 (2.31*)
House property right	0.979 (-0.08)	1.202 (1.34)
Land property right	0.935 (-0.23)	0.796 (-1.55)
Bank usage	2.289 (3.62***)	1.781 (5.59***)
Household deprivation	0.81 (-0.39)	0.361 (-1.39)
Poor space*non-deprived households	1.557 (0.68)	1.625 (1.53)
Poor space*unhealthy individuals	0.992 (-0.01)	0.776 (-1.18)
Household Head	0.787 (-0.66)	0.716 (-1.87)
Child at home	0.678 (-1.49)	0.936 (-0.55)
Language	3.879 (1.94*)	1.664 (1.63)
Caste(with ref. others)		
SC	1.247 (0.72)	1.275 (1.21)
ST	1.265 (0.69)	1.780 (2.80*)
OBC	0.593 (-2.03*)	0.921 (-0.43)

Education	0.903 (-1.57**)	0.877 (-3.74***)
Education^2	1.000 (2.43**)	1.007 (2.84**)
Age	1.280 (3.18***)	1.109 (2.80**)
Age^2	0.996 (-2.83**)	0.998 (-2.11*)
Region (with ref. Coastal)		
KBK	0.698 (-1.14)	1.268 (1.49)
Inland Central/Northern	0.403 (-3.84***)	1.124 (0.83)
Constant	0.005 (-2.24**)	0.422 (-0.64)
No. of Observation	753	2,559
LR Chi2	104.08	263.01
Prob>Chi2	0.000	0.000
Pseudo R2	0.1400	0.0950

Note: Exponentiated coefficients; z statistics in parentheses $p < 0.05$, $p < 0.01$, $p < 0.001$

Table 4: Results of District level Analysis

Variables	OLS - Urban	OLS - Rural
Wealth Index	-0.002 (-0.08)	-0.054 (-2.02**)
Average Education years	-0.049 (-3.23***)	-0.047 (-3.50***)
Household deprivation	-0.151 (-0.84)	-0.387 (-1.94*)
Female autonomy	0.092 (0.56)	0.098 (0.76)
House right	0.266 (2.47**)	0.26 (2.43**)
Land right	-0.187 (-0.93)	-0.21 (-1.11)
Bank usage	0.429 (3.36***)	0.397 (3.01***)
Household head	-0.221 (-0.30)	0.304 (0.44)
Average no. of children at home	-0.223 (-0.56)	-0.317 (-0.84)
Language	0.008 (0.06)	0.003 (0.02)
Constant	0.415 (1.69)	0.6 (2.62**)
Observations	30	30
F-value	13.08	22.13
Prob> F	0.000	0.000
R^2	0.7190	0.7441
Root MSE	0.055	0.052

Note: Robust standard errors in parenthesis ; $p < 0.1$, $p < 0.05$, $p < 0.01$

Article

An Analysis of Productivity and Efficiency of Mining Sectors in Odisha

Odisha Economic Journal
Volume 53 • Issue 2 • 2021
pp. 100-115
Journal of the
Orissa Economics Association
OEA

Kailash Chandra Pradhan
Harihar Dehury

Abstract

The study examines the mining sectors in Odisha. The objectives of the study are to examine the trends and patterns of total revenue, investments, turnover, capital stock, fixed capital, and employment in Odisha, and to analyse the productivity and efficiency of mining industries in Odisha. The annual data is considered from 1980 to 2018 and the information hasbeen retrieved from the published article, various related books, journals, and different government websites. The results found an upward trend in total revenue in the mining industries. Moreover, the results have shown that there is a steady growth rate of an investment over the periods and whereas the growth rate of total turnover has declined. The results also revealed that the growth of employment has increased over the periods. The results from the stochastic frontier production model found that employment and capital stocks have a positive and significant impact on production. Finally, the study found that the technical efficiency has declined substantially with relatively small and the total factor productivity has increased at a very slow pace over the period in the mining industries in Odisha.

Keywords: Mining sector, Revenue, Capital stock, Employment, Stochastic frontier production, Odisha.

Kailash Chandra Pradhan, Associate Professor, Department of Economics, Mahatma Gandhi Central University, Motihari, Bihar. Email: kailasheco@gmail.com

Harihar Dehury, M.Phil. Scholar, Department of Economics, Mahatma Gandhi Central University, Motihari, Bihar. Email: dehuryharihar95@gmail.com

1. Introduction

Many developed countries in the World are developed by the advance in the industrial sector. In the modern era, countries such as the U.S.A., China, Australia, and Japan have rich and advanced industrial sectors. Generally, to promote or run the industries, it is necessary to develop or set up the industries based on the availability of raw materials. India has a reach in minerals which provides a favourable environment to run the mining industries. The mining-based industry generates employment directly or indirectly and produces the industrial output accordingly to the demand.

The mining sector (excluding atomic and mineral) provides 4,77,399 employments per day in 2016-17. About, 79 per cent were working in the public sector and about 21 per cent were working in the private sector. In the year 2016-17, the shares of the total labour force are engaged about 77 per cent in fuel minerals, 17 per cent in metallic, and 6 per cent in non-metallic minerals. The latest survey presents that India's ranking in world mineral production; was 3rd in aluminium and steel, 4th in chromite, iron ore and lead, 5th in bauxite, 6th in copper ore and 7th in manganese. The estimated growth in real GVA in 2019-20 is 4.9 per cent against 6.6 per cent in 2018-19. Moreover, the GVA at Basic Prices for 2019-20 from the 'Mining and Quarrying' sector is estimated to grow by 1.5 per cent as compared to a growth of 1.3 per cent in 2018-19. Currently, 100 per centof FDI has been allowing forthe automated route for mining and extraction of metal and non-metal ores.

The state of Odisha is occupied as one of the richest states in India, in terms of mineral resources, these resources are largely immaculate as mining and very intensive capital for industry. However, Odisha is a leading producer of Chromites, Bauxite, Granite, Iron Ore, Manganese Ore, Sillimanite, Quartzite, and Dolomite. It is the sole of the ruby of mining resources which is constituted of 96 per cent Chromate, 93 per cent Nickel Ore, 90 per cent Platinum group metal (PGM), 51 per cent Bauxite, 69 per cent Coal, 44 per cent Manganese, 34 per cent Iron Ore, 25 per cent Sillimanite, 24 per cent Fire Clay and 10 per cent Dolomite. As per the acid mine drainage (AMD), It is 150.62 million tonnes of rut line resources which are accounted for by the Department of Atomic Energy (DAE) of Odisha. The GDP growth rate of Odisha has increased from 7.4 per cent in 2017-2018 to 8.4 per cent in 2018-19. Over the last five-year, on average, the growth rate of Odisha has

grown at a faster rate than the states such as Punjab, Haryana, and Chhattisgarh. However, Odisha managed to control the population growth rates, which have also improved the per capita income position from 25 ranks to 16 ranks in India. In Odisha, agriculture is the main source of livelihood and nearly 48 per cent of people are working in this sector. But the industrial sector has played a vital role in the State's economic growth. It comprised nearly 39.5 per cent of Gross State Value Added (GSVA) in 2018-19. The share of the mining sector contributes 10.79 per cent in 2018-19. There are serious challenges in Odisha concerning the slow pace of urbanization, the backwardness of agricultural activities, poverty and malnutrition, and unemployment in the industrial sector as well as the non-industrial sector.

Odisha has rich in mineral resources, but it is a backward state in India. It is evident that around 99 per cent of Iron ore is produced by the major five States: Karnataka, Odisha, Chhattisgarh, Goa, and Jharkhand. Odisha has occupied the second position in Iron Ore and more than 50 per cent of Bauxite production has been produced in this State. In the case of Coal production, Odisha is the second producer State after Jharkhand. From this point of view, Odisha is very rich in mineral resources. Still, Odisha is having poverty, unemployment, low per capita income, poor standard of living, backward industrial development, poor quality of infrastructural, etc. It is important to understand various issues pertaining to the mining sectors and the productivity and efficiency of mining sectors in Odisha.

2. Review of Literature

Anumber of studies exist on different socio-economic and environmental issues related to the mining industries in India. Kujur (2008) studied the displacement of local residents in Chhattisgarh due to a Rs.60 crore investment for the development of mining and transportation purposes. Spending Rs.632 crore, the major industries have been established in Raipur and Durg districts. The study found that about 238 villages were affected due to these industrial activities and forest land was lost.

Using remote sensing data and GIS over a period of 30 years Joshi et al. (2008) examined the impact of industrialization in a dry tropical region, Chhattisgarh. They indicated that the industrial activities resulted in the permanent destruction of indigenous forests. The study found that about

22.22 per cent of forest areas were completely cleared due to industrialization and about 24.52 per cent of forest areas were partially damaged. Most people are satisfied with these mining activities because they gotemployment.

Heather (2013) examined theenvironmental mis-assessment development and mining in Odisha. This paper studied Niyamgiri mine and related Lanjigarh refinery expansion in Odisha to a set of environmental impact assessments (EIS). The study also highlighted the shortcoming impact assessment framework that all risks can be accounted for from a desk-based study with local people in the affected area. The Government has rejected of environmental clearance in Niyamgiri mine subject to regular controversy and, the Vedanta Company was not permitted to do the mining operation.

The performance of public and private mining firms in India has been examined in Das (2013). The study, using firm-level data for 1988-2006, found that the total factor productivity of private mining firms was more than that in the public sector firms in three sectors - metallic, non-metallic and coal. In the initial years, private sector firms outpaced the public sector firms in the petroleum sector, whereas afterwards, the productivity of public sector firms surpassedof private firms in a few years. The study also found there were no significant differences between the environmental performance of public and private mining firms. Finally, the study found that most households were not satisfied with the compensation paid by both public and private sector mining firms.

The impact of the mining sector on the Odisha economy and its effect in terms of the value of total extractions, total employment, contribution to GDP and total revenue has been studied in Panda (2014). The author has taken the data from the period 2000-01 to 2010-11 for the analysis. The results found that mining extraction has increased over the periods, but its impact on the annual growth rate of employment and total revenue is not effective. The contribution of the mining sector tothe GDP growth rate has been found positive. The study found that corruption started from allotment to lease and it is also in the valuation of minerals and royalties. Jena (2015) found that the extraction of mining resources hasa positive impact on total revenue, but employment has increased slowly.

Mahanty(2015) studied the economic and working conditions of mining

labour in Keonjhar District of Odisha. The study found that the mining industry provides better employment opportunities, but it neglects the economic conditions of labour. Most of the tribal workers are engaged in the mining field and they do not have any other job options to select after losing the local forest due to mining activities. The study also found that sometimes the tribal workers work as contract workers inthe unorganized sector. By analysing the livelihood of the inhabitants of Keonjhar district Sahoo (2015) found that more than 50 per cent of income is generatedfrom mining activities and but the Human Development Index was very low in the district. The study also found that there were illegal miningactivities in the districts.

The efficiency and performance differentials between state-owned coal companies (SCCs) and privately owned coal companies (PCCs) using data from 2000 to 2016 have been examined in Parida and Madheswaran (2021a). The results from multivariate panel data regression analysis have shown that the private sector significantly outperforms the SCCs in terms of output efficiency and profitability. The results also found that the underperformance of SSCs is due to a lack of technological upgradation, manpower skill deficiency, lack of incentivization and inadequate infrastructural facilities. In another exercise Parida and Madheswaran (2021b) examined the difference in productivity in the public and private sectors of the mining industry in India using the Levinson and Petrin (LP) method. The study considered four sectors, namely metallic, non-metallic, coal and petroleum of the Indian mining industry from 2000 to 2016 for the analysis. The results have shown that the total factor productivity of private forms is superior in three sectors-metallic, non-metallic, and coal than in the public sector. However, in the case ofthe petroleum sector, the result is quite the opposite. The results also suggested measures like provision of incentives, improvement in infrastructural facilities, upgradation of manpower and so on to improve the productivity performance of public sector firms.

These authors have studied different aspects relating to the mining sector such as the production of minerals resources, illegal mining activities, sustainability of the mining sector, dealing with the environmental management system,displacement due to mining activities, and advantages and disadvantages of mining, and problems relating to mining industries development. Some studies have shown the socio-economic conditions of

local people and other aspects of development. There exist limited studies on issues inproductivity and efficiency of mining industries in Odisha. Hence, the present study evaluates the trends and patterns of production, revenue, capital stock, investment, turnover and employment of mining industries in the state using the latest available data set.

The following sectionpresents the data and methodology used to define the objectives of the study.The results and discussions are presented in the fourth section and, finally, the fifth section contains the conclusion and policy suggestions.

3. Data and Methodology

The data for the total revenue, investment, fixed capital, capital stocks, total turnover, and employment is collected from 1980 to 2018 from various government websites such as Odisha Mining Corporation Limited (OMCL), Directorate of Mines, Odisha, and Economic Survey of Odisha and Steel and Iron corporation of Odisha.

The productivity and efficiency of mining industries in Odisha are estimated using a stochastic frontier production function. In the stochastic frontier production function, the capital stock and employment are considered as a regressor and total turnover is considered regressand. The capital stock is estimated using the perpetual inventory method.

$$C_{(t-1)}(1-\delta) = C_{t-1} + I_{t-1} \qquad (1)$$

where, C_t and Ct-1 represent capital stock at the current period and initial period respectively, represent the gross investment at the previous year, represents the rate of depreciation and it is assumed to be 5 per cent over periods. The estimation of the initial capital stocks is as follows.

$$C_{(t-1)} = \frac{i_t}{\delta + goutput} \qquad (2)$$

where, $C_{(t-1)}$ and It represents initial capital stock and gross investment at current periodrespectively, g_{output} denotes the growth of total turnover and represents the depreciation rate. From the above equation, the capital stock is estimated from 1980 to 2018.

To estimate the technical efficiency of mining industries, the stochastic frontier production model of Battese and Coelli (1995) is used. The data of employment and the capital stock are considered as labour and capital respectively to estimate the Cobb-Doggles production function. The production function is estimated is as follows.

$$Y_t=f(X_{it};\ \beta_i)+\varepsilon_t i=1,2,\ 3,\ \ldots\ldots,\ n,\ t=1,\ 2,\ldots T \qquad (3)$$

$$\varepsilon_t = V_t - U_t \qquad (4)$$

where is a total turnover and X_{it} is an ith input variables such as employment and capital stocks at time t. β_i is the coefficient of input variables. The error terms ε_t is divided into V_t and U_t. Both error terms are assumed to be the identically, independently, and normally distributedN $(0,\sigma 2)$.

Variables Definitions:

The study used variables such as output, labour, and capital to estimate the productivity and efficiency of mining industries in Odisha.

Output: The study uses total turnover as a proxy for the output.
Labour:The study uses the total number of employments as an indicator to measure labour input.

Capital: The Perpetual Inventory method is used to construct the nominal capital stock series. The total investment is used to estimate the capital stocks.

4. Results and Discussion

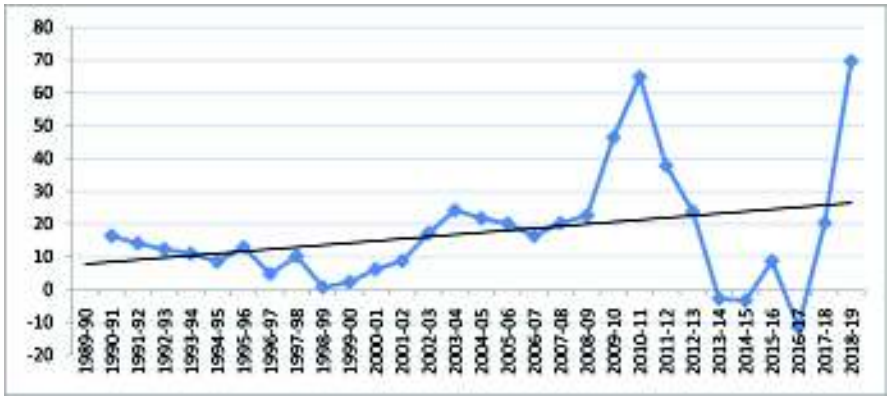
This section presents the trends and patterns of total revenue, investment, fixed capital, capital stocks, total turnover, and employment of mineral industries from the year 1980 to 2018 in Odisha. Moreover, technical efficiency and productivity are estimated using the production function.

4.1: Total Revenue Collection from Mining

Figure 1 shows the growth rate of the total revenue of mining industries from 1989-90 to 2018-19. The highest growth rate of total revenue (69.65 per cent) is reported in the year 2010-11 and the lowest growth of total revenue (-11.44 per cent) is reported in the year 2016-17. The results of the

trend line show that there is an upward trend in total revenue growth in mining industries. The growth of revenue is vital in the development process of an economy. The results found that mining extraction or mining activities haveenhanced revenue growth.

Figure 1: Growth Rate of Total Revenue (Percentage)



Source: Steel and Mines Govt. of Odisha.

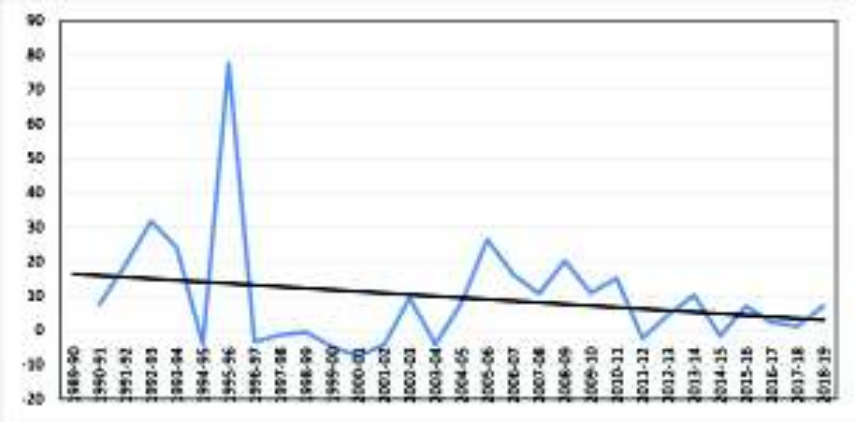
4.2: Mining Capital and Total Turnover

The year over year growth rate of investment is presented in Figure 2. The results show that the growth rate is hiked up two times in the year 1999-00 and 2010-11. The trend line shows that there is a steady growth rate over the period. The growth rate of a fixed asset is presented in Figure 3. The results show there are high fluctuations of growth rate over the periods and the result from the trend line found that the growth of capital assets has declined over periods.

Figure 2: Growth Rate of Investment (Percentage)

Source: Odisha Mining Corporation Limited (OMCL).

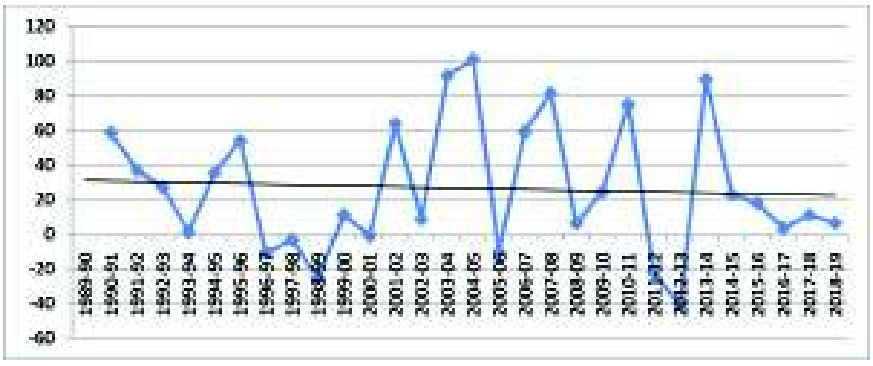
Figure 3: Growth Rate of Fixed Assets (Percentage)



Source: Odisha Mining Corporation Limited (OMCL).

The growth rate of total turnover is presented in Figure 4. The results show that there is a high fluctuation of total turnover in the mining industries over the periods. In some of the years such as from 1996-97 to 1998-99, 2000-01, 2005-06, 2009-10, from 2011-12 to 2012-13, there is negative growth of total turnover. Overall, the trend line shows that the growth rate of total turnover has declined over the period.

Figure 4: Growth Rate of Total Turnover (Percentage)

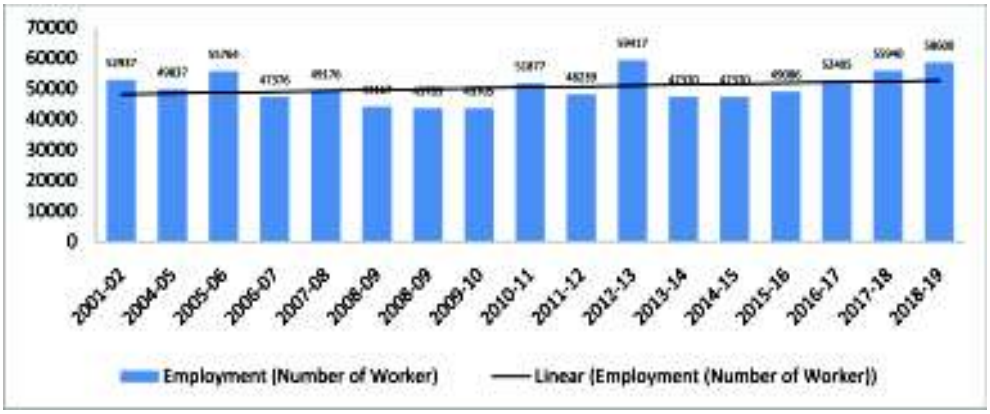


Source: Odisha Mining Corporation Limited (OMCL).

4.3: Mining Sector Providing Employment

Larger numbers of worker depend on various mining across the state of Odisha. Basically, it provides employment opportunities to the local people based on their locational advantages.

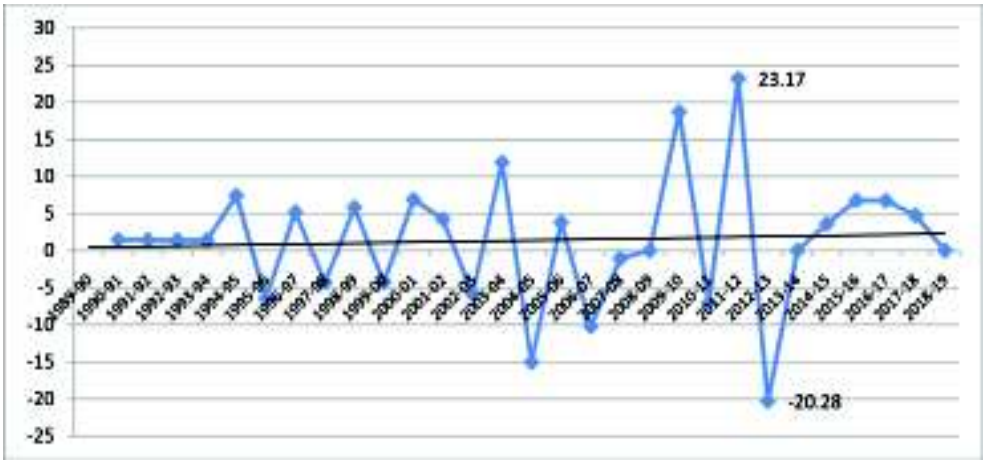
Figure 5: Employment in the Mining Sector



Sources: Directorate of Mines, Odisha, and Economic Survey of Odisha.

Figure 5 presents the number of people who are working in the mining sector. There is a narrow variation of employment data over the period. The results find that the mining sector provides employment to about total 43705 numbers of workers both in 2008-09 and 2009-10 which is a minimum over the periods. In the year 2012-13, the data reported that the highest number of workers (59417) are employed. Figure 6 shows the growth rate of employment from 1989-90 to 2018-19. The highest growth rate of employment is about 23.17 per cent in the year 2011-12 and the lowest growth rate of employment is about -20.28 per cent in the year 2012-13. The results from the trend line revealed that the growth rate of employment has increased over the period.

Figure 6: Growth Rate of Employment (Percentage)



4.4: Descriptive Statistics and Estimation of the Production Function

Table 1 presents the descriptive statistics of input variables such as capital stock and employment and output variablessuch as total turnover of the production function. The results found that the mean value of total turnover, capital stock and employment is Rs. 1230 crores, Rs. 238 crores and 49467, respectively. The results from standard deviation, minimum and maximum values show that there is more variation in the total turnover and capital stock data. The input variables and output are standardised by taking the natural logarithm in the C-D production function. The mean value of ln(total turnover), ln(capital stock) and ln(employment) is 22.25, 19.89 and 10.79, respectively.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Total turnover (in crores)	30	1230	1380	27	4240
Capital stock (in crores)	30	238	375	1.85	1310
Employment	30	49467	8049	23753	58600
lnturn	30	22.25	1.63	19.41	24.47
lncapital_stock	30	19.89	2.18	16.73	23.29
lnemp	30	10.79	0.19	10.08	10.98

The C-D production function is estimated using the stochastic frontier production model of Battese and Coelli (1995). As expected, the sign of employment and capital stocks have shown positive and signsignificance1 per cent and 10 per centlevels respectively and the Wald Chi-square is also positive and significant at a 1 per cent level of significance. The results found that there are increasing returns to scale in the mining industries in Odisha. Further, the results found that the mean value of technical efficiency and productivity of the mining industry is 0.995 and 1.07, respectively.

Table 2: Estimation of Production Function of the Mining Sector

Variables	Coef.	Std. Err.	z	P>z
Dependent variable: lnturn				
lnemp	0.97*	0.58	1.68	0.09
lncapital_stock	0.66***	0.05	12.83	0.00
_cons	-1.21	5.47	-0.22	0.82
Wald chi2(2)	553.82***			
Technical Efiiciency	0.995			
Total Factor Productivity	1.07			
No. Obs.	30			

Note:*, *** represents 10% and 1% level of significance respectively

The technical efficiency and total factor productivity of mining industries in Odisha are presented in Figures 7 and 8. The lowest technical efficiency and total factor productivity are found in the year 2002-03 and the highest technical efficiency and total factor productivity are found in the year 2009-10. Moreover, the results from trend analysis found that the technical efficiency has declined slightly over the periods whereas the total factor productivity has increased slightly over the periods in the mining industries in Odisha.

Figure 7: Technical Efficiency of Mining Industries in Odisha

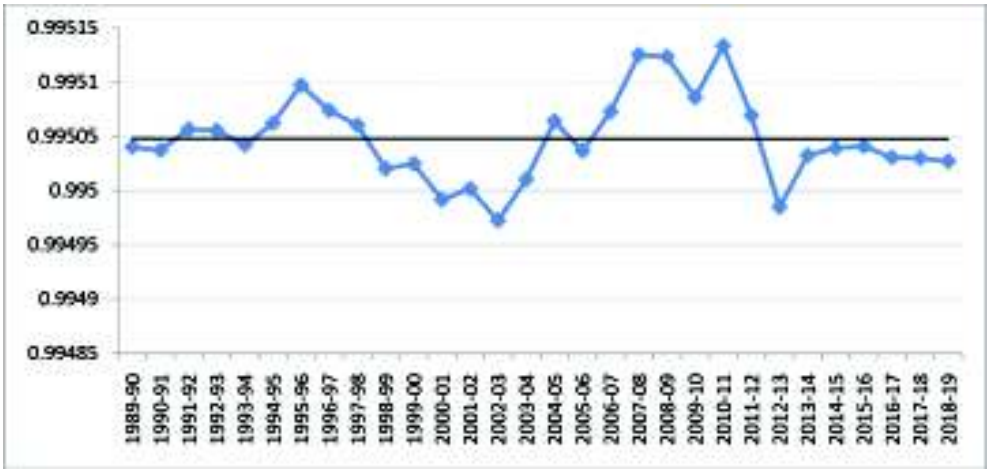
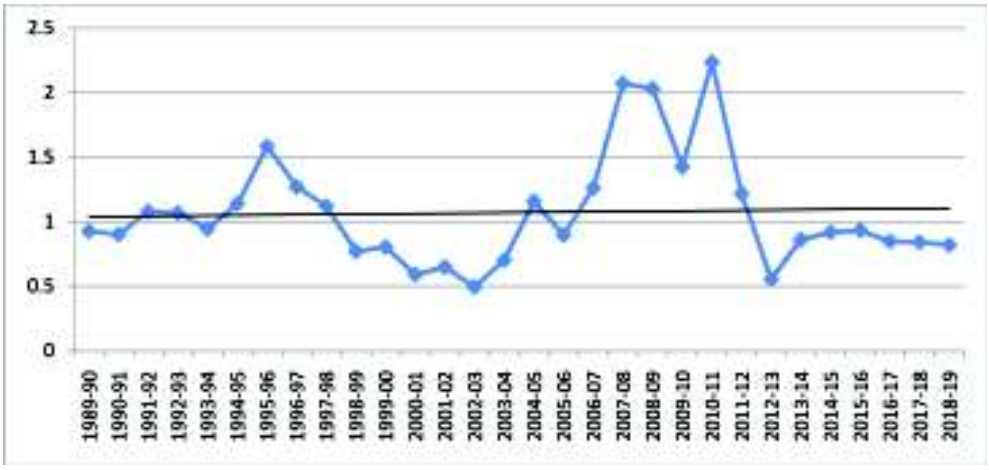


Figure 8: Total Factor Productivity of Mining Industries in Odisha



The main findings of this paper are as follows.The highest growth rate of total revenue was recorded at 69.65 per cent in 2010-11 and the lowest at -11.44 per cent in 2016-17. An upward trend in total revenue in the mining industries was noted. The trend of growth of capital assets over periods has declined. The trend analysis of investment and turnover suggests a steady growth rate of an investment over the periods and whereas the growth rate of total turnover is declining. The mining sector plays an important role in generating employment opportunities; itemployed the highest number of workers with 59417 people in 2012-13 and but, the highest growth rate of employment was achieved at about 23.17 per cent in 2011-12. Employment has increased over the period. Fluctuations were found more in the total turnover and capital stock data than that of employment.

Results from the stochastic frontier production model revealed that the employment and capital stocks have positively significant at 1 per cent and 10 per cent levels, respectively. These indicate increasing returns to scale in the mining industries in Odisha. The mean value of technical efficiency and productivity of the mining industry is 0.995 and 1.07, respectively. The production function pointed to fluctuations in technical efficiency and total factor productivity over the period. However, the technical efficiency has contracted at a slower pace and the total factor productivity has increased at a very slow pace over the period in the mining industries in the state.

The study suggests that the availability of mineral resources is providing a better environment in Odisha. The study suggested that the development does not happen as expected based on the proportion of availability of mineral resources in the state. However, the mining sector provides a very low percentage of employment as compared to total employment provided by other sectors. The mineral rich districts, namely, Jharsuguda, Keonjhar, Koraput and Mayurbhanj continue to remain lagging local economies. The biggest challenge is how to develop these districts through state policies. The government may notify and reregulate the National Mineral Policy (NMP) and environmentally friendly ecosystem to undertake mining activities. The government may provide an appropriate environmental policy to control illegal mining activities and to protect the mining sector in the state.

References:

Battese, G.E. and T. J. Coelli. (1995). A model for technical inefficiency effects in a stochastic frontier production function for panel data, *Empirical Economics,* volume *20*, pp.325–332.

Das, A. (2013). *Performance of Public and Private Mining Firms in India: In Productivity, Environmental and Social Dimensions*, Cambridge Scholars Publishing, Newcastle upon Tyne.

Hilson, Gavin, & Nayee.,Vishal. (2001). Environmental Management System implementation in the Mining Industry. Elsevier, *International Journal of Mineral Processing*, pp.19-41.

Heather., P. Bed. (2013). *Environmental Mis-assessment Development and Mining in Orissa, India.* Published by Institute of Social Studies, pp.101-123.

Jena., Damodar. (2015). Mining and Economy: An empirical inquest with special reference to Odisha. *Orrisa Economic Journal*, Vol. *46*, pp.108-123.

Kujur, M Joseph. (2008*). Development induced displacement in Chhattisgarh: A case study from a tribal perspective Chhattisgarh*. Publish by Social Action. Vol. *58.*

Tawiah,K.A., and Baah.,K. D. (2011). The mining Industry in Ghana: A Blessing or Curse. *International Journal of Business and Science*. Vol.2. No.*12*, pp.62-69.

Wang, Tran, Nguyen. (2015). An empirical studied of Hybrid DEA and Grey system theory on analyzing performance: A case from Indian Mining Industry. Hindawi publishing corporation *journal of Applied mathematics* vol.2015 Article ID 395360, p.15.

Lee, C. Gerhard et al., (1982). *Geological Development Origin and Energy Minerals resources of Williston Basin, Notrh Dakota*. The APPG Bulletin Vol.*66*, Issue 8, pp.989-1020.

Mahanty, Kumari., Ranjita. (2015). Economic and Working condition of Mining labourer in Keonjar distict of Odisha. *Orissa Economic Journal*, Vol.*46*, pp158-167.

Joshi, P. K. et. al. (2008). Assessing impact of industrialization in terms of LULC in a dry tropical region (Chhattisgarh). *Journal of Springer Science and Business Media B.V, Environment Moint* Assess, pp.371-376.

Panda, Gitanjali. (2014). Mining sector its impact on Odisha Economy: Proper utilization of limited resources using forecasting technique. *Journal of Business and Management Science*. Vol.2. No. *3A*, pp.41-45.

Parida, M. and S. Madheswaran. (2021a). *Does Ownership Matter? Empirical Evidence from the Performance of Indian State and Private Coal Mining Companies, Resources Policy*, 74 (C).

Parida, M. and S. Madheswaran. (2021b). Effect of Firm Ownership on Productivity: Empirical Evidence from the Indian Mining Industry. *Mineral Economics,* 34 (2), pp. 87-103.

Sahoo, Minati . (2015). Is Sustainable Mining possible in Odisha? *Orissa Economic Journal*, Vol. *46*, pp.124-146.

Article

Growth of Marine Fish Production in Odisha

Odisha Economic Journal
Volume 53 • Issue 2 • 2021
pp. 116-139
Journal of the
Orissa Economics Association
OEA

P Sujata
Shibalal Meher

Abstract

This paper examines the growth of marine fish production in the state of Odisha, India. To study the growth of fish production semi-log model is used. The non-parametric statistical method such as Mann-Kendall test is utilised to examine the trend in fish production. The magnitude of trend is measured and analysed with the help of Sen's slope estimator. The study is based on the time series data of marine fish production in Odisha during the period 1998-99 to 2019-20. The findings show that there is monotonically upward trend in marine production. But the marine fish production grows at a very slow rate in Odisha. It is suggested that urgent measures may be taken by the policy makers to increase marine fish production in the state to improve the conditions of fisher as well as the growth of GSDP.

Keywords: Marine fish production, Mann-Kendall trend test, Sen's slope estimator, Odisha.

1. Introduction

Oceans comprise the biggest part of the biosphere and contain the most ancient and diverse form of life. Marine organisms represent as vast resources with potential benefits in many areas of life, including mariculture, fisheries, industry, research tools and environment applications.Over the last two decades, fisheries issues have emerged from being merely an obscure sectoral concern to an important growth sector with an expanding role in economic

P Sujata, ICSSR Doctoral Fellow, Nabakrushna Choudhry Centre for Development Studies, Bhubaneswar. Email: psujata11@gmail.com

Shibalal Meher, Professor of Development Studies (Retd.), Nabakrushna Choudhury Centre for Development Studies, Bhubaneswar. Email: smeher62@rediffmail.com

development and food security (James 2007). In recent years, it has emerged as a vibrant sector and is being considered as a strategic sub-sector for promoting agricultural diversification. Fish is an important source of protein, minerals, and essential amino acids. It contributes to the national income, exports, food and nutritional security and in employment generation. It has been recognised as a powerful income and employment generator as it stimulates the growth of a number of subsidiary industries and is a source of cheap and nutritious food, besides being a source of foreign exchange earner.

While the world fish production has increased during the period 1999-2018 the marine fish production as a percentage share in total fish production has declined from 77.35 per cent in 1999 to 64.54 per cent in 2018 (FAO, 2020). However, the share of inland production has increased from 22.65 per cent to 35.45 per cent during the same period. The annual growth of marine fish production is only 0.93 per cent as against 4.71 per cent annual growth of inland fish production.

The fisheries sector plays an important role in the overall socio-economic development of India. With a total fish production of around 13.5 million tonnes during 2018, India contributed around 3.8 million tonnes of the marine fish production and 9.7 million tonnes of inland fish production (Table 1). However, like world fish production, the share of marine fish production in India has declined against increase in the share of inland fish production during the same period. While the share of marine fish production was 49.55 per cent during 1999, it has declined to 28.15 per cent during 2018. It seems that the importance of marine fish production in India has declined as compared to inland fish production. This is despite the fact that the fish production in India has grown at a higher rate than that at the global level in both marine and inland domains.

As per Ministry of Fisheries, Animal Husbandry & Dairying (2020), India is a leading fish producing country and second major producer of fish through aquaculture in the world. India contributes about 7.7% to the global fish production and country ranks 4th in global exports of fish products. The top seven capture producers (viz., China, Indonesia, Peru, India, the Russian Federation, the United States of America and Viet Nam) accounted to almost 50 per cent of total global capture fish production (FAO 2020).

Fishing is a traditional activity, but after India commenced with the First Five-Year Plans, marine fishery sector has developed into a significant commercial enterprise and became more comprehensive and representative in fisheries globally, with both marine and inland fisheries. The estimate of landings of marine fishery resources along the coast in the main land of India for the year 2019-20 is 37.27 lakh tonnes. Gujarat holds the first position for the past few years, with 7.01 lakh tonnes in 2019-20 compared to 6.99 lakh tonnes in 2018-19 accounting for 18.8% of the total landings in the country, followed by Tamil Nadu with 5.83 lakh tonnes (15.64%), Andhra Pradesh 5.64 lakh tonnes (15.13 %), Kerala 4.75 lakh tonnes (12.75%), Maharashtra 4.43 lakh tonnes (11.89 %), Karnataka 4.03 lakh tonnes (10.81%) in 2019-20. Odisha has a share of 4.24 per cent in total marine capture fish production in the country in 2019-20 and stands the lowest in comparison with other major maritime states (Government of India 2020). The compound annual growth rate of marine fish production during 1998-99 to 2019-2020 for various states showed that marine fish production has positive growth in all states except Kerala and West Bengal (Table 2). Though Odisha has a positive growth in marine capture fish production, the growth is lower than that in all-India. With the above background, the present study has made an attempt to study the factors responsible for low growth of marine capture fish production in Odisha.

2. Review of Literature

Marine capture fisheries are undergoing tremendous changes due to increasing fishing effort. Fisheries sector is continuously attracting the concentration of researchers, agricultural scientists, economists, environmentalists as well as policy makers. In the following, the earlier literature have been reviewed to assess their contribution to knowledge, identify gaps and indicate scope for further research.

Ganesh Kumar et al (2010) stated that with the changing composition patterns, emerging market forces and technological developments, the fisheries sector has assumed added importance in India. The development of technology has completely transformed the traditional backyard activity into a booming commercial enterprise. To sustain this growth of the sector in general, technology, infrastructure and market play major roles as enhanced investment in research and development. Technology had been the main factors responsible for the phenomenal growth.

Dash and Patra (2014) analysed the development of fisheries sector in Odisha, a poor coastal state in India, by estimating the trend growth rate and instability indices during the pre- and post-WTO (World Trade Organisation) periods. The results indicate that both production growth and instability have been lower in the post-WTO period relative to the pre-WTO period. While production growth has slowed down because of lower growth in exports following the WTO conditions, instability has declined mainly due to underproduction. Further, the growth rate has been slower and instability lower in Odisha's marine fisheries sector relative to the national scenario notwithstanding the fact that both India and Odisha have come under uniform WTO guidelines and conditionality.

Adiga et al (2015) explained that marine fish production from capture fisheries in India has increased by about six folds during the past six decades. Marine fisheries in India are facing problems of excessive fishing pressure, over exploitation of majority of marine fisheries resources, reduced catch rates, catching juveniles and discards. Over the years, with the help of government schemes and supports, fishing has undergone drastic mechanization leading to imbalance in exploitation across the regions and among the resources. However, in recent years, growth in marine fish production has almost been stagnant. Therefore, monitoring the exploited marine fishery resources at regional level is very important for effective fisheries management for sustainability. It is very important to assess the status of commercially important marine fishery resources to understand their trend over a period of time.

Ancy and Raju (2016) examined the growth trends in marine exports from India and Kerala. Marine fisheries in India, including Kerala are currently passing through a crisis mainly due to stagnation in production, higher operational cost and low profitability. Kerala's fish production and export scenario have transformed due to compliance with WTO regime, stringent regulations from the US Food and Drug Administration, EU regulations and due to social and economic issues. This study examined the profile, the production, export trends, destination changes, product diversification, technological innovations, recent challenges and issues of the fisheries sector. Diversification of production by introducing new commercial species, adoption of new technologies and introduction of processing units for value added products could add new dimensions to the sector.

Sharma (2017) tried to analyse the growth and instability of inland fish production in India. Fish production has increased from 41.57 lakh tonne (24.47 lakh tonne for marine and 17.10 lakh tonne for inland fisheries) in 1991-92 to 95.79 lakh tonne (34.43 lakh tonne for marine and 61.36 lakh tonne for inland fisheries) in 2013-14. It is found that while inland fisheries production has registered a robust growth during this period, the growth in marine fisheries has been slower.

Anuja et al (2017) investigated the trends in marine fish production in Tamil Nadu. Yearly fish production data for the period of 1988-1989 to 2012-2013 were analyzed using Autoregressive Integrated Moving Average (ARIMA) model and Regression analysis (curve estimation). Both the models indicated that Tamil Nadu marine fish production has plateaued and fishermen should be encouraged to adopt sustainable fishing practices.

Gowsalya et al (2019) examined that Inland fishery resources have significantly contributed in fisheries sectors. In this regard, trend of inland fish production of Tamil Nadu was analyzed based on the available resources and utilization and seed production for the last decade. The study was attempted to evaluate the relationship between fish seed production and inland fish production based on time series and utilization of potential of inland water bodies in Tamil Nadu.

Siby and Arunachalam (2020) analysed the growth and instability trends in production and export of fish from India. The instability analysis of fishery sector is done in the production of marine fishery and inland fishery and also in the export volume and value of marine fishery from India for the period 2010-11 to 2017-18 using Coefficient of Variation (CV) and Cuddy Della Valle (CDV) index. They concluded that marine segment of Indian fishery is going through a rough weather. The government needs to do remedial measures to check the fast depletion of resources in marine fishery and at the same time it has to find ways to better utilize the potentials of deep-sea fishing.

Pal and Upadhyay (2020) attempted to study the potential of fish export from West Bengal over the years and to find the appropriate model to characterize the dynamics of export trend in West Bengal. The data of fish export over the years were analysed to find a simple trend/pattern over

the years and further tested by Mann-Kendall trend test which revealed that there is a statistically significant increasing trend in the export data sets of West Bengal.

Mulumpwa et al (2020) aimed to study modelling and forecasting Catfish (Mlamba) species yield from artisan fishery on Lake Malawi in Mangochi District as they are becoming important food fish due to decline of more important fish species such as Oreochromis (Chambo). Most of the wild fish stocks in Malawi either are fully or overexploited. This challenge underpins importance of forecasting using available data to support sustainable fisheries management. Graphical analysis method and Mann Kendall test were used to detect the presence of trends in the time series data set for Catfish and it was found that the possibility that the fishery is being overexploited cannot be ruled out. As such, policy makers should ensure that the fishery is sustainably exploited while maintaining the stable trend.

Boruah et al (2020) used Box-Jenkins model to estimate the trend and growth rate of inland and total fish production in India from 1978-2018. They found that marine fish production has decreased from a share of 71.01% in 1951 to 29.26% in 2018. The production pattern has been shifted from marine to inland. Since the population of India is still growing, to meet the future demand for fish, they suggested for a need to focus more on advanced methods of fish production.

Rajani and Balasubramanian (2021) said that the marine fisheries sector in India has witnessed a phenomenal growth during the last five decades both quantitatively and qualitatively. They studied the marine capture production data from 1985 to 2011 pertaining to three costal states of India such as West Bengal, Andhra Pradesh and Kerala. Marine fish productions of different groups from the states of West Bengal and Andhra Pradesh had good correlation except with Kerala where even negative production was observed especially in crustacean production.

The above studies are mostly concentrated on the growth trends of fish production and their instability at all-India level. The focus on the individual states are however limited. This paper fills this gap by analyzing growth of marine fish production in Odisha, which has remained almost stagnant over the last decades.

3. Marine Fishing in Odisha

The marine environments of Odisha provide enough scope and opportunity for the development of fisheries in the state. The state is fortunately gifted with abundant fishery resources, both marine and inland, which still remain underexploited to a large extent. Fishery resources are classified broadly as pelagic and demersal based on their distribution in the water column. Pelagics are diverse group of small to large fishes which occupy mainly the surface and column layers of the water mass. Most of them are characterised by their shoaling behaviour such as oil sardine, ribbon fishes, carangids, mackerels, other sardines, Bombay duck, anchovies, other clupeids, tunnies. Large numbers of species which are either bottom dwelling or inhabiting mainly along the lower layers of water column are termed as demersal resources such as perches, croakers, silverbellies, catfishes, lizard fishes, flat fishes, elasmobranchs, pomfrets, and goat fishes. Other marine resources are like crustaceans such aspenaeid prawns, non-penaeid prawns, crabs, stomatopods and lobsters; molluscs such as squids, cuttle fish, octopus, bivalves and gastropods (CMFRI 2013).

In the continental shelf waters of Odisha coast, the important pelagic resources comprise of Oil sardine, Hilsa Shad, Anchovies, Ribbon fish, Indian Mackerel, Seer fish. The important demersal resources are Eels, Cat fish, Perches, Sciaenids, Pomfrets. Many researchers have concluded that the demersal fishery potential of Odisha is much higher than its pelagic fisheries. Odisha has vast resources; it is possible to augment fish production in a big way. The maximum sustainable yield for Odisha in the marine sector is 2.9 lakh MT.

From Table 3 it is observed that the commercially important pelagic resources like sardines, lesser sardines, anchovies, mackerels, seer fishes, and carangids show a positive growth rate except for hilsa shad and ribbon fish in Odisha coast during 2003-04 to 2019-20. Hilsa shad is less abundant in Odisha coast and the landings of Hilsa shad continued to decline from previous years. Hilsas are sensitive species. They live in salt water that moves to freshwater for breeding and the hatchlings go back to the sea water and repeat the cycle. One of the main reasons for the decline of the hilsa population is the abundant use of gill nets by fisherfolk, indiscriminate exploitation of a large amount of juvenile hilsa leading to over exploitation, siltation in river beds, decrease in water flow from upstream, climate change

and pollution are other reasons. Overfishing in the bay is a major cause of declining Hilsa catch. Overfishing happens when more fish are caught than the population can replace through reproduction.

The increase in pelagic production was due to motorization of country crafts and introduction of multiday fishing. The demand for demersal groups increased significantly over the years due to increased export demand. The demersal fishes like catfishes, perches, flat fish shows positive growth rate and items like pomfrets, croakers, silver bellies, elasmobranchs show a negative growth rate during 2003-04 to 2019-20. Among six coastal districts in Odisha, a large quantum of marine fish landing was shared by two districts namely Balasore and Jagatsinghpur in 2019-20.

After agriculture, fishery can be termed as the backbone of the coastal Odisha economy. The marine fishery of Odisha assumes importance both in relation to domestic market and export earnings. Fishery has been a traditional occupation of the coastal inhabitants of Odisha. The continental shelf of the Odisha coast is up to 200m depth covering an area of 24,000 sq. km which is 4.5% of the total area of the country's continental shelf. In Odisha, the total fish production (both inland and marine) has increased from 259642 tonnes in 2000-01 to 816464 tonnes in 2019-20. While the marine fish production has increased from 121086 tonnes in 2000-01 to 157312 tonnes in 2019-20 (29.92%), the inland fish production has increased from 138556 tonnes in 2000-01 to 659152 tonnes in 2019-20 (375.73%). As per Directorate of Fisheries Odisha, the sector has exported 66654 tonnes of marine products to foreign countries and earned a foreign exchange of 3243.29 crores in 2019-20. The contribution of fisheries to the total GDP in 2018-19 became 1.53 per cent. The contribution of fisheries GDP to total agricultural GDP increased from 6.82 per cent to 12.23 per cent during the period 2011-12 to 2018-19. Most fishing activity is in coastal waters; deeper waters remain untouched. Actual fish production from Odisha waters is higher than the figures show. The reason being trawlers from Andhra Pradesh and West Bengal fish in Odisha but land their catches in their respective states. Many Odisha trawlers also land their catches in Digha, West Bengal.

A vast coast line is an important gift of nature to the state. The state stands sixth among the states and union territories in India in terms of exposure to sea line with a coast of 480 kilometres. The state has six maritime districts namely Puri, Jagatsinghpur, Bhadrak, Balasore, Kendrapada and Ganjam. Table 4 states that Kendrapara shows a negative growth rate (-1.6%) in

marine fish landing during the period 2000-01 to 2019-20 and it is due to the fluctuations in marine fish production during the study period. According to the marine fisheries census 2016 (CMFRI), there are 1, 15,228 fishermen families in the state with a population of 5,17,623. Of the total fisher folk population, Balasore accounted for 45 per cent followed by Jagatsinghpur (16%), Kendrapara (13%) and Puri (11%). Adult males constituted 31%, adult females 28% and children 41% of the marine fisher folk population in Odisha. Among the six coastal districts, the largest proportion of fishermen families below poverty line was found in Balasore (49%) followed by Puri (13%) and Jagatsinghpur (12%).

About 260210 fishermen are occupied in active and fishing allied activities out of which 62% of the fisher folk are engaged in active fishing and 38% in fishing allied activities. There are 1,62,411 active fishermen of whom 99,972 are fulltime fishermen, 35,609 part-time and the rest engaged in fish allied activities like marketing, labourers, making/repairing net, curing/processing and peeling.

4. Material and Methods

4.1. Data

The analysis consists of year wise data on fish production in India and Odisha and the study period is from 1998-99 to 2019-20. Secondary data on fish production of India, Odisha and different maritime districts of Odisha were collected from reports of Central Marine Fisheries Research Institute (CMFRI), Marine Products Export Development Authority (MPEDA), Handbook on Fisheries Statistics published by the Government of India, Handbook of fisheries published by FAO, Fisheries at Glance published by Directorate of Fisheries, Government of Odisha and concerned government departments and other published sources for analysing the growth of fish production.

4.2. Methodology

The compound annual growth rate of fish production is estimated by fitting a semi-log trend equation of the following form:

$$logY = log(a)+t.log(b)$$

Where Y denotes time series data on production of fish, 't' is the trend term, 'a' is the constant coefficient and 'b' is the slope coefficient. The compound annual growth rate can be calculated using the following equation:

*CAGR = [antilog (log b)-1]*100*

The trend in the production of fish is calculated by using Mann-Kendall's (Mann, 1945 and Kendall, 1975) and Sen's Slope non-parametric trend test. These tests commonly used to show the significance in the time series data. The aim behind the Mann-Kendall (M-K) test is to factually evaluate if there is a monotonic upward or descending pattern of the variable of interest after some time. The non-parametric tests are prominent and well suited for non-normally distributed data. The existence of monotonic trends in the given time series data is examined by using the Mann-Kendall test.

The Mann-Kendall tests tatisticiscal culated as

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} sgn(x_j - x_i)$$

The application of trend test is done to a time series xi that is ranked from i = 1, 2, ……n-1 and xj , which is ranked from j = i+1,2,…….n. Each of the data point x_i is taken as a reference point which is compared with the rest of the data points x_j so that

$$sgn(x_j - x_i) = \begin{cases} 1, & if\ x_j - x_i > 0 \\ 0, & if\ x_j - x_i = 0 \\ -1, & if\ x_j - x_i < 0 \end{cases}$$

A positive value of S indicates that there is an upward (increasing) trend (e.g. observations increase with time) while the negative value of S means that there is a downward (decreasing) trend. The conclusion about how strongly the two variables are monotonically related is made based on Kendall's correlation coefficient, generally known as the Kendall's tau, which is an effective and general non-parametric method of measuring the correlation between two variables. Kendall's correlation coefficient takes the value between -1 to +1. The sign of the coefficient indicates the sign of the slope of relation, i.e., decreasing or increasing trend and the absolute value indicates the strength of the relationship (Hirsch and Helsel, 1993).

Kendall's tau is defined as *tau* = S/D where

$$D = \begin{cases} \sqrt{\left\{\frac{n(n-1)}{2} - \sum_{i=1}^{p} t_i(t_i-1)\right\}\sqrt{\frac{n(n-1)}{2}}} & if\ tied \\ \frac{n(n-1)}{2} & no\ tied \end{cases}$$

A positive value of tau indicates that there is an upward (increasing) trend while a negative value of tau means that there is a downward (decreasing) trend. If tau is significantly different from zero, then based on the data, H0 can be rejected at a pre-selected significance level and the existence of a monotonic trend can be accepted.

The magnitude of the trend is computed by a simple non-parametric method developed by Sen (1968) which is commonly called Sen's slope. Sen's Slope estimator is an adequate tool to determine the magnitude of trend. Generally, the magnitude of trend is measured in terms of ratio, this ratio can give an idea about trend, i.e., either falling or rising or remaining relatively constant. A non-parametric test is taken into consideration over the parametric one since it can evade the problem roused by data skewness (Smith, 2000). It is an adequate tool to determine the magnitude of trend in time series. It is preferable to linear regression, because it limits the in?uence of outliers on the slope (Hirsch et al 1982).

The Sen's slope test statistics is computed by

$$T_i = \frac{y_j - y_k}{j-k} \quad for\ i = 1, 2, \ldots, N$$

Where y_j and y_k are data values at time j and k (j>k) respectively. The median of these N values is represented as Sen's estimator of slope, which is given as:

$$\beta = \begin{cases} T_{\frac{N+1}{2}} & N\ is\ odd, \\ \frac{1}{2}\left(T_{\frac{N}{2}} + T_{\frac{N+2}{2}}\right) & N\ is\ even \end{cases}$$

If β is positive, it indicates incresing trend otherwise decreasing trend.

5. Results and Discussion

Odisha is a maritime state with a rich coast line, favourable continental shelf and has enough potentiality in terms of marine fish production. The basic statistics of the time series data show that average marine fish production during 1998-99 to 2019-20 is 1.30 lakh tonnes in Odisha against 31.94 lakh tonnes in all India (Table 5), showing the share of 5.45 per cent. On the other hand, average inland fish production in Odisha is 2.87 lakh tonnes against 52.65 lakh tonnes during the study period with a share of 4.07 per cent. It is revealed from the table that the production of fish is positively skewed. The test of normality reveals that the data are non-normal (Table 6). Hence, non-parametric trend test is adopted for non-normally distributed data.

The trend in the production of fish in Odisha can be seen from Figure 1. It is found that there is increasing trend in the production of total fish in Odisha. While the trend in the production of inland fish is found to be increasing, it is almost constant for marine fish production, indicating that the production of marine fish has remained stagnant in Odisha.

It is observed that the total fish production in Odisha grows at the compound annual rate of 5.20 per cent during 1998-99 to 2019-20 as against 4.71 per cent at all-India level (Table 7). During this period, the inland fish production grows at a much higher rate than the marine fish production in Odisha as well as in all-India. The growth rate of marine fish production in Odisha is 1.16 per cent during 1998-99 to 2019-20, which is marginally lower than that in all-India (1.62%). However, marine fish production in Odisha has a higher growth than all-India in the latter half of the study period, i.e. during 2009-10 to 2019-20. Still marine fish production in Odisha is not satisfactory as there are underexploited resources.

The M-K test has been employed to analyse the monotonic trends for indicator wise and segmentation period wise fish production. Table 8 provides the results of the tests of Mann-Kendall and the estimates of the Sen's slope statistics. The time series data pertaining to fish production in Odisha as well as India are analysed using the Mann-Kendall trend test for assessing the trend present in the data. It is evident from Table 7 that inland and total fish production in Odisha as well as all-India have upward monotonic trends during the period 1998-99 to 2019-20 as well as in both

the segments, i.e. 1998-99 to 2008-09 and 2009-10 to 2019-20 indicated by the positive value of tau (?). The p-value signifies the trend of production which is statistically significant at 95% confidence level in both time periods. However, the marine fish production show significant upward trend only during the total study period as well as in the second segment, i.e. 2009-10 to 2019-20 but not in 1998-99 in both Odisha and all-India. Sen's slope is found to be lower in Odisha than in all-India, indicating that growth of marine fish production in Odisha is slower than all-India. This indicates that though there is improvement in the growth of marine fish production in both Odisha and all-India, still Odisha is lagging behind all-India.

Odisha is one of the important maritime states of India having excellent scope for fisheries development. It bagged "Best Marine State" award on World Fisheries Day-2020 from the Ministry of Fisheries, Animal Husbandry & Dairying. But the results of the trend analysis revealed that while the inland fish production has increased over the years, the marine fish catch remained almost stagnant for the last decades between 1998-99 and 2019-20 even though there are some rises and falls in Odisha.

The marine fisheries in Odisha is underexploited and needs more investment. Presently in 2019-20, there are 8452 traditional boats, 9281 motorised boats and 1741 mechanised boats in Odisha coast. Such trawlers are usually going till 60-70 km into the sea where the stalks are declining which is one of the reasons for slow growth of marine fish production. The fishermen have to venture beyond 60-70 km distance into the sea which will not put pressure on stalks because the coastal areas are over-fished resulting in depletion of certain species like Hilsa. What the state government needs to focus is to plan out introduction of deep-sea trawlers to the Odisha coast after imparting proper training and guidelines to fishermen. Such steps are required to develop the marine catches mainly through deployment of deep-sea trawlers. There is an urgent need for looking forward the unexploited or least exploited resources so as to meet demand towards the nutritional security. Deep-sea fisheries are those that take place at great depths for fishing tuna and tuna-like species.

The Odisha fishery sector can be more efficient by harvesting strategies on development of new technology. There is a growing need to contribute to technological capacity for the building potential use in the fishing sector. Efforts are expected from government to promote the deep-sea fisheries.

But Odisha needs to be equipped with not only fleets of deep-sea trawlers, but it must also have adequate infrastructure facilities for processing marine products. One of the most important factors for the economic losses of fishery is due to inadequate post infrastructure facilities (Table 9). Being a highly perishable quantity, fish requires proper landing facilities, processing, storage, transport and distribution facilities running through the entire supply chain from capture to consumer. Technological development starting from fishing craft and gear, preservation and processing of fish, packaging and transportation will greatly contribute to the quality of sea food products. Fish production could be increased only marginally, but the unit value of the marine fish products can be increased by reducing post-harvest losses. Processing helps reduce food loss and waste, thus reducing the pressure on the fisheries resources, and fostering sustainability of the sector.

Fish products are unpredictable in regards to quantity production and it is utmost important on the part of fishing industry to manage the seasonal fluctuations by maintaining a balance with a proper established distribution system. Suitable arrangements in preservation after the catch is placed on board or landed so as to maintain its freshness and the quality of the whole. Techniques of cold storages and frozen storage are important parts of the fishery industry and they are expected to become all the more important in future. Availability of cold storages and freezer facilities for preservation in producing areas is essential so that production and consumption is not hampered. Further, development of well-connected distribution system for ready transport of the products to distant places is required so as to prevent losses. Improving the quality of the value-added fishery products and making it more appealing will attract new consumers by bringing Odisha into more sophisticated industrial processing development.

6. Conclusion

The paper has analysed the growth of marine capture fish production in Odisha. The results revealed that there is monotonic upward trend in marine fish production. But the growth of marine fish production in Odisha is very slow compared to the inland fish production. While the inland fish production has increased over the years, the marine fish catch remained almost stagnant during 1998-99 to 2019-20 even though there are some rises and falls in Odisha. At the same time, Odisha is lagging behind all-India in the growth of marine fish production. Odisha's marine fisheries is

underexploited and needs more investment. Efforts are expected from government to promote the deep-sea fisheries. Odisha needs to be equipped with not only fleets of deep-sea trawlers, but also adequate infrastructure facilities for processing marine products. For fisheries production to go up, and the condition of fishers to improve, various measures needs to be taken by the state government without delay. Many initiatives are already made by the government and still further needed to improve the growth of marine fish production.

Figure 1: Trend in the production of fish in Odisha

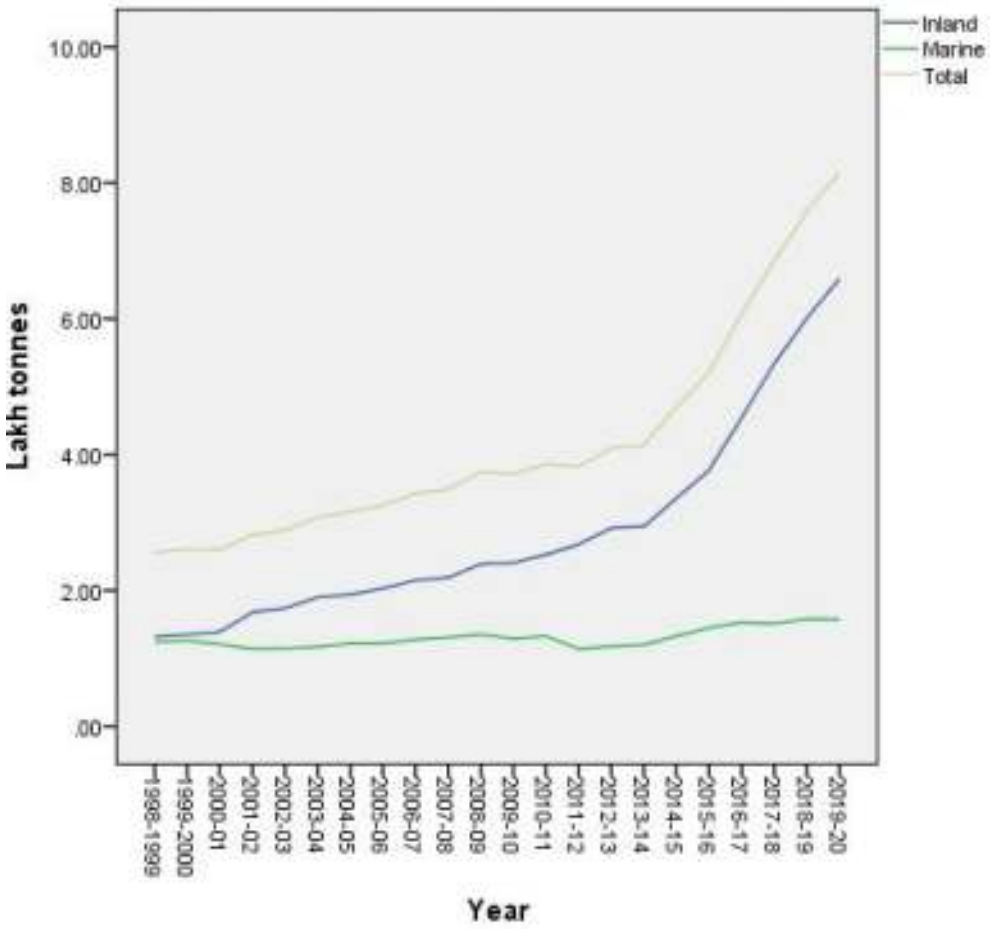


Table 1: Fish Production in India (in Lakh Tonnes)

Year	Marine	Inland	Total	Marine fish production as % of total fish production	Inland fish production as % of total fish production
1999	2.78	2.83	5.61	49.55	50.45
2000	2.76	2.85	5.61	49.20	50.80
2001	2.80	3.09	5.90	47.46	52.37
2002	2.96	2.96	5.93	49.92	49.92
2003	2.96	3.07	6.03	49.09	50.91
2004	2.88	3.31	6.19	46.53	53.47
2005	2.87	3.79	6.66	43.09	56.91
2006	3.04	3.99	7.03	43.24	56.76
2007	3.09	3.88	6.97	44.33	55.67
2008	3.36	4.60	7.95	42.26	57.86
2009	3.29	4.57	7.86	41.86	58.14
2010	3.28	5.19	8.48	38.68	61.20
2011	3.27	5.61	8.88	36.82	63.18
2012	3.32	5.92	9.24	35.93	64.07
2013	3.44	6.34	9.78	35.17	64.83
2014	3.57	6.89	10.46	34.13	65.87
2015	3.64	7.18	10.82	33.64	66.36
2016	3.60	7.80	11.40	31.58	68.42
2017	3.70	8.90	12.60	29.37	70.63
2018	3.80	9.70	13.50	28.15	71.85
GR (%)	1.62	6.91	4.71		

Source: Government of India, 2020.

Table 2: Valuation of Marine Fish Landings by State (1998-99 to 2019-20) (Lakh Tonnes)

States	Average landing (1998-99 to 2019-20)	Minimum Value	Maximum Value	CV (%)	Growth rate (%)
Andhra Pradesh	3.66	1.83	6.05	40.54	6.84
Goa	0.91	0.32	1.18	23.71	2.74
Gujarat	6.73	5.85	7.44	5.84	0.59
Karnataka	2.84	1.28	4.14	36.89	6.32
Kerala	5.50	4.14	6.09	10.31	-1.26
Maharashtra	4.36	3.87	4.75	6.02	0.74
Odisha	1.31	1.14	1.59	11.35	1.48
Tamil Nadu	4.17	3.08	5.83	16.43	2.41
West Bengal	1.78	1.52	1.97	6.04	-0.28
Andaman & Nicobar Islands	0.33	0.12	0.40	19.82	2.76
Daman & Diu	0.20	0.11	0.32	30.43	3.62
Lakshadweep	0.15	0.08	0.30	35.79	4.24
Puducherry	0.38	0.19	0.47	16.08	1.28
Total	32.32	27.79	38.53	10.99	1.78

Source: Calculations based on Report of Handbook on Fisheries Statistics 2020, Government of India, 2020.

Table 3: Valuation of Marine Fish Landings in Odisha by Resource (2003-04 to 2019-20)

Fish Resources	Average landing (2003-04) to (2019-20)	Maximum rate	Minimum rate	CV (%)	Growth rate (%)	% Contribution in total production (2019-20)
Elasmobranches	4265.87	5774	1199	23.04	-0.69	2.37
Oil sardine	5334.02	7455	1502	35.81	3.99	3.39
Other sardines	3687.34	5618	746	39.20	4.47	3.57
Hilsa shad	3592.93	5978	1876	31.92	-1.83	1.95
Anchovies	3574.69	5644	557	39.66	7.65	3.49
Silver bar	22999.64	2822	1342	16.03	-0.09	1.51
Ribbon fish	6954.68	12268	3152	34.79	-0.69	4.91
Carangids	3228.26	4677	1130	28.72	3.99	2.89
Indian Mackerels	4953.87	8609	1856	33.18	2.09	3.46
Seer fish	3111.09	4540	1679	32.25	5.44	2.87
Mullets	5657.70	7451	2659	26.18	1.16	4.68
Catfish	7508.93	10114	1619	29.94	1.39	6.39
Perches	3443.88	6645	1564	47.96	5.93	3.11
Croaker	10018.72	12535	6551	17.32	-1.14	6.91
Silver bellies	2246.11	5637	1029	47.56	-0.69	0.79
Pomfret	7548.77	9954	4872	18.94	-1.83	4.67
Flat fish	1740.40	2532	1093	24.02	2.09	1.61
P shrimp	10515.75	14244	6116	18.66	1.16	7.86
Non-P Shrimp	3226.46	7233	1543	46.67	2.80	1.97
Crustaceans	2120.92	3807	1085	38.60	5.44	0.43
Cephalopods	2667.65	3541	2014	15.80	0.93	2.05
Total	133444.65	158321	114296	10.89	1.62	100.00

Source: Calculations based on Report ofDirectorate of Fisheries, Odisha

Table 4: Valuation of Marine Fish Landings by District (2000-01 to 2019-20)

District	Average l landing (2000-01 to 2019-20)	Minimum Value	Maximum Value	CV (%)	Growth rate (%)
Balasore	34568.6	27234	43133	12.57	1.09
Bhadrak	11417.6	9216	13358	10.62	1.32
Jagatsinghpur	34009.7	28196	42725	13.60	1.74
Kendrapada	8584.5	4798	13594	27.23	-1.60
Puri	30772.8	11659	39598	21.39	1.69
Ganjam	11566.1	6777	30989	41.86	3.20
Total	130919	113893	158321	11.25	1.47

Source: Calculations based on Report of Directorate of Fisheries, Odisha

Table 5: Descriptive Statistics for the Time Series Data of Fish Production in India and Odisha: 1998-99 to 2019-20

Parameter	Mean	Median	Standard Deviation	Standard Error	Skewness	Kurtosis	Minimum	Maximum
All India								
Inland	52.65	47.66	23.22	4.95	0.91	-0.12	26.02	104.37
Marine	31.94	30.64	3.69	0.79	0.40	-1.31	26.96	38.53
Total	84.58	78.07	26.76	5.71	0.84	-0.35	52.98	141.64
Odisha								
Inland	2.87	2.40	1.50	0.32	1.33	0.96	1.32	6.59
Marine	1.30	1.27	0.14	0.03	0.83	-0.44	1.14	1.58
Total	4.18	3.73	1.63	0.35	1.34	0.91	2.56	8.16

Source: Calculations based on Report of Handbook on Fisheries Statistics 2020, Government of India.

Table 6: Tests of Normality

	Kolmogorov-Smirnov test			Shapiro-Wilk test		
	Statistic	df	Sig.	Statistic	df	Sig.
Marine fish Production	.151	22	.200	.887	22	.017
Inland fish Production	.209	22	.013	.845	22	.003
Total fish Production	.236	22	.003	.834	22	.002

Source: Calculations based on *Report of Handbook on Fisheries Statistics* 2020, Government of India.

Table 7: Compound Annual Growth Rates of Fish Production (%)

	1998-99 to 2008-09	2009-10 to 2019-20	1998-99 to 2019-20
All India			
Inland	5.44	8.39	6.66
Marine	0.69	1.86	1.62
Total	3.28	6.17	4.71
Odisha			
Inland	6.41	11.17	7.15
Marine	0.93	3.04	1.16
Total	3.99	8.89	5.20

Source: Calculations based on Report of Handbook on Fisheries Statistics 2020, Govt. of India.

Table 8: The Mann-Kendall Trend Analysis Results and Sen's Slope Estimator: 1998-99 to 2019-20

Indicators	Segmentation Period	Kendall's tau	p-value	trend at 5%	Significance	Sen's slope
India						
Inland	1998-99 to 2008-09	1	0.0001	Increasing	Significant	1.73
	2009-10 to 2019-20	1	0.0001	Increasing	Significant	5.55
	1998-99 to 2019-20	1	<0.0001	Increasing	Significant	2.99
Marine	1998-99 to 2008-09	0.382	0.119	Increasing	Insignificant	0.21
	2009-10 to 2019-20	0.891	0.000	Increasing	Significant	0.72
	1998-99 to 2019-20	0.827	<0.0001	Increasing	Significant	0.54
Total	1998-99 to 2008-09	0.927	0.0001	Increasing	Significant	2.02
	2009-10 to 2019-20	1	0.0001	Increasing	Significant	6.16
	1998-99 to 2019-20	0.98	<0.0001	Increasing	Significant	3.65
Odisha						
Inland	1998-99 to 2008-09	1	0.0001	Increasing	Significant	0.104
	2009-10 to 2019-20	1	0.0001	Increasing	Significant	0.418
	1998-99 to 2019-20	1	<0.0001	Increasing	Significant	0.142
Marine	1998-99 to 2008-09	0.455	0.062	Increasing	Insignificant	0.015
	2009-10 to 2019-20	0.673	0.005	Increasing	Significant	0.04
	1998-99 to 2019-20	0.532	0.001	Increasing	Significant	0.018
Total	1998-99 to 2008-09	0.964	0.0001	Increasing	Significant	0.119
	2009-10 to 2019-20	0.921	0.0001	Increasing	Significant	0.495
	1998-99 to 2019-20	0.974	<0.0001	Increasing	Significant	0.150

Source: Calculations based on Report of Handbook on Fisheries statistics 2020, Government of India.

Table 9 Infrastructure Facilities for Processing Marine Fish and Fish Products in Odisha, 2021

Particulars	No	Capacity (MT)
Seafood exporter from Odisha	49	900
Processing plants	33	
Storage premises	22	
Freezing plants	26	215.02
Ice plants	57	613.5
Landing centres	69	
Harbours	4	
Fish drying	99	
Cold storage	12	67

Source: Directorate of fisheries Odisha

References:

Adiga, S.M., Ananthan, P.S, Divya Kumari, H.V., and Mallikarjun, H. (2015). An analysis of long term catch trends in marine fishery resources of Karnataka State, India.*Applied Ecology and Environmental Research,* 14(1): 201-213.

Ancy, V.P., and Raju, K.V. (2016). Trends in marine products exports from India: *Issues and challenges. International Journal of Research in Finance and Marketing*, 6(3): 100-112.

Anuja. A, Yadav V. K., Bharti V. S., and Kumar N. R. (2017). Trends in marine fish production in Tamil Nadu using regression and autoregressive integrated moving average (ARIMA) model. *Journal of Applied and Natural Science,* 9(2): 653-657.

Boruah, B.B., Roy, P., Dutta, A., and Hazarika, B.B. (2020). Forecasting marine and total fish production in India using arima models. *Indian Journal of Economics and Business,* 19(2): 161-174.

CMFRI. (2013). CMFRI *Annual Report* 2012-2013. Technical Report. CMFRI, Kochi.

Dash, R.K., and Patra, R.N. (2014). Marine fisheries in India: Issues of growth and instability during the pre- and post-WTO periods. *IOSR Journal of Economics and Finance,* 5(2): 40-51.

FAO. (2020). *The State of World Fisheries and Aquaculture 2020*. Sustainability in Action, Rome.

Government of India. (2020). *Handbook on Fisheries Statistics 2020.* Dept. of Fisheries, Ministry of Fishery, New Delhi.

Gowsalya T., Kanaga V., and Sundaramoorthy B. (2019). Trend analysis of inland fish production of Tamil Nadu with special references to resources and seed production. *International Journal of Current Microbiology and Applied Sciences,* 8(8): 101-107.

Hirsch, R., and Helsel, D. (1993). Statistical treatment of hydrological data. In D. R. Maidment, (ed.), Handbook of Hydrology, McGraw-Hill, New

York.
Hirsch, R.M., Slack, J.R., and Smith, R.A. (1982). Techniques of trend analysis for monthly water quality data. *Water Resources*,18: 107-121.

James, P.S.B.R. (2007). The Indian fisheries sector at the threshold of sixty momentous years of independence: *In retrospect and prospect. CMFRI, Cochin*, 15-51.

Kendall, M.G. (1975). *Rank Correlation Methods*. Charles Griffin, London.

Ganesh Kumar, B., Datta, K.K., and Joshi, P.K. (2010). Growth of fisheries and aquaculture sector in India: needed policy directions for future. *World Aquaculture,* 41(3): 45-51.

Mann, H., B. (1945). Nonparametric tests against trend. *Econometrica,* 13: 245-259.

Mulumpwa, M., Jere, W., Kakota, T., Mtethiwa, A., and Kang'ombe, J. (2020). Modelling and forecasting of catfish species yield from Mangochi artisan fisheries of Lake Malawi in Malawi. *African Journal of Food, Agriculture, Nutrition and Development*,20(7): 16864-16883.

Pal, P., and Upadhyay, A. D. (2020). The potential of fish export from West Bengal: An analysis. Indian Journal of Hill Farming,33(2): 357-359.

Rajani, M., and Balasubramanian, A. (2021). Statistical analysis: Marine capture production of West Bengal, Andhra Pradesh and Kerala. *International Journal of Bio-resource and Stress Management*,12(4): 370-376.

Sen, P. K. (1968). Estimates of the regression coefficient based on Kendall's Tau. *Journal of the American Statistical Association,* 63(324): 1379-1389.

Sharma, H. (2017). Growth and instability of inland fish production in India. *AgroEconomic Research Centre Fishery Technology,* 54: 155-161.

Siby, K.M., and Arunachalam, P. (2021). Growth, instability and demand elasticity of Indian fish exports.MPRA Paper No. 107747.

Smith, L. (2000). Trends in Russian Arctic river-ice formation and breakup. *Physical Geography,* 20 (1): 46-56.

Websites

https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1674522Ministry of Fisheries, Animal Husbandry & Dairying 2020.

https://odishafisheries.nic.in/index06f2. html?p = report & type = 11 Directorate of Fisheries Odisha.

https://www.fao.org/3/ca9229en/ca9229en.pdfThe State of World Fisheries and Aquaculture 2020. https://www.indiaspend.com/uploads/2021/10/14/Marine_Fisheries_Census_INDIA_2016.pdf.

Article

Changes in Production and Labour Regimes in Automobile Industry: A Study from Gurgaon-Manesar Region

Odisha Economic Journal
Volume 53 • Issue 2 • 2021
pp. 140-162
Journal of the
Orissa Economics Association
OEA

Amit Chakraborty
Nayanjyoti

Abstract

The focus of the study is the recent transformations in production regime and its consequences for labour in the Indian automobile sector. In last few decades, the Fordist-Taylorist standardized mass production regime have been transformed to a regime of 'flexibleaccumulation' - marked by 'lean' and 'just-in-time' production and new technologies - withboth continuity and rupture. This transforms the labour regime and working conditions further.In this globalized production process, industrial policy of a particular country is now to attractforeign capital, integrate with global production networks (GPNs) and move up the value chain.This study found that this process has consequences for changes in labour regimes too.Contractualization and informalization of labour, erosion of collective bargaining power oflabour vis-à-vis capital and worsening working condition and job security co-existing with profitaccumulation creates contradictions and conflicts at different levels and influences the dynamicand restructuring of the production process. With field-based case studies from Gurgaon-Manesar-Bawal industrial region in Haryana, a

This is a revised version of a working paper by the authors titled "Changesin Production Regimes and Challenges to Collective Bargaining: A Study of the GurgaonIndustrial Belt" (CSE Working Paper 2018-19, Azim Premji University.

Amit Chakraborty, PhD Scholar, Center for Economic Studies and Planning, Jawaharlal Nehru University, New Delhi.Email: amitdinhata@gmail.com

Nayanjyoti, PhD Scholar, Department of Anthropology, Delhi University, Delhi.
Email: nayanjyoti@gmail.com

leading automobile cluster in India with thepresence of three of India's leading car and two-wheeler producers, namely, Maruti Suzuki, Honda and Hero MotoCorp and hundreds of auto component suppliers shaping the regionalproduction networks, this study explored the transformation in production and labour process onthe shop floor, informalization of labour in production and the dynamic contradiction betweencapital and labour particularly in last one decade.

Keywords: Automobile Industry, Labour Process, Informal Labour, Collective Bargaining.

Introduction

This study focuses on the key transformations in the production and labour process and the consequent effects on composition of labour and collective bargaining mechanism in the automobile sector particularly in last decade, with field based studies from Gurgaon-Manesar-Bawal industrial belt in Haryana, India. The automobile industry is a key sector in manufacturing in India.The attempt to integrate Indian economy with GPNs in last few decades seems partially successful in capital and technology intensive automobile industry. Gurgaon-Manesar-Dharuhera-Bawalindustrial belt in Haryana has been a leading automobile cluster and a major destination of foreign and Indian capital investment in the automobile sector in the post-liberalization period. This region has also emerged as a prominent region of industrial disputes, trade union struggles and capital-labour conflict.

Review of Literature and Research Gap

In last few decades a significant restructuring has taken place in the modus operandi of global capitalism through the trans-nationalization of production i.e., a splitting up of production into segments, which are scattered across various regions or factories across the globe. The traditional production base of the global North has shifted to developing economies of the global South to tap the low-wage non-unionized labour regimes and emerging markets. But it is not just a linear expansion; rather a complex web of networks seems to be emerging, with multiple actors, influences, positive or negative feedback mechanisms or path dependence, affected by local, national and global institutions. Mainstream orthodox economic theories of production function, free market exchange and equilibrium,

international trade theories and so on, cannot satisfactorily explain these transformations. The global value chains (GVCs) or GPN framework, particularly the later, explains this transformationbetter.

Gereffi and Korzeniewicz's work (1994) first theorized Global Commodity Chains to explain the concrete basis of 'globalization'. GCC was described as sets of inter-organizational networks clustered around one commodity or product, linking households, enterprises, and states to one another within the world economy (Gereffi et al, 1994). Later a subtle but significant shift occurred from GCC to GVC, which drew resources from Porter's (1985) 'value-system', a set of inter-linked complete firms, which have all the required business functions, a concept already established in industrial economics. GPN theorists criticized GVC's framework as being restricted and limited in terms of exploring territoriality and the role of various actors, and also criticized the 'chain' metaphor that represented a vertical and linear sequencing (Hess and Yeung, 2006). They argued production networks to be a generic form of economic organization and inherently dynamic, in a process of flux, in the process of 'becoming'- both organizationally and geographically (Coe et al, 2008).

This study prefers the GPN approach to analyze the recent transformations in regional automobile industry in Gurgaon-Manesar region. But similar to mainstream economics, this GPN framework too treats firms and technology like 'black-box', cannot engage with the transformations at the level of shop floor labour process and thus cannot properly accommodate 'labour' as an active subject in the transformation process. Recently,a growing minority of researchers have raised these questions.

There have been some efforts to relocate Marxist class theory in labour process and production networks. An important aspect is of class formation at local/factory level, regional and the national/transnational level. E. P. Thompson (1963) in *The Making of The English Working Class* focuses on the subjective and experiential aspect of 'class formation' that is determined by the production relation in which people enter often involuntarily. Selwyn (2012) emphasizes on some points of importance - "(i) the interactions between the material requirements of commodity production, (ii) attempts by firms to establish a labour force and structure the labour regime around these requirements, within the context of competitive accumulation, (iii) processes of class formation in (and often beyond) the geographical region

of commodity production and, (iv) how workers movements and organizations attempt, sometimes successfully, to structure the socio-spatial environment in their favour." Class formation has an objective basis in the organization of production and labour. It has a subjective dimension- active class conflict and class struggle that coalesces different sections of workers into a common identity and interest of 'working class' as a whole. It generates a sense of class power in its collective action that the individual workers are unable to experience. Eric Olin Wright (2000) makes distinction between two different types of bargaining power of workers that can potentially disrupt the process of production- structural and associational power. Workers have structural power "on the basis of their particular location in the production process and their capacity to disrupt it or stall it" (ibid). It is determined by importance of the commodity manufactured at that location and the structure of value chain governance. Silver (2003) elaborates further on Wright's argument by detailing two types of structural powers possessed by workers - marketplace bargaining power and workplace bargaining power. She notes that, "marketplace bargaining power emerges from tight labour markets because of relatively high employment level and the ability of workers to leave the job and survive on some other income sources". Workplace bargaining power emerges from "the strategic location of a particular group of workers within a key industrial sector". This insight is important for the framework of GPN as well as for this study. The labour agency and subjectivity at the nodes of production networks and the consequences of class action along the supply chain force capital to restructure and deploy counterstrategies. This has been discussed in context of the capital-labour conflict in automobile sector in Gurgaon-Manesar industrial belt. The combination of these two kinds of bargaining powers in opposition to capital articulates the potential and direction of the workers struggle and its capability to assert its agency and influence the dynamics of GPNs. But because of capital's larger mobility and the presence of massive reserve army of labour, it is possible for regional or global production networks to often reconstitute themselves and thus weaken the bargaining strength of working class. In that case, the workers struggle and it's organized form may not be capable of fully retaining the gains made by the struggles in the production process in the factories, in socio-economic context and as institutional reforms within the GPNs. Thus, class formation is not once and for all. Class formation may be reversed into class disintegration for many reasons - because of transformations in production and labour regimes, internal segmentation and informalization,

weakening and collapse of class organizations due to repression and other reasons, flight of capital etc.

Objectives

The objective of the study is to explore the recent transformations in production regime and its consequences for labour in the Indian automobile sector. In last few decades, the Fordist-Taylorist standardized mass production regime has been transformed into a regime of 'flexible accumulation' - marked by 'lean' (Womack et al, 2007) and 'just-in-time' production and new technologies - with both continuity and rupture. This transforms the labour regime and working conditions further. In this globalized production process, industrial policy of a particular country is now to attract foreign capital, integrate with Global Production Networks (GPNs) and move up the value chain. This process has consequences for changes in labour regimes too. Contractualization and informalization of labour, erosion of collective bargaining power of labour vis-à-vis capital and worsening working condition and job security co-existing with profit accumulation creates contradictions and conflicts at different levels and influences the dynamic and restructuring of the production process. With field-based case studies from Gurgaon-Manesar-Bawal industrial region in Haryana, a leading automobile cluster in India with the presence of three of India's leading car and two-wheeler producers, namely, Maruti Suzuki, Honda and Hero MotoCorp and hundreds of auto component suppliers shaping the regional production networks, this study seeks to explore the transformation in production and labour process on the shop floor, informalization of labour in production and the dynamic contradiction between capital and labour particularly in last one decade.

Methodology and Data

The study is based on primary survey work of qualitative nature amongst primarily factory workers/union members done in different time periods between 2011 and 2021. Primary respondents are workers of different segments, plant-level Trade Union leaders and Trade Union activists of the belt, with some inputs from secondary literature, workers magazine and data published by the companies and the government. A preferred methodology to explore the dynamics inside the factory in terms of production and labour regime, labour process and capital-labour conflicts

has been to have small meetings with different sections of workers, with a few workers at a time resulting most of the time in a kind of collective discussions - with union body members, permanent workers of different departments (like, assembly, paint shop, weld shop, etc.), temporary workers of different categories (like, contract workers, TWs, trainees, etc.), terminated workers from a particular factory, and so on. The purpose of this methodology has been to find out the gradual transformations in the organization of production and labour, and the strategies and counterstrategies of labour and capital in the domain of production of each plant through long narratives. Along with these field-based interactions, the company websites with Annual Reports of companies, materials from various journals and websites including Automotive Component Manufacturers Association (ACMA) and Society of Indian Automobile Manufacturers (SIAM), workers magazines, reporting and articles from different mainstream newspapers have been studied.

Analysis and Findings

- The Regional Automobile Production Networks in Gurgaon-Neemrana Industrial Belt

The automobile clusters in Gurgaon-Manesar and Dharuhera-Bawal in Haryana form a contiguous expanding zone of an industrial belt which houses one of the major auto clusters in India. Some parts of the industrial belt are over three decades old, while some are three years old. Its history is rooted in the process of liberalization of the Indian economy from the 1980s. From the beginning of the 1980s, significant restructuring in the Indian automobile industry in collaboration with Japanese MNCs took place. In 1983, Maruti Udyog Limited (MUL), a joint venture of the Government of India and Suzuki Motor Corporation, established its plant in Gurgaon and launched the model Maruti 800 which soon captured a large share of the 4-wheeler segment of the market. To promote indigenization, it had to adopt Phased Manufacturing Program (PMP), following government policy, which required 92 per cent localization of components within 5 years from the start of production. MUL, to reduce its vulnerability of production, attempted to develop a strong base of supplier companies and encouraged its local vendors to adopt flexible practices or advanced technology (Bhargava, 2010). This facilitated the process of establishment of strong supply base of

auto components in Gurgaon-Manesar-Dharuhera industrial belt, which later extended to Bawal industrial area.

Hero Honda, established in 1984 as a joint venture between Hero group and the Japanese Honda company in Dharuhera, launched the four-stroke engine motorcycle in 1985, and it gradually became the market leader. It helped the development of auto cluster in Dharuhera. In 1994, the government de-licensed car production. Following on the heels of Maruti, other global players entered the industrial belt. In 1997, a new government policy allowed the companies to localize 50 per cent of production within 3 years and after that 70 per cent of production within 7 years, thus further liberalizing the market. In 2000, Honda set up its plant in Manesar. Apart from cars, companies were permitted to export components and ancillaries, and as a policy it further promoted the integration of Indian automobile sector to global production networks of the industry. In last one decade, the auto belt has expanded to Tapukara-Khuskhera-Neemrana belt of Alwar district of Rajasthan. All these contributed to a strong regional network of auto assemblers and vendor companies, well connected to global production networks and practices.

In this auto cluster, there is complex web of interactions of lead firms and different tiers of suppliers. In the Auto belt, there is a seemingly vertical structure of production networks, where OEMs (Original Equipment Manufacturers) form 'node' or 'hub'. OEMs are assembler plants and no production of components take place in those plants (unlike Hindustan Motors, the manufacturer of iconic ambassador car, which, under a Fordist model of production, had Foundry and Forging shops and used to produce 1800 components of Ambassador under one shade and used to assemble them). Under 'just-in-time' or 'lean' production model, where there is hardly any inventory in the assembler plants, the 1st tier supplier companies supply components continuously in batches. For example, 1st tier vendor companies like Apollo, MRF, Bridgestone, Ceat, JKTyre etc. supply tyres to Maruti Manesar car plant many times a day. For each component, seats come in each 30 minutes in batches, whereas some components like fasteners come once in 4-5 days. Some components come from Japan too (like some bots for seat and steering, ECU for engine sub-assembly, etc). The OEMs have multiple sources, i.e. 1st tier supplier companies for each component to reduce uncertainly and promote cost-cutting. 2nd tier suppliers are those which supply components to 1st tier suppliers. For example, IJL supplies automotive lighting systems to Maruti Suzuki as 1st tier supplier. But it has

around 500 vendor companies, which are 2nd tier suppliers, to supply wires, bulbs, plastic body parts, screws, paints, more than 150 types of chemicals to IJL. NSK Rane supplies steering parts to Maruti Suzuki. But for steering assembly, Mitshubishi supplies motors, Kaparosuppliers column components to NSK Rane as 2nd tier suppliers. 3rd tier suppliers supply components for auto parts production in 2nd tier plants. Thus, the production network has deep backward linkages, extending to informalized production in small workshops and home-based production.

OEMs in the belt: Maruti Suzuki (Gurgaon, Manesar), Honda 2-wheeler (Manesar, Tapukara), Hero MotoCorp (Gurgaon, Dharuhera, Neemrana)

Supply Chain: Global players (Bosch, Denso, FCC, Delphi, Continental etc), Joint ventures of Indian and foreign (mostly Japanese) companies (Krishna Maruti, IJL, Munjal Kiriu, etc), Indian Groups (Rico Auto, Amtek Auto, Minda Group, Omax Auto, SPM, Autofit etc), 2ndand 3rd tier MSMEs, informal workshops.

To be more precise, the polarization or power relations do not seem to exactly reflect the rigid vertical order of OEMs (Original Equipment Manufacturers), 1st tier suppliers, 2nd tier suppliers and 3rd tier suppliers. A kind of de-verticalization seems to be relevant where a single firm can supply parts to OEMs or to component assemblers. A different kind of polarity seems to be growing. On the one side there are OEMs like Maruti Suzuki, Honda, Hero Honda etc and global component suppliers like Delphi, Denso, Bosch, Pricol etc. having relational linkages with the lead firms. The labour process, work organization or technology of these firms has broad similarity and they have in-house R&D. They are the main players in the production network and benefit from increasing integration with global market. In the middle there are large enterprises that operate as 1st or 2nd tier vendors. They benefit from domestic growth of automobile industry and are important players in regional production network. Increasing global competition creates a further polarization in this segment. At the bottom there are large numbers of tiny, small and medium enterprises that have no idea of 'lean production' or 'technological upgrading' and face immense struggle to survive. And the production network at its downstream extends to the informality of slum production.

The industrial belt has been a place of many militant workers struggle and with a legacy of a strong trade union movement. But in last few years an

ongoing structural transformation in the production and labour regimes has posed serious challenge before the trade union struggle and the process of collective bargaining.

The Changes in the Production Regime

- Changes in Labour Process, New Technology and Increasing Disposability of Workers

To undermine the collective assertion of labour, capital has shown different strategies. One way is to crush the workers' movement and damage the confidence of workers and then go for the necessary restructuring of work, technology and production process without any significant resistance so that the previous objectivity of workers struggle gets changed and undermined. After the 3-month long workers' strike of 2000, Maruti Suzuki management could crush the resistance and terminate the main leadership. They, then introduced a VRS scheme to reduce the workforce, increased the number of contract workers to undermine the strength of permanent workers, restructured production where contract workers would run the main work, and co-opted a section of workers and formed a separate union. But often capital is forced to make a compromise with labour to avoid larger damage. Thus the struggles of Hero Honda workers in late 1980, Honda workers in 2005 or Maruti Suzuki workers in Manesar in 2011-12 could achieve their right to form union. Then capital has to accept some concession for labour. But, in gradual course, in Hero Honda, and partially in Honda, management was successful to contain the union representing the interest of only permanent workers who gain from increased productivity, whereas the main burden of production was on contract workers.

In this section we study the production and labour process of two most advanced and leading auto assembly plants of Maruti Suzuki, Manesar which was also the center of a most militant plant-based workers struggle in past one decade.

Case Study: Maruti Suzuki, Manesar Plant

Maruti Suzuki Manesar has three plants - A, B, C. During the strike of June 2011, there was only A plant. B plant started in August 2011, and the C plant started in end-2012. The production has tripled since then. In each plant in each shift 480 cars are produced. In last two and a half years, a

flexi-line, which is operated manually, has been installed in plant A in 2015 with a capacity to produce 250 cars/shift for emergency purposes. Among a total workforce of 7000, only 1700 are permanent workers. All others are hired as temporary workers (TW), contract workers, apprentices, student trainees who work along with permanent workers in the same nature of production work in press shop, weld shop, paint shop, bumper shop, injection moulding and assembly lines. A new worker needs 7 days training after joining regarding basic production processes, safety, 5S etc, then is sent to the line where some permanent worker or old TW takes the charge of 21-days line training, while giving production.

The Production and Labour Process

The production process in this assembly plant starts from press shop, where the sheet-metal is cut or pressed generally one day in advance, which means what is pressed today will go to be assembled tomorrow. There are, in Manesar plant, several lines of power presses. They are quite automated, and press-tools of these machines change without human intervention, according to different types of parts to be pressed. The press-shop runs on three shifts. The harder works, such as taking out pressed parts from the machines, is done by temporary/contract workers and apprentices. Still, in general the press-shop work is less hard, as most work-stations are here machine-stations, and it gives a little breathing space for the workers while the machine works. But in the weld-shop and assembly line the workers have really harder time. In weld shop in Manesar A-plant, there are 250 to 300 hand-welders, and there is full automation in B and C plant. Since 2006, here the numbers of work-stations got reduced from 16 to 8 and thereafter since June 2011 from 8 to 4, through increased degree of automation and using more robots. But so far work got re-distributed in such a way that employee numbers did not get reduced as much as there was job redesigning and work was replaced (in general one robot substitutes three to ten workers, depending on the nature of job). In the paint shop painting robots will be seen rubbing shoulder with the human workers. But that does not reduce workload. Temporary worker needs to carry 70-80 screens of car up and down the stairs.

There are many work-stations on the long-block assembly-line, attended by one worker each. Each worker has to have several operations for a car within a cycle-time or takt-time of 60 seconds. Let us take some operations,

for example. The engine block arrives and then it is washed. A single worker uses a crane, then clamps the engine block, after that operates the washing machine, and lastly takes the engine out - being forced to be habituated in multi-tusking, but hardly acquiring a 'skill' in real sense. Thereafter another worker fits the crank-shafts which are also checked, then washed, and then fitted manually. This fitting is physically one of the most demanding works as the crank-shaft's weight is 15 to 20 kg. In the context of a developing country like India, the cheap labour to a great extent determines the work organization and much less mechanization takes place in those works which are not that important for standardization or quality of products, however brutal the work may be.

• New Technology, Skill and Disposability of Workers

Along with human workers, more than a thousand robots work in the plant. Over the time, the plants have been mechanized and automated. New plants, B and C, have much more automation, with fully automated weld shops and paint shops. Even many manual works in A plant has been replaced by machines in last few years. Advanced fuel filling in assembly, earlier done by workers, has been replaced by machines. Tire shifting in Final-2 line in assembly is now done by robots. Wind shield sub-assembly is now done by robots. Still due to presence of more manual nature of works in A plant, maximum number of workers, including maximum numbers of permanent workers are there. In the assembly line of B plant, the ratio of permanent workers and temporary workers is 1:4. In C plant, the ratio is tilted more towards temporary workers. B and C plants have less work stations too. There is no final-3 line in B and C plant, those works are distributed between final-1 and final-2 lines.

Permanent workers are required particularly for those kinds of works which are sensitive to skill and experience, and which are crucial to the entire production process. Here we list few such works which are skill/experience dependent:

i) 'Maru-A' - those works where a mistake may lead to the risk of accident and thus is threatening for car/life, are categorized under 'Maru-A' stations. These are important work stations where experienced/permanent workers should be working. These works are done under strict inspection;

ii) In chassis section - axle fitting, engine fitting, fuel pipe fitting;

iii) I n final assembly - all works related to steering, break setting, parking lever setting, headlight setting (coupler connection) etc.

These show that increasing automation is taking place in these works to become less dependent on the skill/experience of workers.

Some works are crucial for the running of production process. There will be production loss if the working stops at final-1, final-2, final-3 sub assembly lines. Thus the consistent role of the workers is important in this part of production. In trim section, chassis section and final-1 and final-2 lines, on an average there could be maximum 20-25 stoppages of very short interval to ensure no production loss at the end of the shift. For final-3 and vehicle inspection, maximum 5-10 such stoppages will be affordable. Otherwise daily production may come down below 480 cars a day. When a defect is spotted in the car, the worker may show either yellow signal or red signal in the display board. Yellow signal calls for the immediate attendance of supervisor/reliever to correct the defect while the production line moves. If within two cycles (120 seconds) the defect is not corrected, the line stops. In case of red signal, the line immediately stops. In the assembly line, skill and experience was needed to manage parts for different models of cars. In last 4 years, new technology in the form of VTS system and 'PikaPika' system has smoothened this problem and has made skill and experience more redundant. Every car has a set of data associated to it, and accordingly parts are fitted to it. Its model should be specified, like Swift or Ertiga or Balleno. It may be petrol or diesel variant. It may be model variant, like long variant (LXI) or high variant (ZXI, with advanced technology). It has a PSN number (production serial number, in the range of 1-10000) for specific identification. All the data for a car comes from paint shop to assemble via VTS system as soon as the car joins the assembly line. 'PikaPika' system has enabled of blinking of container of appropriate parts associated to a car as soon as it reaches a worker. Say, if it is Swift Dzire, then the appropriate Dzire part container blinks, and the workers picks up the appropriate part to fit to the car. Thus even the new workers can run the production without making many mistakes.

- **The Capital-Labour Conflict and Consequent Restructuring of Production and Labour Process (2011-18)**

It is an important node in the automobile production network. Any disturbance in this node has serious ripple effect along the supply chain, as was seen during the strikes of 2011-12. Thus the workers here enjoy a

particular nature of structural power, and the company management is highly aware of that. The bitter experience of 2011-12 incidents pushed Maruti management to industrial restructuring. If we study closely the post-strike events unfolding after the struggle in Maruti Suzuki in 2011, we see, management was forced to increase the tea-break from 7.5 minute to 15 minutes, to decrease the speed of assembly line, to increase transport facility for workers, employ more workers so that now a worker gets a 'reliever' when s/he goes to the toilet. The contract workers could take two holidays in three months, which was not the case before the dispute. They were allowed only one holiday which also had to be approved by the supervisor and that hardly happened. The permanent workers could take 4 holidays in three months. But all this implies that for capital to maintain its profit margin, it has to transfer the crisis elsewhere, and one option is across value chain. As part of this cost-cutting exercise, the company initiated measures to step up localization levels and to pare the number of tier-I suppliers over the next two-three years. The company expected to save up to Rs 2,000 crore a year. To secure the supply side, Maruti Suzuki has made a deal with FIAT to obtain 100,000 engines per year and also decided a merger with Powertrain to ensure the supply of diesel engines. Maruti adopted 40 ITI colleges in Gujarat, to ease the supply of labour when in need for it. By outsourcing work to companies such as Belsonica, FMI, Krishna Maruti, SKH Metal which operates on the Maruti premises, a formal division is created between workers in the same factory.

In the period of 2012-14, when there was no union active inside the plant, many coercive changes took place. A system of taking 7-month 'company casuals' instead of contract workers started, as the 'company casuals' being on the pay-roll of company could be under greater monitoring of the company. After 7 months, these casual workers were discharged and the next batch was taken in for another 7 months. While regular workers are kept under constant pressure, the reserve army of discharged workers is called back to run the production work in case the permanent staff went on strike. The management effectively stopped taking regular workers. Earlier there were relievers in each line, to help run the process of production in case someone was absent from the line or from duty. Now there were no relievers. Earlier, in vehicle inspection (V.I.) department for road test there were 16-17 workers in A?plant; now, the same amount of work was managed by 8 workers only. In the Trim line, there were 125-130 workers;

now there were 70-80 workers. Also, in Final?1 assembly line there were 4 areas and each headed by a supervisor; now there were 3 areas for the same work with 3 supervisors, few workstations and still fewer workers.

After the activation of Maruti Suzuki Workers Union in 2014, the salary of the permanent workers increased substantially after the wage settlement in 2015. The working condition changed in favour of workers due to increased collective bargainng power of workers in the plant. Also, the formation of 'Maruti Suzuki Mazdoor Sangh', a federation of 4 unions of Maruti group (Maruti Gurgaon, Maruti Manesar, Maruti Suzuki Powertrain and Suzuki Motorcycle) and 2 unions of Belsonica and FMI (vendor companies at Maruti Szuki Manesar plant premises) increased the bargaining capacity of workers. Assembly line speed was decreased due to bargaining from union and cycle time per car got increased to 60 seconds in Manesar plant (before 2011 it was 48 seconds). Per shift car production came down to 480 (from 550 in 2011). One reliever per 8-10 workers is the norm now, making space for workers to go to toilet, drink water and take short break during work. Other facilities including incentive, housing plan, home loan, car loan etc were provided to permanent workers.

Thus, the Maruti management in process of reducing the conflict with permanent workers in the plant, made sure that the substantial disruptive capacity of workers at Maruti, the node of production network, get mitigated. There were four types of responses from the management. First, An understanding was made with the union to maintain peace and reduce uncertainty, and meanwhile further mechanization was undertaken to reduce the control of workers over production process and to make skill and experience more redundant and thus to make the workers more disposable. Second, apart from absorbing the militancy of permanent workers, the workload was transferred to temporary workers of various categories, deepening internal segmentation of workers and informalization of work was furthered. Third, new technologies of electronic control of supply chain by minutes helped Maruti to increase control over supply chain, centralize the flow of materials and components and transfer any crisis down the supply chain. The vendor companies were further 'disciplined' to meet the need of Maruti and were penalized heavily for any deviation. The vendor companies, with reduced bargaining power vis-à-vis assembler plant, now became more intolerant to workers subjectivity and unions in their own plants. Fourth, a gradual preparation of shifting

production to newer plants with higher automation and more flexible labour force started. In the newly established Gujarat plant of Maruti Suzuki, operational for last one year, the temporary workers (TW) get a salary of Rs. 8000-10000, compared to Rs. 15000-16000 received by TWs in Manesar plant. Still now no trainee/permanent workers are there, and temporary workers run the entire production for last one year. Workers are not allowed to take their mobile phones inside. Increased mechanization has ensured less stoppage time and high productivity and intensification of work. This new production regime threatens the workers' rights achieved through protracted struggle in Manesar.

The Changes in Labour Regime: Contractualization and Informalization of Work

The decade between the defeat of Maruti Gurgaon struggle (in 2000) and the beginning of Maruti Manesar struggle (in 2011) shows this strong process of contractualization taking shape in core production process. They accounted for nearly two-third to three-fourth of the total workforce in all auto assembler units including Maruti, Honda and Hero Honda, and major first tier suppliers. In many cases (including Honda Manesar plant) the job contract was renewed by the contractor with a break of 3-4 days after each six months to ensure that the worker could not claim to have worked 240 days a year and hence could not have claimed to be in 'continuous service' or to be permanent. However, the same workforce of contract workers were usually retained (even when the contractor changed) as their experience and skill was important to the company. The labour regime inside the plant consisted of permanent workers (on company pay-roll), trainee workers (on probation, usually for 2-3 years before they are made permanent), apprentices (one year) and contract workers (shown under different contractor/contract agency).

Maruti Manesar plant workers struggle in 2011-12 was effectively the first one that seriously challenged the contract system, struggled for the permanency of contract workers and put forward the possibility of a common struggle against the internal segmentation of workforce. Permanent workers struck work and occupied the plant in October 2011 as 1200 contract workers, who earlier had joined the strike with permanent workers in June and September, were not taken back by the management, and ultimately the contract workers were taken back. After union formation

in February 2012, the first demand that the union put forward before the management in its Charter of Demands was the permanency of all contract workers. As the management refused to talk on this demand, the bargaining process suffered, tension escalated and finally 18 July incident of clash between workers and management and their bouncers took place, leading to the death of one HR manager and subsequent crackdown on workers.

The 18 July Maruti incident exposed some threats of the contract systems to the management. Firstly, the similar working condition faced by the permanent and contract workers and the bonding that develops through working in the line side by side together for years bring the permanent and contract workers together in the struggle against the management. Secondly, as the contracts workers were not on company pay-roll, they had less attachment to the plant and less direct control by the management. After the incident, the Maruti Manesar management terminated all 1800 old contract workers (along with 546 regular workers) and declared the abolishment of the contract system in core production. But that declaration did not mean that they would substitute the contract workforce by regular workers. The management introduced a new category of 'temporary workers (TW)'. They were taken by the company as fresh recruitments directly from the campus interview or off-campus interview under company pay-roll for 7 months only (to meet the condition of less than 240 days a yearof work). After 7 months, the entire batch of workers would be removed and a new fresh batch would be taken. The management has this database of workers and can call them as required. TWs became the largest part of workforce in Maruti Manesar, replacing contract workers. Till date, it is so. Following Maruti, many companies later started this practice of 'fixed term' workers. Also, 6-month contract system became a significant practice, where a batch of contract workers was taken for 6 months only. After 6 months, that batch was replaced by a new batch. These practices of 'Temporary workers', 'fixed term' workers, '6-months contracts' created a workforce that is insecure, has lesser interaction with permanent workers, and is difficult to organize.

Another process of informalization of workforce, which started mainly in Bawal industrial belt in 2012-13 onwards and diffused elsewhere, involved the practice of making diploma-holders or B.Tech degree-holders part of workforce under the categories of 'Diploma Trainee (DT)', 'Diploma Apprentice', 'Engineering Trainee', 'Diploma Engineering Trainee' etc. These

unemployed degree holders used to come to work from far away states like Uttar Pradesh, Bihar, Jharkhand, Madhya Pradesh etc and worked as 'trainees' in these companies for one to three years period. They were on company pay-roll, but as staff and not under the category of 'workers'.Yet they had to do the same work in the core production process as they other workers inside the plant.

In the period of 2013-18 these two forms of workers started dominating over permanent workers and contract workers working for a long time and that had significant effect on the strength, confidence and role of unions and collective bargaining mechanism. Lately in last one year, a new category has been added to this process of informalization of work. Those with 12th pass certificate or admission in a college or an ITI institute are taken by the company under the categories of 'Student Trainee', 'National Employability Enhancement Mission (NEEM) Trainee' etc under the Central Government Scheme of 'PradhanMantriKaushalVikasYojna' and offered stipend below minimum wage and promised a certificate after three years or so.

Three conditions seem to facilitate these processes of informalization of work:

- Changes in production process with mechanization, automation, new technologies and division of labour have made workers more disposable. Apart from some very specific types of work, experience and skill are being made increasingly redundant.
- Unemployment crisis has created a huge reserve army of labour. Those waiting for a job outside company gates are ready to accept any type of employment condition.
- The changes in labour laws (changes in Apprentice Act 1961, Contract Labour Act 1970, introduction of 'Fixed Term Employment' etc) and an institutional mechanism (Labour department, Labour Court and Industrial Tribunal)reluctant to enforce the existing labour laws have facilitated the informalization of work.

We looked into a few representative case studies to understand the process of informalization of work and changes in labour regimes. Two tables, given below, present two case studies of contractualization and informalization of workforce in an assembler and a supplier unit in this region.

Table 1: Composition of Workforce in Maruti Suzuki, Gurgaon Plant

Categories	Permanent	TW-1	TW-2	CT	ST	Apprentice	Contract
Salary (in Rs. in January 2018)	40,000-45,000 (starting)	19,800 (in hand)	19,800 (in hand)	19,800 (in hand)	10,400	13,500	17,000
Period	--	7 months	7 months	2 years	3 years	1-2 years	--
Dress	Light yellow shirt, pant	Light violet shirt, colour pant	Light violet shirt, colour pant	Light blue shirt, blue pant	Blue shirt, slate chocolate colour pant	Light violet shirt, chocolate colour pant	Dress provided according to contractor

Source: Compiled by authors, based on field studies in 2017-18.

Table 2: Composition of Workforce in India Japan Lighting, Bawal Plant*

Category	DAA (Diploma Act Apprentice)	DEA (Diploma Engg. Associate)	DET (Diploma Engg. Trainee)	NEEM trainee	Contract	Company Trainee (CT)	Permanent
Period	1 year	2 years	1 year	3 year	--	2 year	--
Salary (in January 2018)	9,500	10,500	12,500-14,000	7000-7,500	8200 (minimum wage)	15000	27000
Number	300-400	100	Earlier 77, now all fired.	250 (incr.)	300-400	19	89

Source: Compiled by authors, based on field studies in 2017-18.

Note: * Vendor company of Maruti Suzuki and others)

Automobile Industry in Transition (2018-2022): Volatility, Disruption and New Technologies

In Indian context, a series of events, government policies and socio-economic factors have influenced the automobile industry. Demonetization and GST impacted the MSME sector adversely and thus the lower strata of automobile supply chain got negatively impacted. In 2018-19, the automobile industry faced serious fall in demands due to various factors - lack of effective demands, NBFC (Non-Banking Financial Company) crisis, upgrades in

emission norms from BS-4 to BS-6 resulting in increased price of vehicles, etc. Uncertainties related to the process of transition to EV (Electric Vehicles) also hindered investment in production capacities in short run. All these factors resulted in the stagnation in automobile industry before the pandemic hit.

In this context, the COVID-19 pandemic and resulting lockdown since March 2020 severely impacted automobile production. Due to lockdown, halt in production and restrictions in transport, global automobile supply chain was disrupted. The pandemic majorly hit the Indian auto sector. Lockdown in pandemic period resulted in shutting down the production units at OEMs and thus crippling the supply chain. Also, production cuts due to slump in demand negatively impacted employment. According to the Parliamentary Panel report, the estimated job loss due to pandemic in the automobile sector was 3.45 lakh. The largest carmaker Maruti Suzuki cut temporary workforce by 6%. There is a huge number of migrant temporary workers in the auto sector. Overwhelming majority of them did not get payment for lockdown period when the production was stopped. The job loss, lack of payment and the difficulty during lockdown forced them to go back to their villages. This process of reverse migration made the operation of plants difficult even when lockdown was lifted.

In Indian auto market in last two years in the pandemic period there has been major digitalization. The connected car market in India is still now at a nascent stage. But with more and more use of industry 4.0 technologies like Artificial Intelligence, Industrial Internet of Things (IIoT) and virtual reality, there are expectations for its growth in near future. Google has collaborated with automakers in the process of developing infotainment, telematics, ADAS etc for automobiles. Apart from IIoT, big data and cloud technology are being used to develop automotive telematics system based on data created from and flowing to vehicles through wireless networks. Many are optimistic about a technology-led disruption in auto industry via CASE (connected, autonomous, shared and electric) vehicles in future days. The EV segment is undergoing major disruption in India too. With supportive government policies towards EV and FAME subsidy, EVs are slowly but steadily capturing new markets and this trend may develop significantly in coming years, causing major disruption in automobile section, its production process and supply chain. Hybrid vehicles are also having growth in demands. Automobile vendor companies are also preparing for

the shift to EV. According to ACMA (Automobile Component Manufacturers Association), majority of new investments of auto component industry is towards EV segment and application of industry 4.0 technologies. The transformation is essential for auto component industries to survive. Presently, there is 90% hardware and 10% software in an average car in India. According to SIAM reports, the hardware percentage will come down to 40% in coming days. Supply chain will be transformed accordingly.

Root of Capital-Labour Conflict and Erosion in the Collective Bargaining Mechanism

The trade union movement, which was rooted in the struggles of 1960-70 under a Fordist production regime and a social contract between capital and labour mediated by the welfare state and expressed under a trade union bargaining mechanism codified in labour laws, faced a difficulty to engage with the new wave of plant level workers militancy in new industrial regions, particularly in auto-belts. With the splitting up of production in many units after the collapse of Fordist regime and in the era of economic globalization and emergence of production networks, the earlier associational power of thousands of workers working under one shade got changed. In the new industrial regions, in time of 'just-in-time' production, one main feature of recent plant-level workers struggle was that the militancy of the workers were triggered by the worsening working condition in the new production and labour regime and their confidence generated by the structural power the enjoyed operating in important locations in the production networks. Thus the central trade unions could not appropriately represent these struggles. This tendency was visible not only in Gurgaon-Neemrana belt but other industrial regions like Chennai-Sriperumbudur, Pune-Nasik, Rudrapur-Haridwar, Ahmedabad-Sanad-Dholra etc, reflected by the militant struggles of Maruti, Honda, Hyundai, Tata Nano, Toyota etc.

We see that the intensification of work, the worsening working condition, excessive control of management over labour processes and dehumanization in terms of being an appendage to machines triggered unrest among workers and 'union formation' was not the end but the means to alter this working condition. Shared experiences of labour process brought together permanent and contract workers in their struggles. Thus the root of struggle was contestation over the conditions of work on shop floor. With their

union, they could bargain better for that. The workers were aware of their capacity to affect the production at the nodes and thus the capacity to disrupt the entire supply chain production. This gave them a 'structural power' because of their locational advantage. The workers were also aware of the fact that the company earned huge profit because of the hard labour of the workers, but their share of that was abysmal. Without union, it was hard to bargain for their share. This dynamic contradiction of labour-capital determined much of the changes in production and labour regime, and the fate of collective bargaining.

But before it could generalize to a representative tendency of recent workers struggle in organized manufacturing sector, the restructuring of production and labour regime by capital substantially reduced workers bargaining strength. Workers subjectivity at the important locations of production networks is either being contained or co-opted (among high-salaried permanent workers) or being smashed or dispersed. The main burden of production is now on a new workforce, young contract/trainee/temporary workers/diploma workers etc, who do not imagine getting a permanent job and are not attached to any particular factory for more than few years. These workers are not part of union. This has led to lesser control over production by the union, has negatively impacted the possibility of halt of production during a strike call by the union and has affected collective bargaining mechanism. Also the institutional changes have aided to the decline of collective bargaining mechanism. In earlier days, the main institutions to deal labour matters was labour court, industrial tribunal and labour department. As criminal and civil courts and police-administration now take increasing pro-active role to decide the matters related to labour disputes and labour unrest, the role of labour court and labour department take a back seat.

Summary and Conclusions

The development process marked by accumulation in the leading industrial sectors like automobile has its own underbelly - labour. The changes in production process is influenced by the dynamic contradiction between capital and labour on the shop floor - a tendency that has been relatively less explored in industrial organization and development studies. This study shows that the changes in production regime in last decade has serious consequences on labour - increasing disposability and job insecurity,

increasing internal segmentation and informalization of labour force in production, challenging working conditions, skewed wage structure containing majority workforce at the bottom end and declining collective bargaining mechanism. This has created some serious capital-labour conflict in different factories in last decades, including in Manesar plant of Maruti Suzuki, India's leading carmaker. Now as India's automobile industry is passing through a transition in last few in terms of Electric vehicles, BS VI pollution standards, automation and adoption of technologies associated to fourth industrial revolution (like big data, artificial intelligence, cloud computing, industrial internet of things, etc.) post-COVID supply chain disruption, demand crisis and volatility, the development course in India's automobile sector should also properly accommodate the interest of labour.

References

ACMA Annual Reports (2020-21). *Living with Volatility: Survival, Revival, Growth.*

Bhargava, R. C. with Seetha (2010). *The Maruti Story: How A Public Sector Company Put India on Wheel.* Collins Business.

Coe, N. M., Dicken, P., Hess, M. (2008). Global production networks - debates and challenges. *Journal of Economic Geography*, 8: 267-269.

Gereffi, G. and Korzeniewicz, M. (ed.) (1994). *Commodity Chains and Global Capitalism*. Praeger.

Hess, M., Yeung, H. W. (2006). Whither global production networks in economic geography? Past, Present and future. *Environment and Planning,* 38.

Porter, M. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance.* Macmillan.

Selwyn, B. (2012). Beyond firm-centrism: re-integrating labour and capitalism into global commodity chain analysis. *Journal of Economic Geography*, 8: 205-226.

SIAM Annual Reports, 2018-19, 2019-20.

Silver, Beverly J. (2003). *Forces of Labour: Workers' Movement and Globalization since 1870*. Cambridge University Press.

Thompson, E. P. (1963). *The Making of the English Working Class.* London: Penguin.

Womack, J. P., Jones, D. T., Roos, D. (2007). *The Machine that Changed the World.* Simon and Schuster.

Wright, Eric Olin. (2000). Working-class power, capitalist-class interests, and class compromise. *American Journal of Sociology*, 105(4): 957-1002.

Research Note/Commentary

Impact of Income Inequality on Human Development in Emerging Economies: A Panel Data Analysis

Odisha Economic Journal
Volume 53 • Issue 2 • 2021
pp. 163-175
Journal of the
Orissa Economics Association
OEA

Bhavya Logar
Nausheen Nizami

Abstract

Even as emerging economies have been experiencing stupendous economic growth since the early 2000s these are still plagued with persistent income inequality. This has given rise to a debate around the distribution of income and its impact on development. The present research focuses on examining the impact of income inequality (measured by Gini coefficient) on the development (measured by HDI) in emerging economies using the Standardised World Income Inequality Database (SWIID), 2020. The study utilizes panel data for nine emerging economies, namely, Argentina, Chile, Russia, Brazil, China, Mexico, India, Indonesia and South Africa from 2008-2017. It is observed that inequality had a negative impact on transmission channels such as education and health. The research showed a negative correlation between human development and income inequality.

Keywords: Emerging economies, human development, income inequality, panel data analysis, distribution of income

I. Introduction

Emerging and developing economies have been experiencing a synchronized period of growth, increasingly contributing more than the developed countries. In the span of two decades these economies have doubled their

Bhavya Logar, Gratduate, School of Liberal Studies, Pandit Deendayal Energy University, Gandhinagar. Email: logarbhavya123@gmail.com

Nausheen Nizami, Associate Professor (Economics), School of Liberal Studies, Pandit Deendayal Energy University, Gandhinagar. Email: nausheen.economics@gmail.com

share in the world economy. In 2017, they accounted for 75 per cent of the global growth in both output and consumption. External and structural changes like terms of trade, improved and advanced financial markets, open economy, rapid industrialization, liberalization and globalization account for this tremendous growth in the emerging economies. The post-2000 period saw especially remarkable economic growth of these emerging market economies, mounting up to 80% of the global economic growth since 2008 financial crisis. However, despite the stupendous growth these economies are still plagued with a considerable income gaps and persistent income inequality (International Monetary Fund, 2017).

The average level of income inequality experienced in OECD countries was 0.32, contrarily it was 0.49, 0.50, 0.51, 0.61, 0.62 in India, Brazil, China, Indonesia and South Africa respectively[1] (Organisation for Economic Co-operation and Development, 2018).

Thus, despite the colossal growth witnessed in recent years, the last three decade have seen a rise in income inequality (measured by Gini coefficient of disposable income) in emerging economies (EEs). Interestingly, the phenomenal growth has been marked with increased inequality in emerging economies. Latin American Region and Brazil specifically from the EEs was the only exception to have witnessed a decline[2] in inequality in the last two decade. Thus, increased GDP with increasing income inequality has refuted the traditional "trickle-down approach" and given rise to the most debated issue of recent times i.e., distribution of income. Apart from this, another factor contributing to rise of inequality is reduced labour-income share compared to capital-income share in the national income. Moreover, with the labour's declining income share the dispersion of earnings are increasingly becoming skewed (Global Economy and Development, 2016).

Additionally, tax and transfer policies or other re-distributional policies have greater impact in advanced economies, typically playing a smaller

[1] Some of these countries are famously classified under the BRICS acronym which was coined by Jim O Neil as a representation of some promising emerging market. And almost all of these countries have high GDP growth rates.

[2] The recent declining trends in Latin America have been attributed to policies like increased higher education spending and increased tax revenues; along with GDP growth.

redistributive role in emerging economies. Besides, in emerging economies access to and cost of public services such as health and education have greater distributional consequences than tax or transfer policies. Thus, it is imperative to study the impact of prevalent income inequality on development of emerging economies on more comprehensive level than only over income/GDP.

Thus, this study aims to assess the impact of income inequality on development in emerging economies. Traditionally, measures like Gross National Income (GNI) or Gross Domestic Product (GDP) have been incorporated to study the relationship between income inequality and development of countries. However, GDP is relativelya narrow measure that does not take into account the various channels through which inequality can impact development. Thus, this paper considers a more new and holistic measure of development i.e., Human Development Index (HDI) to study the relationship between income inequality and development. HDI is a composite index with health, education and living standard indices. Hence, proving to be more coherent with the objectives of the study i.e., to assess the impact of income inequality as measured by Gini coefficient on human capital measured by HDI. The next section delves deeper into the existing literature on income inequality and its relationship with growth or development.

II. Income Inequality and Human Development: Evidences from Literature

Income inequality and its association with economic growth were brought to attention by modern economist Simon Kuznets. He proposed the inverted-U hypothesis-economic growth increases inequality in the early stages of development, however in later stages the effect inverts and incremental growth reduces income inequality bringing an equalizing effect. (Kuznets, 1955). Following Kuznets, Kaldor proposed a reverse relationship suggesting that unequal distribution of income can result into economic growth. He emphasized greater savings lead to greater investments and capital accumulation necessary for long-term growth(Kaldor, 1955-56; 1957).

Simultaneously, Solow's income growth theory of convergence influenced international policy on income distribution and growth; arguing that growth

in less developed countries (LDCs) would be much faster than developed nations. (Solow, 1956). The outcome of Kaldor–Kuznets–Solow consensus was a policy mindset which advocated that inequality promoted growth, this growth then led to reduction in inequality. Notably, much of these policies were influenced by political and ideological factors. The following decades witnessed flourishing research on inequality, income distribution and its effect on growth. However, the results were ambiguous, contradictory, and inconclusive (Deininger & Squire, 1998; Higgins & Williamson, 1999; Savvides & Stengos, 2000; Barro, 2000; Forbes, 2000). For instance, till the 1970s, not only US but most of the OECD countries experienced growth path akin to an inverted-U curve. However, the validation of the inverted-U hypothesis was less clear in the LDCs (Aghion, Caroli, & Garcia-Penalosa, 1999). Research supporting positive relationship was based on (a) higher savings rate (Kaldor, 1955-56) and (b) growth-inducing incentives based on inequality (Mirrlees, 1971).

Several scholars observed various transmission channels where inequality had a negative and rather limiting effect on growth. Investment in human capital was an important factor in both growth and income distribution since a cohort of middle-class can enable the economy to transition from the agricultural to industrial or service economies (Galor & Zeira, 1993; Higgins & Williamson, 1999).

Recently, Thomas Piketty criticized Kuznetshypothesis in that there was no automatic decrease in inequality in the later stages of development. Gathering the most extensive dataset on inequality from 1910 to 2010, he observed that the fall in income inequality was due to two World Wars and other shocks rather than market operations or economic growth alone. He proposed an S-shaped curve rather than an inverted-U shape curve (Piketty, 2014). Supporting this hypothesis Branko Milanovic proposed a sinusoidal curve, arguing that it was the 'second Kuznets Curve' that rose owing to technological changes, globalization, etc.(Milanovic, 2016). Although no common consensus is formed yet it is understood that income inequality and economic growth impact each other through transmission channels.

III. HDI, Transmission Channels and Income Inequality

Given the salience of transmission channels, income inequality's effect on the broader spectrum of development other than GDP is evident. Schooling

and institutions serve as a primary channel by which inequality lowers per capita in comeon institutions (Acemoglu, Johnson, & Robinson, 2001), on schooling (Schultz, 1963; Easterlin, 1981; Mankiw, Phelps, & Romer, 1995) and both schooling and institutions (Easterly, 2007; Sokoloff & Engerman, 2000). Thus, it is apparent that income inequality had adverse effects on several aspects of human capital apart from income making it imperative to analyze the same with a broader measure of growth like HDI.

Evidence exists that HDI has an inverse relationship with income inequality as measured by the Gini coefficient. HDI has 3 components namely, education, health, and GDP; it was noted that education and health, projected S-curve while the GDP component held the traditional Kuznets Hypothesis of an inverted-U curve. Overall, the curve was less steep against HDI compared to GNI/GDP per capita. At low levels of development, there was a shallower rise in income inequality followed by a significant fall at higher levels of development. As observed in the previous section, it was held that an increase in the access to education can have a higher impact on 'equalizing' the income than growth (Theyson & Heller, 2015).

Thiel (2016) found a negative long-run effect of income inequality on human development. Like the previous study by Barro (2000), he found that there exists a positive short-run effect on development. However, detecting a negative short-run effect on education signaling at a specific transmission channel. Inequality was negatively correlated with all the development measures i.e., per capita income, secondary school enrollment rate and institutional performance; concluding that inequality caused some degree of underdevelopment (Easterly, 2007; You, 2013).Thus, it is vital to study the effect of inequality on measures like HDI for crucial insights regarding transmission channels (Thiel, 2016).

IV. Data

The study aims at evaluating the impact of income inequality over a broader dimension of development rather than income per capita denoted by GDP/ GNI. Therefore, HDI is utilized to evaluate the impact of income inequality measured by Gini coefficient on development. The data for HDI is collected from *Human Development Report* and Data Centre of the United Nations Development Programme (UNDP, 2020).

For Gini coefficient, data is taken from Frederick Solt's Standardised World Income Inequality Database (SWIID), 2020 (Solt, 2020). The SWIID dataset considers Luxembourg Income Study (LIS) as the standard (Solt, 2014). The study comprisesbalanced panel data with 90 complete observations from nine emerging economies (three from each of the HDI groupings) spanning over the period 2008-2017. Table 1 shows the summary of descriptive statistics.

Table1: Descriptive Statisticsfor HDI and Gini Coefficient

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
Gini coefficient	90	31.10	32.40	63.50	45.8089	7.53607	.892 (.254)	.942 (.503)
HDI	90	28.40	56.30	84.70	73.7256	7.46694	-.382 (.254)	-.642 (.503)
ValidN (list wise)	90							

Note: Standard error in parentheses. All the values are multiplied by 100.

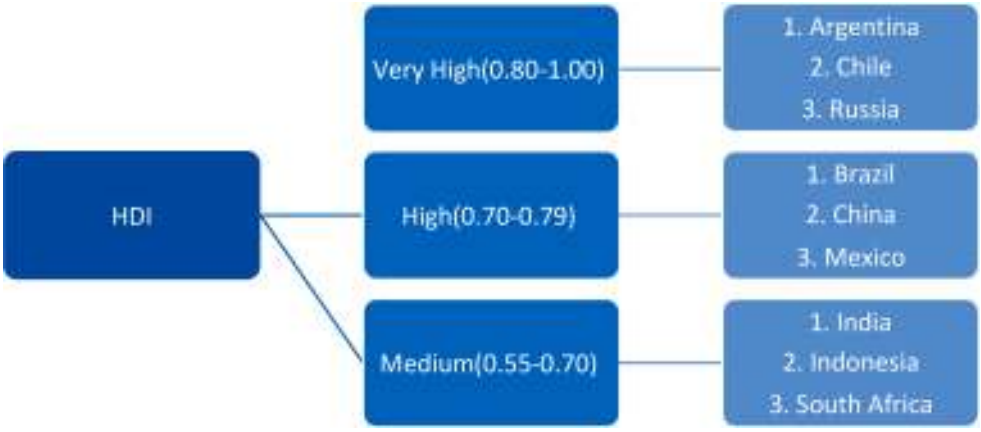
Source: Authors'calculation

V. Methodology

The sample was formulated using stratified random sampling. Nine emerging economies were picked three each from top three strata of HDI i.e., Medium (0.55-0.70), Hi gh (0.70-0.79) and Very High (0.80-1.00)[3], to represent the population of the emerging economies uniformly.Countries considered in the analysis are Argentina, Brazil, Chile, China, India, Indonesia, Mexico, Russia and South Africa. The sample has been designed in a way to represent the population accurately and inclusively.

[3] HDI has four levels namely, 'Very High', 'High', 'Medium' and 'Low'. However, for the purpose of the study few emerging economies are classified in the 'Low HDI' i.e., 0.55 and below category. Thus, only the top three levels of HDI are considered for the sample.

Figure 1: Sampling and Research Methodology



Source: Authors' Conceptualisation

I. Results and Discussion

A. Association Between Income Inequality and Human Development

This section deals with the empirical analysis of the data. The first part comprises evaluating the Pearson correlation coefficient between income inequality and human development. The second part comprises ascertaining the causality between income inequality (measured by Gini Index) and human development (measured by HDI) through econometric models suitable for panel data analysis.

A.1 Correlation:

Table 2: Correlation Statistics

		Gini coefficient	HDI
Gini coefficient	Pearson Correlation	1	**-.544****
	Sig. (2-tailed)		.000
	N	90	90
HDI	Pearson Correlation	**-.544****	1
	Sig. (2-tailed)	.000	
	N	90	90

Source: Authors' calculation.
Notes: ** Correlation is significant at the 0.01 level (2-tailed)
Both Gini coefficient and HDI values are multiplied by 100.

Table 2 estimates the Person correlation coefficient at -0.54, statistically significant at 1% level, implying that income inequality and human development demonstrate an inverse relationship in line with the empirical literature reviewed above. However, this does not signify any causality and hence an empirical model is formulated.

A.2 Regression Analysis

Four econometric models have been used to analyze the best fit model for the given panel data. The simple linear regression models used are Ordinary Least Square (OLS) model, Least Square Dummy Variable (LSDV) model, Fixed Effect (FE) and Random Effect (RE) model.

The general empirical model utilized in the study is as follows:
$HDI_{it} = \alpha + \beta GiniIndex_{it} + \varepsilon_{it}$ where HDI is the dependent variable and Gini Index is the independent variable. HDI_{it} symbolizes the HDI for the country *i* in year *t*, $GiniIndex_{it}$ includes Gini Index for a country *i* in year *t*. Here, the *t* ranges from 2008 to 2017.

Table 3 shows estimates of the four different regression models conventionally used for panel data analysis. Column 2 shows estimates obtained by simple OLS model. Column 3 and column 4 use LSDV model and FE model, respectively, used to capture entity-specific heterogeneities holding them constant; here the entities are the selected countries. Column 5 represents the RE model which determines independent effect as random over time, incorporating dependencies *between* and *within* the entities.

Table 3: OLS Estimates on Effect of Inequality on Human Development, 2008-2017

Independent Variables	*OLS Model*	*LSDV model*	*Fixed Effects Model (within)*	*Random Effects Model*
Intercept	98.41780*** (4.11379)	————	————	102.42356*** (7.93587)
Gini Coefficient	-0.53903*** (0.08863)	-0.6645** (0.1993)	-0.66454 ** (0.1993)	-0.62647*** (0.16607)
R-square	0.288	0.9994	0.12202	0.13921
F-statistics/Chisq	36.99***	1.629e+04***	11.118***	14.2312***

Source: Authors' calculation.

Notes: Dependent variable is the HDI. Standard errors are reported in parentheses clustered for countries. *, **, *** represents significance at 10%, 5% and 1% levels respectively. Chi-square statistics is used for random effect model only.

All the four models exhibit a negative relationship between income inequality and human development in the emerging economies. The Gini coefficient estimates are significant at 5% level of significance for LSDV and FE model and at 1% level for OLS and RE models. The LSDV and FE models produce similar results with a difference in R-square value i.e., 0.9994 and 0.122, respectively. The study conducted pFtest (to compare pooled OLS and FE model) and Hausman (FE and RE models) test to determine the best fit model for the sample.

Table 4: Test for Appropriateness of Models

Statistics	pFtest	Hausman Test
F-statistics/Chi-square statistics	134.01***	0.11933
p-value < 2.2e-16	0.7298	
Null Hypothesis	Rejected	Not Rejected

Source: Authors' calculation

The pF test shows a significant F-statistics at 1% level of significance; thus, the null hypothesis of OLS being a better fit than fixed effect model is rejected.[4] The Hausman test indicates that the chi-square statistics is not statistically significant. Hence, null hypothesis cannot be rejecte dimplying that the RE model is a better fit for the sample; as error terms of individual entities are not correlated with the regressor (i.e., Gini coefficient).

Conclusively, the RE model estimates a 0.623 unit decrease in human development with unit increase in income inequality amongst the emerging economies. The R-square is approximately 14 per cent indicating that 14 per cent of variation in human development can be accounted for by the prevailing levels of income inequality in the emerging economies.

[1] LSDV model is not compared for the ease of computation as it produced the same results as fixed effects.

II. Conclusion

The purpose of this study was to examine the impact of income inequality on human development in emerging economies over the recent decade (2008-2017). As emerging economies have been experiencing rapid growth since more than a decade now, it is imperative to ascertain the inclusivity of the growth. Historically, income inequality has been studied in the context of economic growth as measured by GDP or GNI per capita. However, this study lays premise on HDI to assess economic development accounting for a holistic perspective. Additionally, as several studies observe, income inequality impacts other transmissionchannels like education and health. Thus, it seemed prudent to employ HDI for evaluating the effects of income inequality on overall development of emerging economies.

It was found that income inequality (measured by Gini coefficient) and human development (measured by HDI) in emerging economies exhibited a negative correlation with Pearson correlation coefficient of -0.544 being significant at 1% level of significance. In panel data estimation, all the four econometric models namely, OLS, LSDV, FE and RE depicted a negative association between income inequality and human development. The RE model was the most suited empirical model and it showed a unit increase in income inequality led to 0.62 unit decrease in human development level in emerging economies. As previous studies have also concluded that education and healthcare systems had a negative channel effect on income inequality, the result was plausible. The model suggested a 14 per cent variation in human development of emerging economies can be accounted for by variation in income inequality. Logically, with rising income inequality lesser number of people had access to education, health, sanitation, etc. Thus, overall human developmentis bound to decline.

References

Acemoglu, D., Johnson, S., & Robinson, J. A. (2001). The colonial origins of comparative development: an empirical investigation. *The American Economic Review, 91*(5), 1369-1401. Retrieved from https://www.jstor.org/stable/2677930

Alesina, A., & Perotti, R. (1994). The political economy of growth: A critical survey of the recent literature. *The World Bank Economic Review, 8*(3), 351–371. doi:https://doi.org/10.1093/wber/8.3.351

Barro, R. J. (2000). Inequality and growth in a panel of countries. *Journal of Economic Growth, 5*(1), 5-32.

Deininger, K., & Squire, L. (1998). New ways of looking at old issues: Inequality and growth. *Journal of Development Economics, 57*(2), 259-287. doi:https://doi.org/10.1016/S0304-3878(98)00099-6

Easterlin, R. A. (1981). Why isn't the whole world developed? *The Journal of Economic History, 41*(1), 1-17.

Easterly, W. (2007). Inequality does cause underdevelopment: Insights from a new instrument. *Journal of Development Economics, 84*(2), 755-776. doi:https://doi.org/10.1016/j.jdeveco.2006.11.002

Forbes, K. J. (2000). A reassessment of the relationship between inequality and growth. *American Economic Review, 90*(4), 869-887. doi:10.1257/aer.90.4.869

Galor, O., & Zeira, J. (1993). Income distribution and macroeconomics. *Review of Economic Studies, 60*(1), 35-52.

Global Economy and Development. (2016). *Income Distribution within Countries: Rising Inequality.* Brookings Institution.

Higgins, M., & Williamson, J. (1999). Explaining inequality the world round: Cohort size, kuznets curves, and openness. *NBER Working Papers, 7224*.

International Monetary Fund. (2017). *World Economic Outlook: Gaining Momentum?* Inetrantional Monetary Fund.

Kaldor, N. (1955-56). Alternative theories of distribution. *The Review of Economic Studies, 23*(No. 2), 83-100. Retrieved from http://www.jstor.org/stable/2296292

Kaldor, N. (1957). A model of economic growth. *The Economic Journal, 67*(No. 268). Retrieved from http://www.jstor.org/stable/2227704

Kuznets, S. (1955, March). Economic growth and income inequality. *The American Economic Review, 45*(1), 1-28. Retrieved from http://www.jstor.org/stable/1811581

Mankiw, N. G., Phelps, E. S., & Romer, P. M. (1995). The growth of nations. *Brookings Papers on Economic Activity, 1*, 275-326. doi:https://doi.org/10.2307/2534576

Milanovic, B. (2016). *Global Inequality: A New Approach for the Age of Globalization*. Harvard University Press. doi:https://doi.org/10.4159/9780674969797

Mirrlees, J. A. (1971). An exploration in the theory of optimal income. *Review of Economic Studies*, 175-208.

Organisation for Economic Co-operation and Development. (2018). *Inequalities in Emerging Economies: Informing the Policy Dialogue on Inclusive Growth.* OECD.

Piketty, T. (2014). *Capital in the Twenty-First Century.* Retrieved from http://hdl.handle.net/10986/24858

Savvides, A., & Stengos, T. (2000). Income inequality and economic development: Evidence from the threshold regression model. *Economics Letters, 69*(2), 207-212.

Schultz, T. (1963). *Economic Value of Education.* New York: Columbia University Press.

Sokoloff, K. L., & Engerman, S. L. (2000). Institutions, factor endowments, and paths of development in the new world. *Journal of Economic Perspectives, 14*(3), 217-232. doi:10.1257/jep.14.3.217

Solow, R. M. (1956). A contribution to the theory of economic growth.*The Quarterly Journal of Economics, 70*(1), 65-94. Retrieved from http://www.jstor.org/stable/1884513

Solt, F. (2014). The standardized world income inequality database. *Working paper, SWIID Version*.

Solt, F. (2020, May). Measuring income inequality across countries and over

time: The standardized world income inequality database. *Social Science Quarterly*, 1183-1199. doi: https://doi.org/10.1111/ssqu.12795

Theyson, K. C., & Heller, L. R. (2015). Development and income inequality: A new specification of the Kuznets hypothesis. *The Journal of Developing Areas, 49*(3), 103-118. Retrieved from https://www.jstor.org/stable/24737310

Thiel, F. (2016). *The Effect of Inequality on (Human) Development –Insights from a Panel Analysis of the Human Development Index*. Unpublished Master Thesis. Universitat de Barcelona.

UNDP. (2001). *Human Development Report.*United Nations Development Programme.

UNDP. (2020). *Human Development Report-The Next Frontier Human Development and the Anthropocene.* United Nations Development Prgoramme.

You, S. T. (2013). Inequality does cause underdevelopment:Comprehensive analyses of the relationship. *Thesis*.

Some Remedies for Textbook Economic Theory

Macroeconomics – An Introduction

by Alex M. Thomas,
Cambridge University Press,
Cambridge, 2021. pp. xx + 234,
Paperback. Price not stated.

Odisha Economic Journal
Volume 53 • Issue 2 • 2021
pp. 176-179
Journal of the
Orissa Economics Association
OEA

Goddanti Omkarnath

Textbooks invariably enter into the moral structures of learning community. They shape, often for a life time, the student's belief system about her discipline. This is especially the case with modern textbooks on economic theory, what with the latter's highly convoluted history. As undergraduate education in economics becomes globally standardized, textbooks tend to promote mono-economics or the posturing that mainstream neo-classical theory constitutes the only theory available or at any rate it is the best.Further, withtextbookexposition couched in mathematical symbols and axiomatic reasoning,it is hard to judge whether the student is made to grasp theory or master its technique. Oscar Wilde's cynic may be someone 'who knows the price of everything and the value of nothing', but the contemporary student of economics may not have the faintest idea that her textbook theory of prices could be invalid.

We are faced with the dominant neo-classical economic theory which regularly fails in its primary task, namely to explain such basic phenomena of capitalism as prices, income distribution and growth; a theory which could neitheranticipate nor adequately account for any of the major crises that capitalism has witnessed over the past century; a theory which has been charged with a deep internal inconsistency arising from its explanation

Goddanti Omkarnath, Formerly Professor in School of Economics, University of Hyderabad, Hyderabad. Email: omkarnath.hyd@gmail.com

of profits; and finally a theory which, with all its failures as a science of capitalism, still pretends to have answers for the more complex problems of underdevelopment. Challenges of both curriculum and pedagogy arise here.One way forward for curricular reform is to allowmainstream theory to juxtapose with alternative theories.The teaching community must be supported in the production of a new series of pedagogic textbooks in this light. Pedagogy must moreover be sensitive to economic policies in operation, institutions and histories. The overarching principle must be that economic theory is but an instrument of policymaking.Such a synergy between curriculum and pedagogy will afford the student a genuine pleasure of discoveryapart from an identifiable set of professional skills.

Alex Thomas's new textbook marks a welcome beginning in this direction and the author admittedly found inspiration for the venturein his formative training in India (p. xviii). The introductory book is on macroeconomics, a branch dealing with theories of output and employment, money and prices and economic growthfor the capitalist economy. Departing from the conventional cut-and-dried format, Thomas orchestrates theory with a combination of history of economic thought, economic accounting, policies, data and measurement, and not the least, reflections on the applicability these theories to the Indian economy. In the illustration of specific institutions and processes in Indian economy, works of even vernacular literature are invoked. Together with its engaging prose, the bookwill be an attractive resource forthe student.

Three core chapters deal with money, output/employment and growth respectively.Another two chaptersconsider policies for employment and price stability. Much of the analysis turns on Keynes (Kalecki is mentioned but seems to be subsumed under Keynesian theory; p.66), the critique of pre-Keynesian theory (neutral money and the Say's Law), and a clear distinction between Keynesian (demand-led) growth theory and the neo-classical (supply-led) growth theory. The opening chapters provide relevant concepts and definitions. A novel feature of the accounting section is the inclusion of a flow-of-funds table, although all data refer to the Indian economy. It is rightly pointed out that pre-Keynesian theory is misidentified in textbooks with 'classical' theory (although Keynes himself was perhaps responsible for this as he called every economist before him, save Malthus, as 'classical'). A copious list of additional readings is provided at the end of every chapter while data sources are conveniently listed at the end.

We believe the book's purpose of promoting pluralism in the teaching of economic theory will be better served if in the next edition it draws upon some additional elements of both Keynes' and neo-classical theories.First, since full employment of labour and capacity is not an assumption but a conclusion of neo-classical theory, it is important that the studentunderstands the mechanism by which the strong conclusion is reached. The Say's Law,being a proposition, does not reveal that mechanism. The mechanism also goes deeper than the familiar statement offlexible prices and flexiblewageand interest rates. It resides in the smooth working of the supposedly universal principleofsubstitution. The principle, as readers of Marshall and Hicks know,forms the fulcrum on which the entire demand-supply-equilibrium theory turns. And it could be illustrated by a simple model of general equilibrium of two goods-two factors-two classes.Secondly and per contra, Keynes' conclusion of unemployment ina competitiveeconomy needs to be demonstrated by a device other than the usual Keynesian Cross diagram. In particular, the student's attention must be drawn to a key feature of Keynes' theory rarely highlighted in textbooks viz. the principle of the primacy ofquantities.In Keynes aggregate demand (a quantity) determines output (a quantity) and employment (a quantity) without so much as the mediation of prices and wages. In other words, there is a line separating the quantity variable from the price variable in goods as well as labour markets (This of course is a characteristic feature of all Classical and Marxian political economy). The component-wise explanation of aggregate demand -- consumption (C) and investment (I) -- will now fall in place, although here the student's attention needs to be drawn to the psychological foundations of Keynes' 'propensity to consume' and the 'marginal efficiency of capital'.

Thirdly, the demonstration of the multiplier as a process, as against its statement as a formula (1/s) or as a geometrical feature of an affine consumption function in the Keynesian Cross diagram, emerges clearly in the two-commodity model of Kalecki. The device of the 'box diagrams' developed by Professor Amit Bhaduri in his 1983 textbook remains an excellent pedagogic tool. Nothing comparable exists in Keynes' essentially one-commoditymodel. However, there is a substantivetheoretical reason why the Kalecki model must appear explicitlyin the book. Kaleckiestablishes a direct link between aggregate demand and income distribution, while Keynes only appeals vaguely to the marginal productivity principle. Fourthly, the discussion of Keynes' theory in the book will be incomplete

withouthis explanation of the price level.Fifthly, a rounded statement of Keynes' method must include the'wage unit' which is his standard for measuring aggregates.The author does discuss at length Keynes' adoption of the Marshallian 'short period'. But the student must know that Marshall needed the 'short period' in the first place to ward off the problem of returns to scale in his static theory.Finally, the student in this day and agemust be told that Keynes had sounded warning bells about two other threats to the stability of capitalism than just effective demand failures: (i) The threat of inflation of primary commodity prices and (ii) the threat of excessive speculation in asset markets. Strikingly enough, all the threats have been borne outby history: The first by the Great Depression; the second, by the two Oil Shocks of the 1970's; and the last, by the global financial crisis which broke out in 2008.

The success of textbooks of heterodox economic theories seems to depend on theirformat of presentation. Does the textbook rendition of a theory appearasan integrated'system'or as an assortment of loosely knit concepts and methods strewn all round?When conceived as a system, the primary objective of a given theory must beclosely aligned withthe theory's analytical structure and methods designed specifically to realize the stated objective. For example, we can identify systems such asthe neo-classical system, the system of Keynes or the system of Kalecki. Such a format allowsthe student to understand and evaluate a theory for its consistency and explanatory power. In the second case of an ad hoc choice of concepts and methods, the student will be disoriented and will have to seek refuge either in a historian of economic thought (taken to be a chronology of ideas) or in a methodology guru. The advantage for the student of such diversion, even if it were possible in semester programmes, is not obvious.We might seewhy the 1973 textbook by the redoubtable Joan Robinson (with John Eatwell) failed.The book under review does not attract this risk but we believe it could have done better by rolling out Keynes' system in some more detail, especially because most textbooks today reduce Keynes to the IS-LM chart.

Instructions for Authors

Before submitting the manuscript, authors are requested to read the aims and scope of the journal, instructions for submission and ethics in publishing. Papers not prepared accordingly may be turned down or would be asked to resubmit.

Organizing the Paper

File one

1. Title of the Paper: Title of paper should be limited within 14 words
2. Author(s) Name(s) and Institutional Affiliation(s) with Email id(s)
3. An Abstract within 250 words
4. Up to six Keywords with JEL Classification

File Two

1. Title of the Paper
2. Introduction
3. Review of Literature and Research Gap
4. Objectives
5. Methodology and Data
6. Analysis and Findings
7. Summary and Conclusions
8. References

Length of the paper: Maximum 8000 words including tables, references and notes
Font: Times New Roman font size 12.
Line Spacing: Double spacing

Referencing Style (in perusal of the APA Format)

Journal Article

Patnaik, P. (1998), Amartya Sen and the theory of public action. Economic and Political Weekly, 33(45), 2855-2859.

Book Chapter

Benito, G., & Gripsrud, G. (1995).The internationalization process approach to the location of foreign direct investment: An empirical analysis.In R. B. McNaughton, &M. B. Green (Eds.), The Location of Foreign Direct Investment: Geographic and Business Approaches (pp. 43-58). Aldershot: Avebury Press.

Book

Levien, M. (2018). Dispossession without development: Land grabs in neoliberal India. New York: Oxford University Press.

Website

Rao, M. G. (2017).Central transfers to states in India: Rewarding performance while ensuring equity. Report prepared for the NITI Aayog. Retrieved from https://niti.gov.in/writereaddata/files/document_ publication/Final%20Report_25Sept_2017.pdf(Date of last access Month Date Year)

Beck, T. (2015). Microfinance: A critical literature survey. (World Bank Independent Evaluation Group Working Paper No. 4). Retrieved from https://openknowledge.worldbank.org/handle/10986/23546 (Date of last access Month Date Year)

Submission Checklist

Ensure the following before submitting the manuscript:

- Full name(s) of author(s) with e-mail ids, mobile/phone numbers and full postal address(es)
- For multi-authored manuscript, designate one as the Corresponding Author
- Include an Abstract (200-250 words) and Keywords (up to 6)
- All tables, figures, maps, appendices, etc. referred to in the text must have numbers, titles and sources; add notes and units wherever relevant
- Ensure only those references cited in the text are present in the 'References' list and these must be complete in all respects; for online sources, complete URL and date of last access must be mentioned
- Check for grammar and spellings
- Obtain prior permission for use of any copyrighted material from other sources (including the Internet)
- Mention any conflict of interests (or, its absence) involving the manuscript

All correspondence must be addressed to editoroej@gmail.com


ORISSA ECONOMICS ASSOCIATION