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- ▶ Research Articles
- ▶ Book Reviews/Review Articles
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Editorial

This issue of the *Odisha Economic Journal* contains a set of interesting policy-oriented articles based on detailed empirical analyses. The issues covered relate to taxation, farming, growth, local banks, MSMEs, education and climate change adaptation. Of these seven articles three are Odisha related.

The first article (by Shubham Garg, Karam Pal Narwal and Sanjeev Kumar) deals with if and how the announcement of Goods and Services Tax (GST) impacted the stock market in India. Employing the GARCH model and half-life of volatility decay methodology the paper shows that the volatility in the Indian stock market index reduced drastically with the announcement of GST. This has policy implications for traders and investors. Another article (by Ahab Rizvi and Shahid Ashraf) undertakes takes a comparative study between India and Pakistan in assessing the impact of climate change on the yield of rice. The study makes a case for providing subsidised agricultural inputs, improvement in irrigation and better weather forecasting technologies. These initiatives would contribute to boost farm productivity.

In an enquiry into the growth and relative economic position of the state of Odisha, a paper (by Priyabrata Sahoo) observes that even as during the post-1990s Odisha recorded faster growth, in per capita income terms its performance was much lower compared several other states. The growth driver remains the tertiary sector raising questions about if manufacturing and even the primary sector have been sidelined in the process. Another article (by Ranjan Kumar Nayak) looks into determinants of profit of District Central Cooperative Banks (DCCBs) in Odisha. Considering several variables, it concludes that cost of management, working capital and per employee business are important factors towards raising profit of the DCCBs. The analysis also finds that loans, advances, income and investment are key determinants.

Taking the case of a relatively less developed Mayurbhanj district a paper (by Minati Mallick and Pragyan Parimita Nayak) explores the impact of

COVID-19 pandemic on the MSMEs, with reference to their growth, investment, production and employment. The study informs that MSMEs, especially those unregistered, had experienced substantial drop in their business. The shutting down of enterprises had rendered hundreds jobless. As MSMEs remain a vital sector for growth and employment, state must pay careful attention to their needs.

Focusing on school infrastructure and its relation with educational outcomes a paper (by Subhransu Sekhar Sahoo and Mitali Chinara) observes that key facilities as computers, girls' toilets and even boundary walls contribute towards transition. It suggests that such investments in school infrastructure would not only meet aspirations of children but also help attain Sustainable Development Goals.

The next article (by Thomson Kaleekal and Radhika K.) is an attempt to identify major determinants of strategies for climate change adaptation and details how small and marginal farmers in coastal wetlands of Kerala state combine these strategies to make a living. Farmers typically opt for various coupling strategies to speed up their transition from non-viable land uses to climate-resilient cultivation practices and crop selections. Such a choice, however, depends on the availability of affordable technologies, ecological changes brought in by climate change and institutional incentives.

In the Research Note/ Commentary (by Anuradha Gulati Dasgupta and Nidhi Gupta) an assessment is made of the impact of Common University Entrance Test (CUET) on undergraduate admissions in the University of Delhi. It is held that while this initiative has been unable to curb the culture of high cutoffs it has led to a drop in the admission of girl students.

This issue includes two book reviews.

Keshab Das
Executive Editor,
Odisha Economic Journal

Article

GST Implementation and Stock Market Index Volatility and Efficiency: Empirical Evidence from Indian Stock Market

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Shubham Garg
Karam Pal Narwal
Sanjeev Kumar

Abstract

The current study examines the impact of the Goods and Services Tax (GST) announcement on the volatility and efficiency of the stock market index in India. The study uses the daily closing prices of the NIFTY-50 and NIFTY-50 future index from April 2011 to April 2019. Moreover, the study has employed the GARCH (1, 1) modeling and half-life of volatility decay methodology for achieving the objectives of the study. The result shows that the volatility in the Indian stock market index is reduced drastically with the announcement of GST in India. The findings are supported by the market expectation that the implementation of GST will reduce the tax

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burden on consumers and producers by eliminating the cascading effect of taxation. The results are supported by the APT, Proxy effect, and Tax effect hypothesis and unsupported by Efficient Market Hypothesis. The current study is helpful for investors and traders and will act as a roadmap for government and policymakers in future policy formation and announcement of macroeconomic policies.

Keywords: Arbitrage pricing theory; Goods and Services Tax; Market efficiency; Tax effecthypothesis; Volatility clustering.

1. Introduction

The Goods and Services Tax (GST) is a major tax reform in tax structure to combine all indirect taxes under an umbrella for the creation of 'One Nation, One Market, and One Taxation' by removing the cascading effect of taxation in India (Sherawat and Dhanda, 2015). Over worldwide, 160 countries have already adopted the GST in their respective territories[1]. GST is a consumption- based taxation system in which tax is levied on value addition in each stage of the manufacturing process. It is an important component of long-term fiscal reform initiative of the Indian government. The implementation of the GST is anticipated to endow with the much-essential stimulant for the economic growth to the Indian economy by changing the existing system of taxation for free movement of goods and services in the economy and also removing the cascading effect of tax on already paid taxes (Khoja and Khan, 2020). However, the proposed GST regime for India's economy is well criticized before its implementation due to the inflationary impact of GST in other countries. Valadkahni and Layton (2004) revealed that the adoption of GST increases the prices of goods and services by 2.6% during its implementation stage in Australia. However, the impact of inflation was found to be transitory which prevails only in the short-run during its implementation. Similarly, Sahoo *et al.,* (2017) found in their study that out of 8 countries that have implemented GST in their respective territories, China faced an inflation increase of 9.81% in the introductory year and an increase of 15.215% in the immediately subsequent year. However, according to their study New Zealand and Portugal experienced a price drop after GST implementation. Palil and Ibrahim (2011) also found in their study that the consumers were worried about price hikes of at least

4% with the implementation of GST in Malaysia. The introduction of GST in Malaysia has sparked debate among academicians, professionals, policymakers, and the general public on how GST will affect the cost of products and services. Malaysians also believed that the adoption of GST would have a detrimental effect on society and cause inflation, as their economy was already heavily dependent on household spending (Islam *et al.*, 2017). Similarly, Sankar R (2017) has found that the GST implementation has a favorable impact on the Indian economy as a whole. But on sectoral classification, the GST has both pessimistic and optimistic effects on every industry, creating a speculative environment of uncertainty and anxiety among investors and shareholders.

The announcement of the macroeconomic news usually came as a shock and create an environment of uncertainty in an economy as some sections of the society get benefit from it while other sections bear it up. Similarly, the announcement of the GST in the Indian economy has changed the tax structure for the whole Indian economy as some industries have gained a benefit from it, while others have borne up an increase in their tax rates. The adoption of the GST is a new experience for the Indian economy and Indian households as it creates an environment of anxiety, worries, and uncertainty in the economy for taxation to various industries which can cause worries, shocks, and uncertainties indirectly to the stock market. The prediction of the stock market volatility has long been a subject of immense interest for both market participants and policymakers. The existing literature has confirmed the notion that the change in government micro and macro-economic policies affect the daily fluctuations in stock prices. Zare *et al.* (2013) found that monetary policy announcement has a higher impact on the volatility of the stock market in bear periods in comparison to bull market periods, as predicted by finance constraint models. Adra and Menassa (2022) demonstrate that the shock cause by monetary policy decision of Federal Reserve plays an important role in determining both risk adjusted and absolute returns from value investing. Similarly, Rangel (2011) investigated the impact of the macro-economic announcement on the volatility of the stock market using the Poisson-Gaussian GARCH process. They found that the announcement day has a very small impact on the volatility for most of the macro-economic announcements except for employment announcements which tend to boost stock market volatility on the day of the announcement.

Bora and Basistha (2021) analyzed the impact of covid-19 outbreak on the volatility of the Indian stock market. They revealed that the returns in the pre covid-19 period were higher in comparison to post covid-19 outbreak period. Similarly, Ghosh and Bhattacharyya (2014) found that an expansionary monetary policy lowers the volatility of both the bid-ask spread and weighted average call rate. Narayan (2014) examined the four major concerns of implementation of GST as an increase in the price level, regressive nature of GST law, possibilities of increasing GST rate regularly with time, and potential misuse of GST revenue by the negligent government due to corruptive practices. Prabu *et al.*, 2016 also studied the impact of monetary policy announcement on the stock market in India. Their results revealed that the announcement of rigid monetary policy has negative impact on stock indices, but the results are statistically insignificant. Moreover, the announcements of unanticipated policies have a positive but weak impact on banking sector indices specially. Haron and Ayojimi (2019) investigated the effect of announcement of GST on the stock market index of Malaysian namely KLCI and KLCI-F by controlling the effect of CPI, PPI, and unemployment. They found that the Malaysian stock market volatility enlarge with the GST announcement in comparison to the pre-GST period demonstrating that the awareness programs organized by the Malaysian government before the announcement of the GST do not yield meaningful results. Cakan *et al.*, (2015) analyze the impact of the US macroeconomic announcement surprise on the 12 emerging stock markets with the application of the GJR- GARCH model. They found that the volatility shocks are persistent and any bad news about the US inflation increases the asymmetric volatility in 5 out of 12 countries under the study and that volatility asymmetric jump up with bad news about US unemployment in 4 out of 12 countries.

The existing literature has well documented that the stock market indexes are volatile and they begin responding to future events even before they occur (Haron and Ayojimi, 2019). This indicates that a piece of information has a significant impact on the volatility of the stock market index. These kinds of shocks and policy amendments create uncertainty in the market as already documented in previous studies. Therefore, because of the time-varying volatility nature of the financial time series, the study has employed the volatility model (GARCH 1, 1) to investigate the impact of the macroeconomic announcement stock market returns volatility. Thus, the purpose of the current study is to examine the impact of the announcement

and implementation of GST in India on the Indian stock market index volatility by segregating the event period into pre and post-GST period.

2. Review of Literature

For as long as the stock market is functioning, the investors and traders have attempted to examine and forecast the future prices of securities and capital market changes to earn profitability and security of their invested funds (Celebi and Hönig, 2019). The common consensus is that asset prices are sensitive to economic news. The concept that independent asset values are affected by a vast range of unpredicted events and that certain events have a more extensive impact on asset prices in comparison to others appears to be supported by daily experience (Chen *et al.,* 1986).

The fact that the volatility of the stock market is driven by the uncertainty in the macro-economic variables and the announcement of the changes in the macroeconomic policies is well documented in past literature (Fama, 1981; Chen *et al.*, 1986; Wasserfallen, 1989; Boyd *et al.*, 2005; and Haron and Ayojimi, 2019). The inflationary era during the time period of the 1970s attract the attention of the researchers to study the relationship between stock prices and inflation, especially for the developed economies. Fama (1981) revealed a negative association between stock returns and inflation and they found that the stocks perform as a poor hedge against inflation. They clarify this negative association with their "proxy effect hypothesis": positive relationship in real activities and stocks and negative association between the inflation and real activities jointly leads to the negative association between inflation and stock market returns. Feldstein (1983) proposed the tax effect hypothesis and they argued that stock market returns are negatively affected by inflation because depreciation and inventory valuation are taxed indifferently. As a result, inflation incorporates a corporate tax liability on a firm and diminishes their after-tax real earning resulting in lowering their stock returns.

The theoretical explanations given by these theories i.e., risk premium, tax hypothesis, and proxy hypothesis have been empirically tested in studies conducted by Mandelker *et al.*, 1985; McCarthy *et al.*, 1990; and Cochran; Defina, 1993 and Lee, 1998. Chen *et al.,* 1986 studied the influence of macroeconomic variables on the returns of the stock market and their effect

on assets pricing by using the APT. They revealed that the term structure spread, industrial production, and expected and unexpected inflation are significant factors for stock markets. As Goods and Service Tax is levied on real activities i.e. selected goods and service taxes in an economy (Haron and Ayojimi, 2019). Therefore, the relationship between the announcement of macroeconomic news i.e. implementation of GST, and volatility of the Indian stock market index can be examined through the tax effect and proxy effect hypothesis proposed by Feldstein, 1983 and Fama, 1981 respectively. Mutually these theories claim that macroeconomic factors lower the stock market returns. The share prices are generally moved in response to the upcoming information which has not been expected by the market participants. Similarly, the Efficient Market Hypothesis (EMH) has also shown that the impact of the surprise news on the stock market is instantaneous. Davies and Studnicka (2018) have found that the UK's decision to leave the EU negatively affect the stock market sentiments and the initial relative loss occurred due to this reason to global value chain (GVC) firms were not reversed even after the recovery of the market. Wagner *et al.*, (2018) discover a significant reaction of corporate tax reforms 2017 in the USA on stock market, particularly among high-tax companies, and conclude that taxes form *very important* components of firm value.

The present study differs from previous studies in many ways conducted in this area for India. First, the previous studies have mainly focused on the impact of the Asian and global crisis i.e. stock market crash during 2007, and demonetization on the Indian stock market volatility. This study differs from past studies on Asian markets by integrating the time-varying volatility features of financial series and investigating the impact of the macro-economic announcements on stock market volatility in India. Moreover, this study also controls the impact of other macroeconomic variables which equally triggered the Indian stock market index volatility to avoid spurious results while observing the impact of GST on stock market volatility. The current study is unique which has focused on the impact of GST implementation stock market volatility of India. This study adds to the existing literature by examining the relation between macroeconomic news uncertainty and stock return volatility in a developing and emerging stock market. Secondly, as a novel study, this study enriches the existing literature significantly in this context and provides a pathway of future directions for further study in this domain. Thirdly, this study contributes to developing a better understanding of how macroeconomic news announcement affects small emerging stock markets i.e., India, whose institutions, organizations,

and structure are dissimilar to other developed stock markets. Bernile *et al.* (2016) also emphasized the necessity of assessing the market expectations and the variations in the pre and post announcement periods before releasing the scheduled news.

3. Data and Research Methodology

The present study has examined the impact of the implementation of the GST on the Indian stock market index volatility. The Nifty-50 and Nifty-50 future index have been taken as a proxy to the Indian stock market index volatility due to high liquidity and active traders in Nifty-50. The daily closing prices of the Nifty-50 and Nifty-50 future index are obtained from the website of Nifty India ranging from 1st April 2011 to 30st April 2019. The daily closing prices have been selected as the day-wise information is mostly reflected in the closing prices of the stock index (Mo *et al.*, 2018). To provide an unbiased view of the impact of GST implementation on Indian stock market volatility, it becomes imperative to control other macroeconomics variables that directly affect the volatility of the Indian stock market index. A lot of research has already affirmed that macroeconomic variables affect the return of the stock market (Fama and Schwert, 1977; Kaneko and Lee, 1995; and Lee 1992). Similarly, Ibrahim and Aziz (2003), Booth and Booth (1997), Mookerjee and Yu (1997), Maysami and Koh (2000), and Chen (2007) found that the uncertainty in the inflation rate, interest rates, money growth, reserves, and exchange rates may affect the financial market and return volatility. Tripathy (2011) found that any modification in the interest rate, exchange rate, and international market considerably influence the stock market in the Indian economy and vice-versa. Similarly, Kennedy and Nourizad (2016) investigated the impact of the volatility of the US Dollar's exchange rate against the Euro on stock market volatility. They found in their study that if major drivers of the stock market volatility are controlled, any increase in the volatility of the exchange rate has a favorable and statistically significant impact on the stock market volatility. Therefore, it becomes necessary to control the effect of such macroeconomic variables to provide unbiased results (Haron and Ayojimi, 2019). The volatility in the exchange rate and interest rate is considered as one of the most economic factors that are connected with inflation. Therefore, the present study has taken macroeconomic variables (Exchange and MIBOR rate) as controlling variables to prevent the biasness in the results of the study. The MIBOR rate has been used as a proxy for the interest rate in the Indian economy.

The daily data of exchange and MIBOR rate has been obtained from the official website of the RBI.

To study the effect of GST adoption on the Indian stock market, the return series of the Nifty-50 and Nifty-50 future index has been segregated into different groups and sub-groups to offer a more extensive view of the impact of GST adoption on the Indian stock market volatility. The first set of data covers the period from 1st April 2011 to 18th December 2014 (as on 19th December 2014, the Constitution Amendment Bill was introduced in Lok Sabha) which captures the Indian stock market volatility before the adoption of the GST in the Indian economy. The second set of data ranges the period from 19th December 2014 to 30th April 2019 which captures the Indian stock market volatility after the announcement of GST in India. The second set of the data has been additionally segregated into two different sub-groups to scrutinize the difference in the stock market volatility before and after the GST implementation in India. The data of the first subset cover the period from 19th Dec 2014 to 30th June 2017 which captures the Indian stock market volatility during the period of announcement of GST in India and the second subset covers the data from 1st July 2017 to 30th April 2019 that captures the volatility of Post-GST implementation in India. The data of the closing prices of the Nifty-50 and Nifty-50 future index has been transformed by the use of logarithm compounding returns as shown below:

$$NR_t^{sf} = \log\left(P_t^{close} / P_{t-1}^{close}\right) \times 100 \quad (1)$$

Where NR_t^{sf} represent spot or future returns of the Nifty-50 and Nifty-50 index, P_t^{close} represents current closing prices of the spot or future index prices, and P_{t-1}^{close} represents lagged closing prices of the spot or future index.

Unit Root Test

Before applying any statistical modeling on financial time series, there is a universal precondition to check the stationarity of the financial time series as modeling with non-stationary data may yield spurious and misleading results (Haron and Salami, 2015). To check the stationarity of the data, the ADF and PP unit root test statistics have been used as below:

$$\Delta y_t = \propto + \beta t + \delta y_{t-1} + \sum_{i=1}^{k} \emptyset_i \, \Delta y_{t-i} + \varepsilon_t \qquad (1)$$

$$\Delta y_{t-1} = \propto_0 + \rho y_{t-1} + \varepsilon_t \qquad (2)$$

Where y_t = price series, $\propto$ = constant, β = coefficient on a time trend, k= maximum length of the lagged dependent variable, $\emptyset_i$ = parameter of lagged first, Δy_t = first difference of series y_t, ε_t = pure white noise error term.

The return series of NR_t^S and NR_t^f are stationary at level (i.e. integration of order 0, *I*~ (0)) which demonstrate the satisfaction of the mean reversion property of the nifty-50 and nifty-50 future return series for suitability of application of GARCH modeling on return series. In the control variable, the log exchange rate is stationary at level ((*I*~ (0)), and the MIBOR rate is integrated of order 1 (*I*~ (1)).

Specification of GARCH Model

The study has employed the GARCH (1, 1) model to evaluate the Indian stock market volatility concerning the announcement and implementation of GST in India, while controlling other macroeconomic variables that equally affect the Indian stock market index volatility. This model is an extension of the ARCH model evaluated by Bollerslev (1986), which allows us to express conditional variance as an ARMA process, making it a more efficient alternative to high-order ARCH models. The autoregressive moving average model (ARMA) is considered while developing the mean equation of the model. The AR and MA specifications are collectively used to formulate ARMA model (i.e. AR + MA = ARMA) (p, q) specifications:

$$Y_t = \alpha + \varepsilon_t + \sum_{i=1}^{p} \delta_i y_{t-i} + \sum_{i=1}^{q} \emptyset_i \varepsilon_{t-i} \qquad (3)$$

Where Y_t represents the normal returns for the time period t, δ_i represents the AR coefficient, the parameter p and q represents the autoregressive and moving average of the model respectively, $\emptyset_i$ represents MA coefficient and represent error term. The study has used the values of AIC, SIC, Adjusted R^2, SIGMASQ, and log-likelihood to select the best fitted parsimonious AR and MA models which will describe the nifty-50 index best.

The specified mean equation for and return series is expressed as below:

$$NR_t^S = \propto + \beta_1 NR_{t-i}^f + \beta_2 NR_{t-i}^s + \beta_3 \varepsilon_{t-i} + LNEXR_t + \Delta MIBOR_t + \varepsilon_t \quad (4)$$

$$\varepsilon_t | I_{t-1} N(0, h_t)$$

Where represent spot prices of Nifty return series; represent future prices of nifty return series; represent the lagged value of the return of nifty-50 future series with time-lagged i, represent log Exchange Rate at time t; represent error term in fulfilling the assumptions of represent the information set at time t-1, and N represents normal distribution. The GARCH modeling is one of the best models for studying the stochastic volatility in the area of stock market, derivatives securities i.e. option and futures. The empirical evidence from the past literature has illustrated GARCH (1, 1) as typically one of the best model for volatility measuring (Gokcan, 2000, Hansen and Lunde, 2003 and Haron and Ayojimi, 2019) Therefore, because of the time-varying volatility nature of the financial time series, the study has employed the volatility model (GARCH 1, 1) to investigate the impact of the GST announcement on stock market returns volatility as expressed in equation (5):

$$\sigma_t^2 = \propto_0 + \sum_{i=1}^{q} Y_i \, \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \lambda_j \, \sigma_{t-j}^2 \quad (5)$$

Where> 0; .... 0 and …. 0; is to ensure a positive conditional variance. A GARCH (1, 1) model has been developed by putting p = q =1 in equation (3) that develops the below equation:

$$\sigma_t^2 = \propto_0 + Y_1 \varepsilon_{t-i}^2 + \lambda_j \sigma_{t-j}^2 \quad (6)$$

The assumption of + < 1 is enough to guarantee positive conditional variance.

Where stands for conditional variance summed of its values and squared error lagged values; p and q are two positive integer represent the ARCH term and short-run persistency or a measure of innovation effect on volatility; represent the GARCH term of the model or as an impact of the past value of volatility on today's volatility. The long-run persistency in the market is calculated by the sum of the GARCH and ARCH term i.e. +. The optimality of the model has been decided based on AIC; SIC criterion; Adjusted R square; and numbers of coefficient significance.

In order to examine the efficiency of the Indian stock market with the announcement of GST in India, half life of volatility decay has been employed in the current study as express below:

Half life of volatility decay = $\frac{Log\ .5}{Log\ (\lambda_j + \gamma_i)}$ (7)

4. Results and Discussion

Table 1 represents the descriptive statistics for the Nifty-50 and Nifty-50 future index return series. For all groups and subgroups, the mean return of and prices are positive throughout the whole period which shows that investors have earned a positive rate of returns on their investment before and after the implementation of GST in India during the period of the study. The standard deviation of NR_t^s and NR_t^f prices are positive though out the whole period and are less than unity for all groups. The standard deviation and mean values show that unconditional daily returns of NR_t^s and NR_t^f have flatter tails in contrast to a normal distribution with assumed homoscedasticity and normality.

Table 1 Summary Statistics of Return Series of Nifty-50 and Nifty-50 Future Index

All Data	Mean	Min.	Max.	SD	Skewness	Kurtosis	Jarque -Bera	N
1st April 2011 to 20th May 2019								
NR_t^s	0.000358	-0.060973	0.03738	0.0096	-0.202063	4.991103	331.6007*	1928
NR_t^f	0.000136	-0.062076	0.038107	0.00976	-0.225573	5.121319	377.85*	1928
Pre-GST Announcement								
1st April 2011 to 18th Dec 2014								
NR_t^s	0.000364	-0.041689	0.03738	0.010689	0.027072	4.065714	42.03617*	886
NR_t^f	0.000108	-0.045239	0.038107	0.010989	0.022280	4.134506	47.58893*	886
Post-GST Announcement								
19th Dec 2014 to 30th April 2019								
NR_t^s	0.000353	-0.060973	0.033115	0.008572	-0.571272	6.185709	497.301*	1042
NR_t^f	0.000159	-0.062076	0.030921	0.008574	-0.649784	6.421253	581.5162*	1042
During GST announcement								
19th Dec 2014 to 30th June 2017								
NR_t^s	0.000254	-0.060973	0.033115	0.009331	-0.636683	6.524125	355.1183*	607
NR_t^f	0.0000346	-0.062076	0.030921	0.009288	-0.757274	6.859255	434.7058*	607
After Implementation								
1st July 2017 to 30th April 2019								
NR_t^s	0.00049	-0.027044	0.022974	0.00739	-0.316085	3.642239	14.71949*	435
NR_t^f	0.000334	-0.027086	0.022617	0.007472	-0.286714	3.742753	15.95908*	435

Source: Authors' Computation

Notes: and represent spot return (Nifty-50) and future return (Nifty-50 future index) respectively. The total data of the study are segregated on the basis of the date of the event (i.e., announcement and implementation of the GST in the Indian economy) and statistics result is provided accordingly.

* Significant at 1% level.

This demonstrates the suitability of data for GARCH modeling. The value of kurtosis indicates that the return series of Nifty-50 and Nifty-50 future index is leptokurtic as the value of kurtosis significantly deviated from 3 for all the groups and sub-groups of the return series which demonstrates the non-normality distribution assumptions of the return series. However, the return series of the Nifty-50 series reduces during the period of GST announcement and the post-announcement period in comparison to the pre-GST announcement period in the short-run and the market makes its correction with time. Similarly, the Nifty-50 and Nifty-50 future index is positively skewed before the announcement of GST in the Indian economy which has shifted to negatively skewed with the announcement of GST tax reforms in India. Moreover, the result of the Jarque-Bera test rejects the assumption of normality for both return series at 1% significance since the p-value is less than 0.05 for both return series as indicated in Table 1. This implies that the values of the return series are significantly higher than in a normally distributed series.

Table 2 presents the result of the unit root test which is carried out at level as well as at first difference with ADF test and PP test. The key difference between the PP unit root test and the ADF test is how both of these tests deal with the serial correlation. The ADF uses a parametric autoregression to simulate the structure of errors, whereas the PP test does not consider any serial correlation (Jain *et al.*, 2013). A financial time series is assumed to be stationary when the statistical properties of a distribution i.e. mean, variance, and covariance of the distribution remain constant throughout the time or the series is not displaying any trend over time. If a financial series is found to be non-stationary, then it needs to be corrected by employing differencing (Idrees *et al.*, 2019) The result of the ADF and PP unit root test illustrates that the spot and future returns of the nifty-50 and nifty-50 future index is statistically significant and stationary at level as the computed t-statistics is greater than the test critical values as shown in

table 2. Under the control variables of the study, the log exchange rate is found to be stationary at level as the computed t-statistics for all groups and subgroups of the study is greater than the critical value. However, the MIBOR rate is stationary at first difference as indicated under the decision row in Table 2. Hence, in further analysis, and the exchange rate has been considered as integrated of I(0), and the MIBOR rate is considered as integrated of I(1).

Before applying the conditional variance modeling, it is critical to examine the residuals to find out the presence of the autoregressive conditional heteroscedasticity in the residuals. The ARCH LM test is a test statistic that is used to check the presence of an arch effect by regressing the squared errors on its lags with the h_0 that the lagged regression coefficient is 0 for all i =1…q. The use of the ARCH LM test before proceeding to GARCH modeling is well documented in past literature (Lin, 2018; Endri *et al.*, 2020; and Fang *et al.,* 2020). However, ARCH does not invalidate LS inference but ignoring the ARCH effect may result in loss of efficiency in financial time series. Therefore, to check the existence of the heteroscedasticity in the residuals of the dependent variables, the Lagrange Multiplier (LM) test proposed by Engle (1982) has been employed to confirm whether the ARCH term coefficient (Y_1)is statistically significant or not as presented in Table 3. The ARCH LM test validate the existence of the ARCH effect in the residuals of the return series with other established stylize facts showing the suitability of data for the estimation of the GARCH family models (Ekong and Onye, 2017).

Table 2: Results of Unit Root Test

Data groups	Test Statistics	Trend and Intercept level	Test Statistics				Test Critical Values	
			NR_t	NR_f	LNEXR	Δ MIBOR	1%	5%
All Data	ADF	Int.	-40.62 (0.00)*	-41.88 (0.00)*	-43.84 (0.00)*	-23.17 (0.00)*	-3.44	-2.86
1st April 2011 to	PP	Trend and Int.	-40.62 (0.00)*	-41.89 (0.00)*	-43.88 (0.00)*	-23.18 (0.00)*	-3.97	-3.41
30th April 2019		Int.	-40.59 (0.00)*	-41.88 (0.00)*	-43.97 (0.00)*	-86.79 (0.00)*	-3.44	-2.86
		Trend and Int.	-40.59 (0.00)*	-41.89 (0.00)*	-43.98 (0.00)*	-88.42 (0.00)*	-3.97	-3.41
Pre-GST	ADF	Int.	-26.85 (0.00)*	-27.94 (0.00)*	-29.56 (0.00)*	-15.67 (0.00)*	-3.44	-2.86
Announcement		Trend and Int.	-26.92 (0.00)*	-27.99 (0.00)*	-29.56 (0.00)*	-15.68 (0.00)*	-3.97	-3.41
1st April 2011 to	PP	Int.	-26.76 (0.00)*	-27.91 (0.00)*	-29.60 (0.00)*	-48.13 (0.00)*	-3.44	-2.86
18th Dec 2014		Trend and Int.	-26.86 (0.00)*	-27.97 (0.00)*	-29.59 (0.00)*	-48.55 (0.00)*	-3.97	-3.41
Post-GST	ADF	Int.	-30.77 (0.00)*	-31.38 (0.00)*	-32.89 (0.00)*	-23.47 (0.00)*	-3.44	-2.86
Announcement	PP	Trend and Int.	-30.77 (0.00)*	-31.39 (0.00)*	-32.87 (0.00)*	-23.52 (0.00)*	-3.97	-3.41
19th Dec 2014 to		Int.	-30.73 (0.00)*	-31.37 (0.00)*	-32.96 (0.00)*	-65.45 (0.00)*	-3.44	-2.86
30th April 2019		Trend and Int.	-30.73 (0.00)*	-31.38 (0.00)*	-32.95 (0.00)*	-68.30 (0.00)*	-3.97	-3.41
During-GST	ADF	Int.	-23.48 (0.00)*	-23.91 (0.00)*	-23.36 (0.00)*	-18.19 (0.00)*	-3.44	-2.86
Announcement		Trend and Int.	-23.49 (0.00)*	-23.89 (0.00)*	-23.41 (0.00)*	-18.23 (0.00)*	-3.97	-3.41
19th Dec 2014 to	PP	Int.	-23.47 (0.00)*	-23.89 (0.00)*	-23.34 (0.00)*	-55.04 (0.00)*	-3.44	-2.86
30th June 2017		Trend and Int.	-23.49 (0.00)*	-23.91 (0.00)*	-23.39 (0.00)*	-58.90 (0.00)*	-3.97	-3.41
After	ADF	Int.	-19.96 (0.00)*	-20.46 (0.00)*	-22.44 (0.00)*	-25.44 (0.00)*	-3.44	-2.86
Implementation		Trend and Int.	-19.94 (0.00)*	-20.44 (0.00)*	-22.42 (0.00)*	-25.41 (0.00)*	-3.97	-3.41
1st July 2017 to	PP	Int.	-20.00 (0.00)*	-20.49 (0.00)*	-22.42 (0.00)*	-29.28 (0.00)*	-3.44	-2.86
30th April 2019		Trend and Int.	-19.97 (0.00)*	-20.47 (0.00)*	-22.40 (0.00)*	-29.25 (0.00)*	-3.97	-3.41
Decision			I(0)	I(0)	I(0)	I(1)		

Notes: NR_t and NR_f represent spot return (Nifty-50) and future return (Nifty-50 future index) respectively. The total data of the study are segregated on the basis of the date of the event (i.e. announcement and implementation of the GST in India) and statistics result is provided accordingly. Int. show Intercept. P-values are provided in parenthesis. * denotes significant at 1% level.

Table 3: Results of ARCH LM Test

Statistic	Pre-GST Announcement	Post GST Announcement	During-GST Announcement	After GST Implementation
LM-Statistics				
($N*R^2$)	10.42488*	38.99140*	23.39049*	14.78059*
Decision	There exist an ARCH effect	There exist an ARCH effect	There exist an ARCH effect	There exist an ARCH effect

Source: Authors' Computations

Note: *Significant at 1%

Upon confirming the presence of the ARCH effect in the return series, the GARCH model has been executed to examine the impact of GST on Indian stock market index volatility whose results has been displayed in Tables4 and 5. The optimality of the GARCH model has been evaluated based on AIC, and SICs information criterion, minimum volatility persistence, and maximum log-likelihood ratio. The GARCH (1, 1) model with the smallest values of MAE and RMSE has been considered as the best-fitted model. Tables IV and V provide the empirical results of the impact of GST implementation on Indian stock market index volatility. In each group and subgroup, the ARCH term and GARCH term ($\propto_0 > 0 \ldots Y_1, Y_2, Y_3, \ldots Y_q \geq 0$; and $\lambda_1, \lambda_2, \lambda_3 \ldots\ldots \lambda_p \geq 0$) satisfy the condition of non-negativity to ensure positive variance (Jafari *et al.*, 2007; Haron and Ayojimi, 2019).

Table 4: Results of GARCH model (1, 1) for pre and Post-GST Announcement Period

Statistic types	Regressors	Pre-GST Announcement Period	P-value	Post-GST Announcement Period	P-value
Mean Equation	$\propto$	0.000267	0.00*	0.000184	0.00*
	AR(6)	0.096122	0.0048*	-	-
	MA(1)	-0.41432	0.00*	-0.47541	0.00*
	NR_t^f	0.962834	0.00*	0.987748	0.00*
	NR_{t-1}^f	0.018	0.00*	0.012277	0.0008*
	LNEXR_t	-0.04011	0.00*	-0.01131	0.2413
	Δ MIBOR_t	-5.28E-05	0.6194	-0.00031	0.3452
Variance Equation	$\propto$	9.72E-08	0.0894***	1.26E-07	0.049**
	(GARCH-term)	0.900075	0.0443**	0.80642	0.00*
	Y (ARCH-term)	0.039313	0.00*	0.084899	0.0018*
	T-DIST DOF	12.61185	0.0355**	28.11049	0.2089
	AIC	-10.5258	-	-10.8423	-
	SIC	-10.4663	-	-10.7947	-
	HQC	-10.5031	-	-10.8242	-
	Adj. R^2	0.986201	-	0.98382	-
	MAE	0.000972	-	0.000919	-
	RMSE	0.001253	-	0.001176	-
	D-W	1.996469	-	1.878265	-
Diagnostic Testing	ARCH-1	-	0.843	-	0.3948
	QStatistics	16.613	0.343	13.079	0.667
	Q^2 Statistics	16.828	0.466	16.653	0.478

Source: Authors' computation.

Notes: NR_t^s and NR_t^f represent spot return (Nifty-50) and future return (Nifty-50 future index) respectively. The optimality of the GARCH model parameter (p, q) is determined by the SIC and AIC criteria. The total data of the study are segregated on the basis of the date of the event (i.e. announcement and implementation of the GST in the Indian economy) and statistics result is provided accordingly. The GARCH model with the smallest values of MAE and RMSE is selected as the optimum-fitted model.

*, **, *** Significant at 1%, 5% and 10%, respectively.

Pre GST Announcement Period

The conditional mean equation of Table IV shows that the mean of the Indian stock market index (NR_t^s) is affected by its own past values, current and lagged return of future prices, and random error or innovation of yesterday This represents that the performance of the spot market and the

futures markets are essential for the current returns in the Indian stock market. The positive and highly statistical significant coefficient of NR_t^f shows that the future market plays its role to alleviate price risk exposures to ensure that investors earn at least a risk-free return regardless of the volatility in the Indian stock market index. The GARCH and ARCH term in the variance equation of the GARCH model provide details on the short run and long run volatility in the Indian stock market index respectively. The ARCH parameter (Y) reveals the volatility in the current returns due to past innovations while the GARCH term (A) reveals the presence of volatility persistency in the stock market during the pre and post-GST announcement period. The coefficients of the GARCH and ARCH terms are highly significant for both the pre and post-GST period which evident the presence of short runs and long-run volatility clustering. The sum of the ARCH (1) – lagged squared residuals and GARCH (1) – lagged conditional variance parameter coefficients is (0.939388), which indicates that stock market volatility is highly persistent prior to the GST announcement in India. The volatility in the short-run is smaller in magnitude as indicated by the ARCH term in comparison to the long-run volatility denoted by the GARCH term. Investors should not be worried about short-run volatility in the Indian stock exchange index as short-run volatility should be wiped off in the short period and arbitrage opportunity is short-lived (Basher and Sadorsky, 2016, Haron and Ayojimi, 2019). The macroeconomic variables i.e. interest rate and exchange rate are significantly stable and do not yield any negative effect that may trigger the Indian stock market volatility. This indicates that in the pre-GST announcement period, the Indian stock market volatility is highly persistent and investors are not exposed to greater risk. The results of the pre-GST period are supported by the Arbitrage pricing theory as more than one macroeconomic variable helps in determining the prices of the Indian stock market index.

Post-GST Announcement Period

The mean equation of post GST announcement period presents that the mean of the Indian stock market index (NR_t^s) is influenced by the current and lagged return of future prices and random error or innovation of yesterday. The average lagged return of Nifty-F has been reduced during the post-GST announcement period which shows that the future market in India is consistently performing its role of risk mitigation tool (Haron and

Ayojimi, 2019). In the variance equation, the GARCH and ARCH coefficient is significant statistically which evident the presence of short runs and long-run volatility clustering. The sum of the coefficient of the GARCH and ARCH parameter is (0.891319) close to unity which indicated that the stock market volatility is highly persistent after GST announcement in India. In comparison to the pre-GST announcement period, short-run volatility has increased but long-run volatility has decreased, resulting in lowering the overall volatility of the Indian stock market index. These results are supported by the study of Caporale and Spagnolo, 2016 that negative news has a negative effect and positive news has a significant positive effect on stock returns. The findings of the study are consistent with the proxy effect and tax effect hypothesis which shows that the announcement of macroeconomic news reduces the volatility of the stock market. The change in the volatility of the Indian stock market index is also supported by the results of Evans and Lyons (2008); Vrugt (2009); Rangel (2011) and Vortelinos (2015) where they observe a significant change in stock market volatility upon announcement of macro news.

During Announcement

The conditional mean equation of during the announcement period exhibits that the mean of the Indian stock market index (NR_t^s) is influenced by the current and lagged return of future prices and random error or innovation of yesterday. In the variance equation of the GARCH model, the GARCH and the ARCH parameters are significant statistically. The sum of the ARCH and GARCH parameters is (0.870654), which shows that during the announcement period of GST in India, the Indian stock market is highly persistent. The volatility in the short-run is additionally increased and long-run volatility is further reduced during the GST announcement in India in contrast to the pre and post-announcement period. The overall persistency of the Indian stock market (.870654) is drastically reduced during the announcement phase in contrary to the pre and post-GST announcement period which entails that the GST announcement has a considerable favorable impact on the Indian stock market index. The findings of the study are supported by the proxy effect and tax effect hypothesis proposed by Fama (1981) Feldstein (1983) respectively.

Table 5: Results of GARCH (1, 1) for during and After-GST Implementation Period

Statistic types	Regressors	During-GST Announcement	P-value	After GST Announcement	P-value
Mean Equation	∝	0.000207	0.00*	0.00016	0.00*
	MA(1)	-0.4661	0.00*	-0.49943	0.00*
	NR_t^f	0.989101	0.00*	0.984601	0.00*
	NR_{t-1}^f	0.015017	0.0012*	0.007062	0.2825
	ER_t	-0.02137	0.175	-0.00344	0.7703
	Δ MIBOR_t	-0.00028	0.4441	-0.00016	0.8649
Variance Equation	∝	1.66E-07	0.11	1.89E-07	0.3996
	(GARCH-term)	0.768181	0.00*	0.746014	0.0054*
	Y (ARCH-term)	0.102473	0.012**	0.059403	0.27
	T-DIST DOF	48.41079	0.5625	16.69542	0.1688
	AIC	-10.7224	-	-10.9928	-
	SIC	-10.6497	-	-10.8989	-
	HQC	-10.6941	-	-10.9557	-
	Adj. R^2	0.984665	-	0.982142	-
	MAE	0.000912	-	0.000774	-
	RMSE	0.00115	-	0.00098	-
	D-W	1.896392	-	1.842415	-
Diagnostic Testing	ARCH-1	-	0.6485	-	0.6395
	QStatistics	8.2258	0.942	16.908	0.392
	Q^2 Statistics	14.974	0.597	12.057	0.797

Source: Authors' Computations

Notes: NR_t^s and NR_t^f represent spot return (Nifty-50) and future return (Nifty-50 future index) respectively. The GARCH model's optimality is determined by the SIC and AIC criteria. The total data of the study are segregated on the basis of the date of the event (i.e. implementation and announcement of GST in India) and statistics result is provided accordingly. The GARCH model with the smallest value of RMSE and MAE is selected as the optimum-fitted model. *, **, *** Sig. at 1%, 5% and 10% respectively.

After Implementation

The conditional mean equation of after implementation period demonstrates that the mean of the Indian stock market index (NR_t^s) is affected by the current return of future prices and random error or innovation of yesterday. In the variance equation of the GARCH model, the GARCH parameter is statistically significant. However, the ARCH term is statistically insignificant

which could be the fact that during the announcement of GST, the Indian households have already boosted their purchases due to the fear and anxiety of prices increase in their mind in some sector goods and services after the adoption of GST in India. Hence the short-run volatility tends to be lower during and after the GST announcement period. This entails that the finding of the study is supported by the APT theory proposed by Ross (1976) that the returns of an asset can be forecasted using a linear relationship between the number of economic variables and expected return of the asset and arbitrage opportunities are short-lived as the market reacts quickly to realign market prices. Similarly, in our result, the arbitrage opportunity rise in the market due to taxation law change in India (i.e. increase in short-run volatility) is short-lived opportunity for the investors which is wiped off in the short run. The long-run volatility is reduced in comparison to the pre, post, and during announcement period of the goods and service tax in India.

5. Efficiency of Stock Market in Post GST Announcement Period

In order to examine the efficiency of the Indian stock market during the post GST announcement period, the study estimate the amount of time require by the Indian stock market volatility to revert back to half of its initial value. According to Efficient Market Hypothesis (EMH), the efficient form of market immediately reflect all the available information in the stock prices leaving no room for consistent alpha generation. But the result of the analysis indicates that the market volatility takes a time period of 6 days on an average in post-GST announcement period in absorbing the announcement effect in the Indian stock market index. Thus the study contradicts the Efficient Market hypothesis (EMH) results, as information is not absorbed instantly in the stock market index, as proposed by the EMH hypothesis. However, this time span taken by the market in absorbing the information is smaller than the study of Haron and Ayojimi, 2019 where Malaysian stock market takes a time period of 16 days on an average in fully reflecting the information in KLCI. Therefore, the results indicates that the Indian stock market has taken a longer time period in reflecting the GST announcement information in the stock prices leaving some luring opportunities for investors for booking profits.

6. Concluding Observations

This study aims to observe the effect of GST announcement and implementation phase on Indian stock market index volatility while controlling the impact of other macroeconomic variables that equally impact the Indian stock market index volatility. The finding of the study illustrates that with the announcement and implementation of GST in India, the volatility of the Indian stock market is reduced drastically which implies that the expectation of the government and the policymakers that the implementation of GST will eliminate the cascading effect of taxation and will pass on this advantage to the ultimate consumers is empirically confirmed in this study. The findings of the study are in line with the anticipation of the market that the adoption of the GST in India will reduce the tax burden on consumers and producers by simplifying the taxation system and eliminating the cascading effect of taxation as prevalent under the value-added taxation system. The elimination of tax on already paid taxes ultimately results in reducing the prices of goods and services in India and improving the standard of living by increasing the purchasing power of the consumers. This is also favored by a conspicuous decrease in stock market volatility persistency in India with the implementation and announcement phase of GST in the Indian economy. This illustrates that the awareness programs sponsored by the governments and other groups yield meaningful results and accomplish a successful result. The Government of India has well documented and advertises the benefits of the adoption of GST in the Indian economy which has resulted in reducing the anxiety and worries of the market participants, investors, and shareholders. The findings of the study are contrary to the finding of Haron and Ayojimi, (2019) that macro news announcement enlarges the volatility of the market. The finding of the study is supported by the finding of Chen and Gau (2010) and Bernile *et al.,* (2016) that the macroeconomic news announcement has a significant impact on the stock market volatility. The results are highly consistent with the finding that the announcement of scheduled macroeconomic news reduced the stock market volatility (Beber and Brandt, 2006, Vahamaa and Ajio, 2011). The results are supported by the APT, Proxy effect, and tax effect hypothesis developed by Ross (1976), Fama (1981), and Feldstein (1983) respectively. The result indicates that the market volatility takes a time period of 6 days on an average in post-GST announcement period in absorbing the announcement effect in the Indian stock market index. Thus. the study contradicts the Efficient Market hypothesis (EMH) results, as information is not absorbed instantly.

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Article

An ARDL Approach to Evaluate the Impact of Climate Change on rice Yield in SAARC Nations: A Comparative Study of India and Pakistan

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Abstract

The study is a comparative analysis of the impact of climate change on rice yield in Indiaand Pakistan. In this research, ARDL bound test for cointegration and Error Correction Model (ECM) havebeen used to establish the long and short-run relationship between the climatic variables andrice yield in India and Pakistan using a dataset of 20 years (2000-20).The results show that carbon dioxide and average annual rainfall have a positive impact on the rice yieldin India and Pakistan. The nitrous oxide emission has a negative impact on the riceyield in the long-run in both countries. In the short-run, the temperature increase in India has apositive impact whereas it negatively affects the rice yield in the long-run.The study suggests that the government should provide subsidised agricultural inputs tothe farmers, the irrigation system should be enhanced, better weather forecasting technologiesshould be adopted, and improved seeds should be used by the farmers to tackle climatechange. This research helps in identifying the problems associated with agricultural productivityand can be helpful to the policymakers to frame agricultural policies accordingly.

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Keywords: Agricultural policies; ARDL bound test; Climate change; Cointegration; Error Correction Model (ECM); Rice yield.

1. Introduction

South Asian Association for Regional Cooperation (SAARC) is an organisation and union of states in south Asia. At present SAARC has 8 member nations namely India, Pakistan, Bangladesh, Nepal, Bhutan, Maldives, Afghanistan and Sri Lanka. SAARC was formed so as to promote economic stability, socio-economic development, self-reliance as well as free trade among member countries (Abas, Kalair, Khan&Kalair, 2017). It is the biggest organisation among all other international organisations in terms of population as it comprises of 27 per cent (%) of the total world population. It also accounts for three per cent of the total world's area and also 3.8 per cent (%) of the total world'sGDP (IMF 2015).The SAARC nations are trying to ensure freetrade as well as increase in the levelof investment in the region.Among all the SAARCmember countries, India has been able to attract the highestnumber of FDI (Abdin, 2015).During the last 10 years, India has managed to retain its top spotin FDI inflows followed by Pakistan and Bangladesh. In the year 2015, India surpassed China to become the global destination for FDIs (Kumar &Gopalsamy, 2019). The SAARC region is the most diverse among all other international organisations in terms of cultural, social, political and geographical aspects (Chand, 2010).

A major problem in South Asian countries is the shortage of food supply (Rajeevan, 2013). The reason for the shortage is the usage of primitive agricultural practices. The lackof technological advancement in these countries contributes to the problem of food security (Dar & Asif, 2019). This region is home to more than a quarter of the total world's population. South Asia is predominantly home to a rural population as around 70 per cent (%) of the total population lives in rural areas (Saxena et al., 2015). Agriculture is their main source of livelihood, but it is adversely affected by the climate variations observed over time (Aggarwal& Sivakumar, 2011). The South Asian nations are most affected by climate change in the last three decades. Agriculture is mainly dependent upon the monsoonsbut the climatic variations resulting from global warming have affected the pattern of monsoons. This has resulted in a decline in the productivity of food crops grown in this region (Akhmat Zaman, Shukui, Irfan& Khan,2014).

The agricultural sectorcontributes to employment generation and is a major contributor to the national GDP (Ahmad,Alam,& Haseen,2011). Despite the fact that the contribution of the agricultural sector in the GDP is declining gradually over the years, the level of employment in this sector is steady (Arjun, 2013). Share of agriculture sector in India's GDP has come down from around 50 per cent (%) at the time of independence to 14 per cent (%) in 2018 but this sector still employs around half of the country's population (Jain & Kumar, 2018). The situation of Pakistan is similar to India with the agriculture sector contributing to around 21 per cent (%) of the total GDP and employing around 47 per cent (%) of the total population (Hussain et al., 2018). These countries are among the fastest growing economies among the SAARC nations but the contribution made by agriculture sector in the GDP and its capacity to employ larger chunk of population shows that this sector is still using primitive agricultural techniques resulting in low productivity (Deichmann, Goyal & Mishra, 2016).

Despite huge population in India, it has been able to manage the supply of agricultural products domestically. Rice is the most produced and consumed crop not only in India but also in Pakistan (Jabeen, Mazhar& Goraya, 2010). In India, climate changereduces rice yield by three to five per cent (%) in case of medium emissions whereas it can decline by 3.5 - 10 per cent (%) in case of high emissions of greenhouse gases(Palanisami, et al. 2017). Owing to high nutritional value and multiple usage of the crop, it has become the most widely consumed crop all over the world. India, despite being one of the largest producer and exporter of rice, the level of productivity is not satisfactory (Soora et al., 2013).The predominant cause is the use of primitive agriculture techniques and till date Indian agriculture is labour intensive. India's export to other SAARC countries is much higher than that of import and therefore, India maintains a surplus in the balance of payments while trading with the SAARC nations (Srinivasan, Kalaivani& Ibrahim, 2011). The situation of Pakistan is not very different from that of India as it also facing the problem of low productivity of different crops due to the negative impact of climate change (Kaur & Nanda, 2011). Countries lacking technological advancement are the worst affected by climate change (Jayaraman, 2011).

Depending on future growth scenarios, the IPCC predicts a temperature rise of 0.5–1.2 °C by 2020, 0.88–3.16 °C by 2050, and 1.56–5.44 °C by 2080 for the region (IPCC, 2007). This long-term shift in temperature and

precipitation patterns is more likely to influence cropping seasons, crop cultivation appropriateness, and the occurrence of disease and pests, all of which have an impact on crop yields, productions, and food markets (Mall, Attri& Kumar, 2011). According to studies, the changes in temperature and precipitation patterns are expected to worsen the impact on agricultural output and food security in South Asia (Kaur & Kaur, 2016). These effects were investigated by looking at the link between crop yields and the amount of available soil water during the growing season for different crops. Many crops are harmed by the presence of water and heat stressors during crop establishment and the important growth period (Pathak, Pramanik, Khanna & Kumar, 2014). Changes in temperature and precipitation patterns in South Asia will have severe long-term implications on agriculture if they continue unchecked (Birthal et al., 2014).The real impact of climate change on agriculture varies by crop, location, and adaptation ability to climatic threats, and therefore, adaptive capacity determines agricultural production (Pradhan, Chan, Roul, Halbrendt& Sipes, 2018).

2. Objectives

- To analyse the level of productivity of rice in India and Pakistan.
- To check the extent of climate change in the two countries.
- To assess the impact of climatic variables on the rice yield in the above-mentioned countries.

3. Methodology

This study has been conducted to analyse the agricultural sensitivity to climate change in India and Pakistan.Rice crop has been selected for the analysis as it is one of the most produced and consumed crop in both the countries. The analysis is based on secondary data.The productivity of rice inthe two countries is the basis for measuring agricultural sensitivity to climate change. Auto Regressive Distributed Lag (ARDL) model has been used to analyse the impacts of climate change on the productivity of rice in India and Pakistan. The ARDL model can simultaneously depict the long-term and short-term relationships between the variables. (He, Chen, Chandio, Zhang & Jiang, 2022). The factors that are responsible for climate change are considered as independent variables and they are:

- Average Annual Temperature (TT)
- Average Annual Rainfall (RR)
- Carbon Dioxide Emission (CO_2)
- Nitrous Oxide Emission (N_2O)

4. Data Collection and Period of Study

The data for the study has been collected from various published sources including different websites namely ourworldindata, FAOSTAT, data.gov.in and Indian Meteorological Department (IMD) official website. The data used in our analysis is a time series data covering a period of 20 years between 2000-01 and 2019-20.

Table 1: Variable Description

Variables	Description	Measurement Unit
$Rpro_I$/$Rpro_P$	RiceProductivity in India/Pakistan	Tonnes/Hectare
CO_2	Carbon Dioxide Emission	Metric Tonnes
TT	Average Annual Temperature	Degree Celsius (°C)
RR	Average Annual Rainfall	Millimetres (mm)
N_2O	Nitrous Oxide Emission	Metric Tonnes

Method used:An Autoregressive Distributed Lag (ARDL) model is an ordinary least square (OLS) based model applicable for both stationary and non-stationary time series with mixed order of integration(Frimpong &Oteng-Abayie, 2006). The ARDL model include lags of both the dependent variable and explanatory variables as regressors. The ARDL model is useful for forecasting and to disentangle long-run relationships from short-run dynamics(Pesaran, Shin, & Smith, 2001). One benefit of the ARDL test is that it is more reliable and functions better with small samples of data (Latif et al., 2015). Firstly, verification of the long-run association of the variables was done using ARDL bound test for cointegration. After the verification of long-run association among the variables the Error Correction Mechanism was used to find the short-run dynamics. To understand the relationship

between the dependent and independent variables, the following equation was constructed:

$$RPro_t = \acute{a}_0 + \acute{a}_1 TT + \acute{a}_2 RR + \acute{a}_3 CO_2 + \acute{a}_4 N_2O + e_t \quad (1)$$

By converting all variables of Equation (1) into the natural log, the model is as given below:

$$lnRPro_t = \acute{a}_0 + \acute{a}_1 lnTT + \acute{a}_2 lnRR + \acute{a}_3 lnCO_2 + \acute{a}_4 lnN_2O + e_t \quad (2)$$

where RPro represents the productivity of rice, while t represents the 20-year time period from 2000 to 2019. $\acute{a}_0$ is the constant term while $\acute{a}_1$ to $\acute{a}_5$ are the coefficients of the variables namely rice productivity ($RPro_t$), average temperature (TT), average rainfall (RR), carbon dioxide emission (CO_2) and nitrous oxide emission (N_2O) respectively and "$_t$ is the error term. Now equation (2) can be written in the ARDL form:

$$\ddot{A}lnRPro_t = \acute{a}_0 + @! \sum_{k=1}^{n} \acute{a}_1 lnRPro_{t-k} + @! \sum_{k=1}^{n} \acute{a}_2 lnTT_{t-k} + @! \sum_{k=1}^{n} \acute{a}_3 lnRR_{t-k} + @! \sum_{k=1}^{n} \acute{a}_4 lnCO_{2t-k} + @! \sum_{k=1}^{n} \acute{a}_5 lnN_2O_{t-k} + \ddot{e}_1 lnRPro_{t-1} + \ddot{e}_2 lnTT_{t-1} + \ddot{e}_3 lnRR_{t-1} + \ddot{e}_4 lnCO_{2\,t-1} + \ddot{e}_5 lnN_2O_{t-1} + e_t \quad (3)$$

Here $\acute{a}_0$ represents the drift whereas $\acute{a}_1$ to $\acute{a}_5$ and $\ddot{e}_1$ to $\ddot{e}_5$ are the coefficients of the different variables. In this equation, the lag of the dependent variable i.e.Rice Productivity is considered as a separate independent variable. After establishing the long-run relationship among the variables, the study further made use of the Error Correction Model (ECM) to establish the short-run relationship. Equation 3 can be rewritten in the ECM form:

$$\ddot{A}lnRPro_t = \acute{a}_0 + @! \sum_{k=1}^{n} \acute{a}_1 \ddot{A}lnRPro_{t-k} + @! \sum_{k=1}^{n} \acute{a}_2 \ddot{A}lnTT_{t-k} + @! \sum_{k=1}^{n} \acute{a}_3 \ddot{A}lnRR_{t-k} + @! \sum_{k=1}^{n} \acute{a}_4 \ddot{A}lnCO_2 + @! \sum_{k=1}^{n} \acute{a}_5 \ddot{A}lnN_2O_{t-k} + uECM_{t-1} + e_t \quad (4)$$

where *Ä* represents the first difference of the variables and *u* is the coefficient of ECM used for analysing the short-run relationship between the variables. ECM shows the speed of adjustment in long-run equilibrium after a shock in the short-run.

5. Discussion

Figure 1: India's Rice Yield Trend (2000-2019)

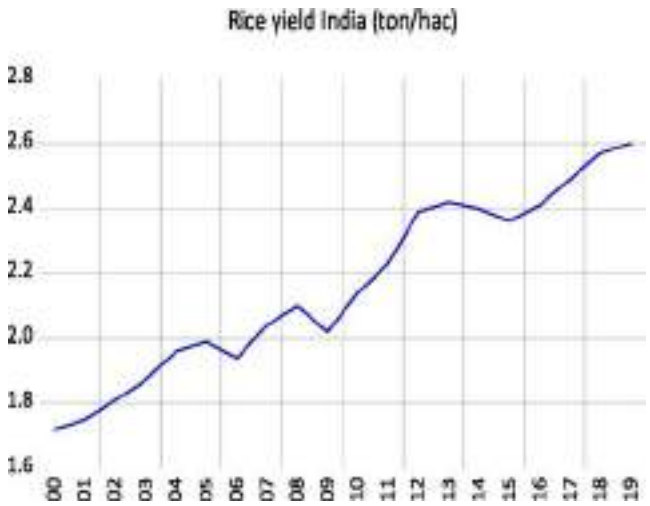
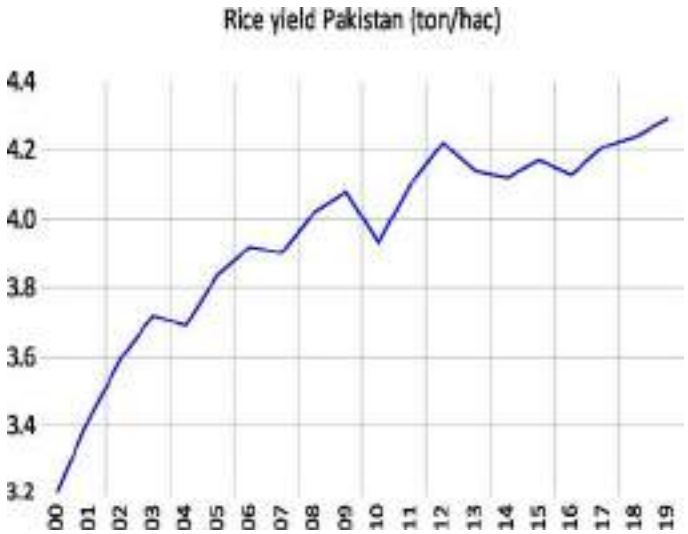


Figure 2: Pakistan's Rice Yield Trend (2000-2019)



India is the world's second-biggest rice producer and the world's largest rice exporter.Despite this, rice productivity in India is not satisfactory. Monsoon affects majority of India's agricultural land, and insufficient capital formation in this sector is one of the key causes of low productivity.Over the last few years, there has been a steady increase in rice consumption, and as a result, even though the output has increased, the productivity trend has not been sufficient. Figure 1 represents the trend of India's rice yield over the years and it is clearly evident from the graph that there is an upward trend but the rate of increase is considerably low. In2000, the yield was around 1.75 ton/hectare and increased continuously over the next five years. The period from 2009 to 2012 shows a rapid increase in the level of productivity as in this period there were optimum rainfalls for rice production. In 2019, the rice yield reached its maximum level at 2.6 ton/hectare.

Pakistan is the tenth largest rice producer in the world. Pakistan's rice exports account for more than eight per cent of global rice trade. It is a significant crop in Pakistan's agricultural economy. It is grown in areas of Sindh, Punjab, and Balochistan, where rice production is the primary source of income for millions of farmers. Figure 2 depicts the trend of the rice yield in Pakistan over the past few years. The Figure shows that the rice yield in Pakistan is far better than that in India. The rice yield in Pakistan also shows an upward trend. In 2000, the yield was around 3.2 ton/hectare and that increased in next three years reaching 3.75 ton/hectare in 2003. In the period between 2010 and 2013, the yield increased significantly and reached 4.15 ton/hectare in 2013. In 2019, the rice yield reached its maximum level at 4.30 ton/hectare.

Figure 3: Average Annual Rainfall Trend in India (2000-2019)

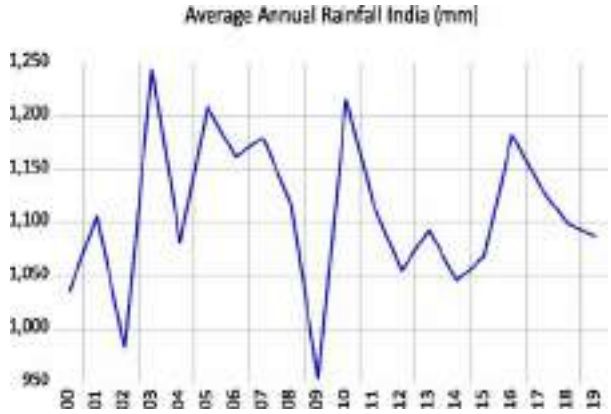
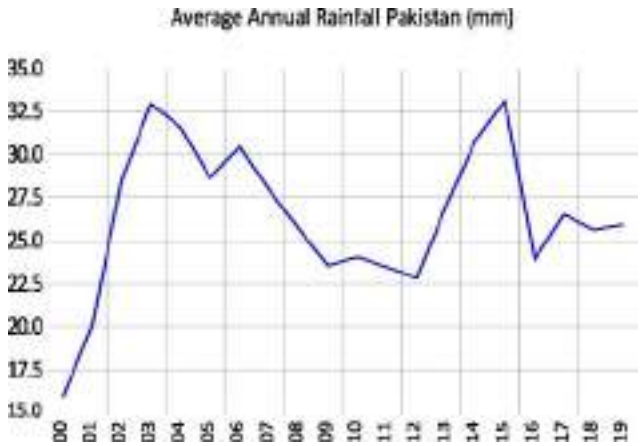


Figure 4: Average Annual Rainfall Trend in Pakistan (2000-2019)



Every year, about 400 cm of rain falls in some parts of India. In Rajasthan and nearby portions of Gujarat, Haryana, and Punjab, however, it is less than 60 cm. Moderate rains fall across the rest of the country. The annual rainfall is significantly unpredictable from year to year due to the nature of monsoons.Figure 3 depicts the trend in average annual rainfall in India between2000 and 2019. The graph clearly shows that India experienced high fluctuations in the average annual rainfall in the mentioned period. The erratic and unpredictable monsoon is the major reason for low productivity of agricultural crops specially that of rice in India. In 2003, the average annual rainfall in India was at its maximum level at around 1240 mm which came down to its lowest level at around 950 mm in 2009, in a span of six years. Subsequetly, a sudden rise in the rainfall was observed reaching 1220 mm in 2010, which came down gradually to 1090 mm in 2019.

Likewise, the rainfall in Pakistan also follows asimilar pattern. The monsoon in Pakistan is also unpredictable and erratic making it difficult for better productivity of agricultural crops. Pakistan also has a regional disparity in terms of amount of rainfall received per year. Figure 4 shows the trend of average annual rainfall in Pakistan between 2000 and 2019. From 2000 to 2003, Pakistan experienced a substantial increase in the amount of rainfall received. In 2000 it was around 15 mm which rose to around 33 mm in 2003. Till 2012, Pakistan witnessed a continuous decline in the amount of rainfall received and it came down to 22.5 mm by the end of 2012. In the next three years the average annual rainfall in Pakistan increased and

reached it maximum level at 33.5 mm in2015. It further declined and reached26.5 mm in 2019.

Figure 5: India Average Annual Temperature Trend (2000-2019)

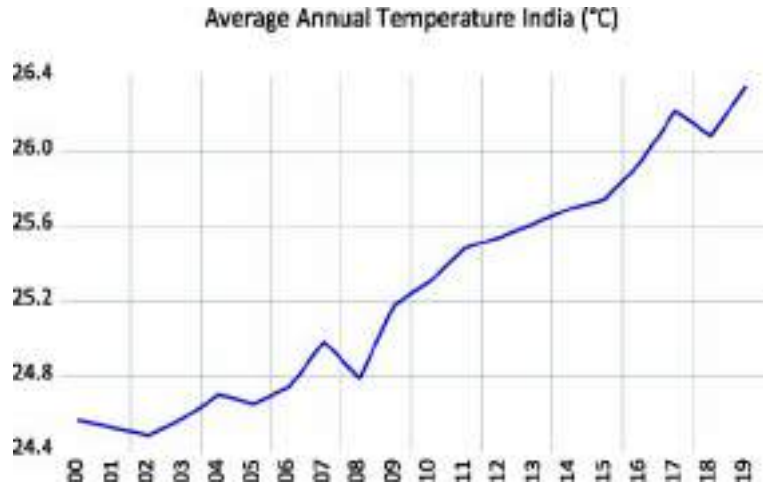
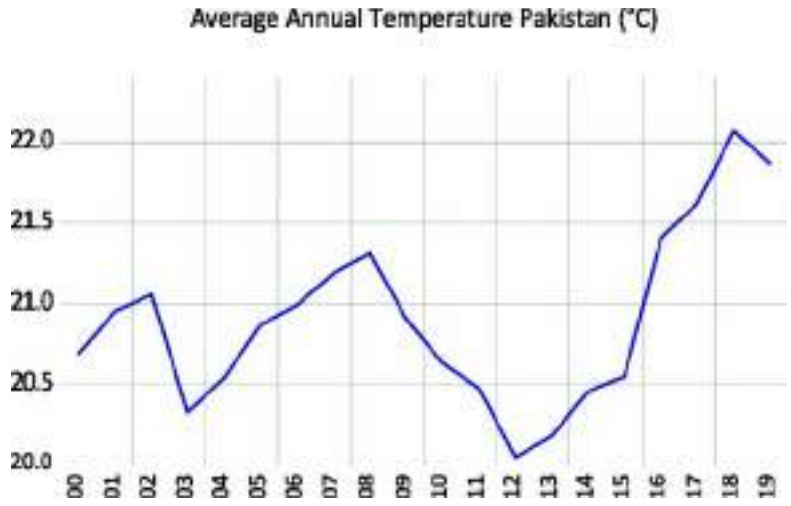


Figure 6: Pakistan Average Annual Temperature Trend (2000-2019)



India has a diverse climate and the average temperature varies throughout India. The northern part of India has a cold climate whereas the northern plains (Haryana, Punjab, Uttar Pradesh, Rajasthan, Bihar and West Bengal) experience extreme climate in the form of severe winters and very hot and

humid summers. The north-eastern and the southern regions of India experience extreme rainfall during summer and winter season and therefore the temperature usually remains in the normal range with high humidity. The central part of India experiences moderate climate as the average annual temperature generally remains between 15°C to 30°C. Figure 5 shows the trend of average annual temperature in India between 2000 and 2019. The graph clearly exhibits an upward trend of average annual temperature. In2002 India experienced its minimum average annual temperature at 24.4°C, which continuously increased till 2007. In 2008, the average annual temperature saw a decline but from 2009 onwards it rapidly increased and reached a maximum at 26.4°C in 2019.

On the other hand, the level of average annual temperature in Pakistan is significantly low when compared to India. Figure 6 shows the trend of average annual temperature in Pakistan. The graph clearly shows the fluctuations in the average annual temperature in Pakistan from 2000 to 2019. The period from 2003 to 2008 saw a continuous increase in the level of temperature whereas in between 2009 and 2012 Pakistan witnessed a sharp decline in the mean temperature which reached its lowest level at 20°C in 2012. Thereafter, the temperature increased significantly reaching its maximum at 22.2°C in 2018.

Figure 7: Emission Trend India (2000-2019)

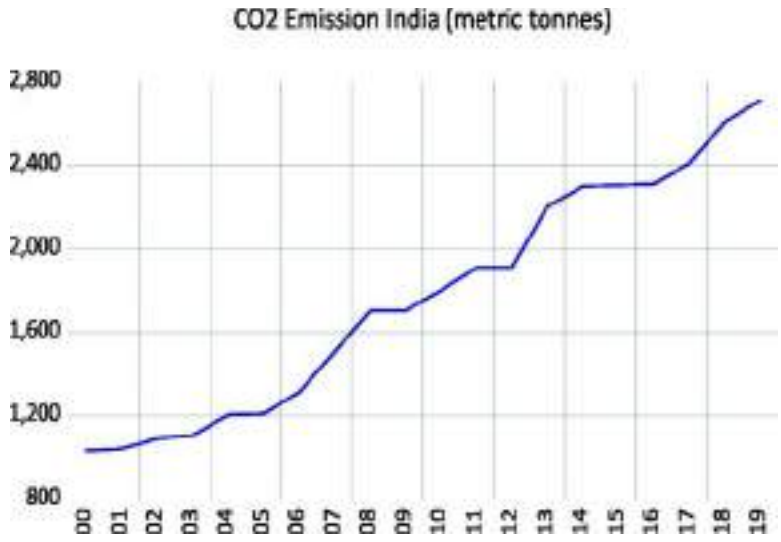
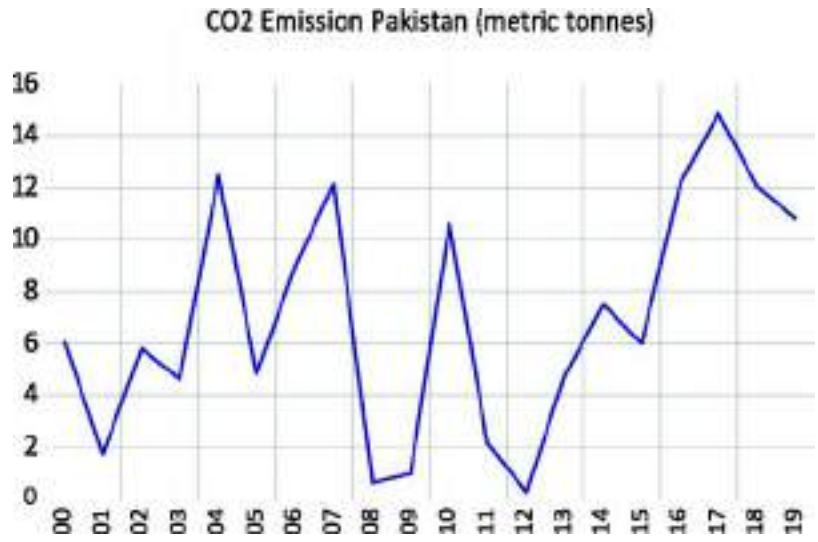


Figure 8: CO2 Emission Trend Pakistan (2000-2019)



India is one of the top carbon dioxide emitting nations in the world. Figure 7 shows the trend of carbon dioxide emission in India over the years from 2000 to 2019. Thegraph shows an upward trend in the CO_2 emissions over the past few years. The level of CO_2 emission in 2000 was around 1050 metric tonnes which gradually increased to 1900 metric tonnes in 2012. CO_2 emission further rose to 2700 metric tonnes in 2019.

On the other hand, the level of CO_2 emission by Pakistan is significantly low as compared to that of India in the past few years. During the same period, Pakistan witnessed several fluctuations in the CO_2 emission. Figure 8 represents the trend of CO_2 emission in Pakistan from 2000 to 2019. Starting with six metric tonnes in 2000 to 12 metric tonnes in 2004, there was a steep decline thereafter, reaching a minimum at 0.5 metric tonnes in 2012. However, in the later years, CO_2 emission rose to reach 14.4 metric tonnes in 2017.

Figure 9: N2O Emission Trend India (2000-2019)

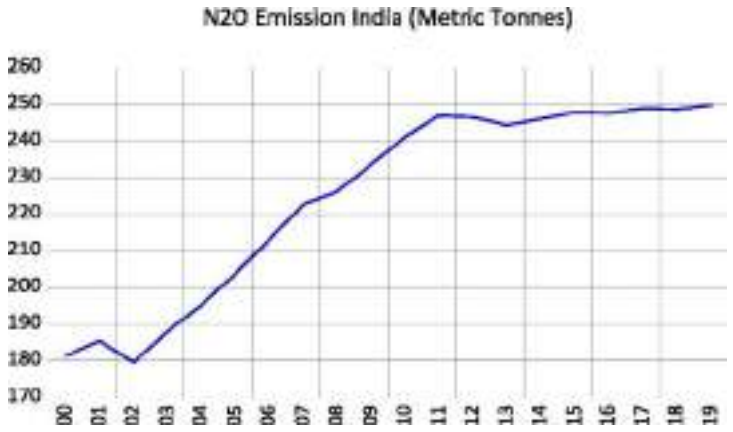
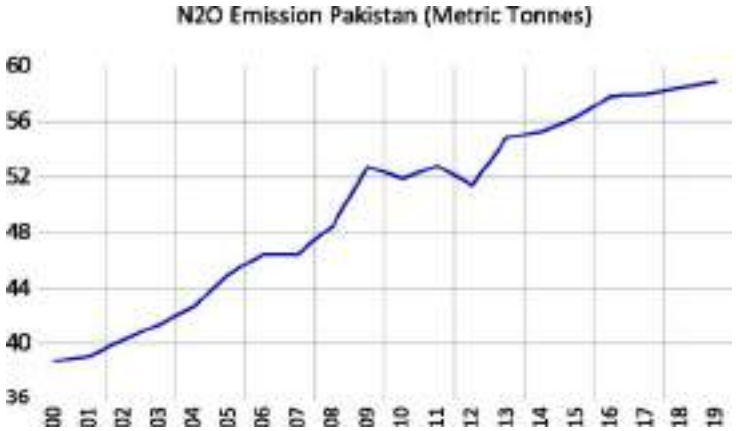


Figure 10: N2O Emission Trend Pakistan (2000-2019)



The burning of fossil fuels is the major reason for nitrous oxide emission in the atmosphere. Industrial activities, agricultural activities, wastewater management and fuel combustion are the other important reasons for the increasing amount of nitrous oxide. Figure 9 shows the nitrous oxide emission trend in India for the period 2000 to 2019. From 2002 to 2011, N_2O emission in India increased continuouslywhereas from 2012 to 2019 the graph shows a stagnant growth in the emission. In 2019, N_2O emission reached a maximum at around 250 metric tonnes.

Nitrous oxide emission in Pakistan also shows an upward in the observed period but the annual emission is significantly low when compared to India. According to Figure 10, the total nitrous oxide emission in the year 2000

was around 39 metric tonnes which increased continuously and reached 52.5 metric tonnes in 2009. From 2010 onwards the nitrous oxide emission in Pakistan saw a fluctuating pattern with an upward trend. It 2019, the nitrous oxide emission in Pakistan was at a maximum at 58.5 metric tonnes.

Table 2: ARDL Bound Test for Cointegration for India

Equation		F-statistics		P-value
$RPro_1 = f(CO_2, N_2O, TT, RR)$		4.2560*		0.000
Critical Value	**10%**	**5%**	**2.5%**	**1%**
Lower Bound I (0)	2.12	2.56	2.88	3.29
Upper Bound I (1)	3.09	3.49	3.87	4.17

Note: *Represents 1% level of significance

It is important to use the ARDL Bound test (Pesaran et al. 2001) for the confirmation of the existence of cointegration among the variables before finding the long-run and short-run relationships between the variables. Cointegration tells the presence of anylong-run relationship among the study variables. The results shown in Table 2 portray the presence of cointegration between the variables using the F-statistics. If the value of the F-statistic is larger than the lower and upper bounds at one per cent level of significance, it implies the presence of cointegration among the variables. Here the value of F-statistics is larger than the lower and the upper bounds at one per cent level of significance and therefore, there is along-run relationship between rice productivity in India, CO_2 emission, average annual temperature, average annual rainfall and N_2O emission.

Table 3: ARDL Bound Test for Cointegration for Pakistan

Equation		F-statistics		P-value
$RPro_1 = f(CO_2, N_2O, TT, RR)$		6.3633*		0.000
Critical Value	**10%**	**5%**	**2.5%**	**1%**
Lower Bound I (0)	1.06	1.89	2.47	3.18
Upper Bound I (1)	2.09	2.49	3.12	3.97

Note: *Represents 1% level of significance

Table 3is the ARDL Bound test for cointegration for Pakistan. The results shown in Table 3 depicts that the value of F-statistic (6.3633*) is larger than the value of lower and upper bounds at one per cent level of significance. Therefore, this proves the long-run association between the study variables.

Long-runEstimation of Parametersfrom Auto Regressive Distributed Lag (ARDL) Model ***(includes 20 observations from 2000 to 2019)***

Table 4: Long-run ARDL for India

Variables	Coefficient	Standard Error
LnCO2	0.132**	0.248
LnTT	-1.182*	0.423
LnRR	0.129**	0.160
LnN2O	-0.348*	0.176
C	-2.039	1.652

Note: *and** denotes 1% and 5% level of significance respectively and rice productivity is the dependent variable.

The study discovers the long-run parameters of the variables after confirming the presence of a long-run link between variables using the ARDL bound test. Agricultural crops,especially rice, is highly prone to changes in climatic conditions in India. The empirical results of the long-run association between the variables are shown in Table 4. The results imply thatcarbon dioxide emission can significantly increase the rice productivity in India. If there is one per cent increase in the level of CO_2 emission then it can increase the level of rice productivity by 0.13 per cent (%). This is because the plants need carbon dioxide for photosynthesis which leads to better productivity.Due to fertilisation effect, a rise in CO_2 concentration increases the yield. It also improves the paddy's ability to utilise water efficiently. A six per cent drop in yield is seen for every degree the temperature rises (Saseendran,Singh, Rathore, Singh & Sinha, 2000). Rise in the mean temperature negatively impacts rice productivity. One per cent rise in mean temperature can lead to a fall in rice productivity by 1.18 per cent (%). High temperature during the flowering stage of rice increases the floret

sterility that causes a detrimental effect on the yield (Yoshida, 1981). Here, the results show that if one per cent increase in the average annual rainfall is observed, it could positively affect the rice productivity and it may go up by 0.13 per cent (%). Nitrous oxide emission negatively affects rice productivity as one per cent increase in N_2O emission leads to a decline in the productivity of rice by 0.34 per cent (%).

Table 5: Long-run ARDL for Pakistan

Variables	Coefficient	Standard Error
LnCO2	0.102**	0.468
LnTT	-0.782*	0.196
LnRR	0.238**	0.247
LnN2O	-0.746*	0.056
C	-1.089	1.942

Note: *and** denotes 1% and 5% level of significance respectively and rice productivity is the dependent variable.

Pakistan has experienced severe climatic changes over the past few years, directly affecting crop growth. Table 5 shows the empirical results of the long-run relationship between the variables. One per cent increase in carbon dioxide will lead to 0.10 per cent (%) rise in rice productivity. This is because CO_2 helps in the process of photosynthesis leading to rise in productivity. Butone per cent increase in the average annual temperature has severe negative impact on the rice productivity as it decreases by 0.78 per cent (%). An increase in the average annual rainfall positively affects the rice growth by 0.23 per cent (%). Ahmad, et al. (2014) concluded that precipitation has a significant impact in improving rice yield in Pakistan. Lastly, an increase in nitrous oxide emission negatively affects rice productivity.A decline of 0.74 per cent (%) can be observed if there is one per cent increase in the level of nitrous oxide emission.

Short-run Estimation of Parameters from Auto Regressive Distributed Lag (ARDL) Model (includes 20 observations from 2000 to 2019)

Table 6: Error Correction Mechanism (ECM) for India

Variables	Coefficient	Standard Error
$DLnCO_2$	0.126**	0.168
DLnTT	0.036*	0.095
DLnRR	0.219**	0.137
$DLnN_2O$	-0.048*	0.132
ECM (-1)	-0.602	0.230

Note: *and** denotes 1% and 5% level of significance respectively.

In the short-run, the climatic variables including carbon dioxide and rainfall significantly affect the rice productivity in India. If one per cent increase in CO_2 emission is observed, there will be an increase in rice productivity by 0.13 per cent (%) whereas an increase in the average annual rainfall by one per cent will lead to a rise in rice productivity by 0.22 per cent (%). Further, the other climatic variables including temperature and nitrous oxide emission have no significant impact on the rice productivity in India in the short-run. One per cent increase in the average annual temperature will lead to an increase in rice productivity by 0.03 per cent (%) whereas an increase in the N_2O emission by one per cent will lead to a fall in the productivity by 0.04 per cent (%) in India in the short-run.

The calculated coefficient of ECM is negative, indicating that there is strong association between variables. ECM depicts the rate at which long-run equilibrium adjusts after short-run shocks. The estimated coefficient for ECM of India is -0.602 demonstrating that any divergence from the short-run equilibrium between climatic variables and rice productivity can be corrected and regained at 0.602 per cent(%) each year in the long-run as shown in Table 6.

Table 7: Error Correction Mechanism (ECM) for Pakistan

Variables	Coefficient	Standard Error
$DLnCO_2$	0.024**	0.298
DLnTT	-0.015*	0.042
DLnRR	0.080**	0.017
$DLnN_2O$	-0.618*	0.012
ECM (-1)	-0.762	0.185
C	0.047	0.016

Note: *and** denotes 1% and 5% level of significance respectively.

In the short-run, the climatic variables do not have any significant impact whereas nitrous oxide emission has a considerable negative impact on the rice productivity in Pakistan. If there is one per cent increase in the level of carbon dioxide emission, there will be an increase in the level of rice productivity by 0.02 per cent (%). An increase in the average annual temperature by one per cent will reduce the rice productivity by 0.01 per cent (%) whereas 0.08 per cent (%) increase in rice productivity will be observed if there is an increase in the average annual rainfall by one per cent. If there is an increase in the nitrous oxide emission by one per cent, there will be a decline in the productivity of rice by 0.61 per cent (%).
Here, the value of ECM is negative (-0.762), implying that there is a strong association between the climatic variables and rice productivity in Pakistan. Since, ECM depicts the rate at which the long-run equilibrium will be adjusted after the shocks in the short-run, the coefficient of ECM suggests that any divergence from the short-run equilibrium between climatic variables and rice productivity can be corrected and regained at 0.762 per cent(%) each year in the long-run.

1. Conclusion and Suggestions

This study primarily focuses on analysing the impact of climate change on rice yield in India and Pakistan. Rice is one of the major food crops produced and consumed in India. At present, India is the top rice exporting nation in the world and exported around 10300 metric tonnes of rice in 2016-17. Despite India being the largest rice exporting nation in the world but its

productivity is below standard. The level of carbon dioxide and nitrous oxide emission increased considerably between 2000 and 2019, contributing towards climate change. The average annualtemperature also increased significantly in the study period and the average annualrainfall has followed a fluctuating pattern depicting unpredicted and erratic monsoons. Auffhammer, et al. (2011) concluded that rice yield (harvest per hectare) was significantly impacted by drought and extreme rainfall in primarily rain fed areas between 1966 and 2002.Indefinite rain and heat stress reduce the rice crop's ability to produce grains. Heat waves would become more intense and frequent as a result of the expected intensification of global warming, which severely reduces rice crop yields (Hussainet al., 2022). The study used the ARDL bound test for cointegration to establish the long-run and the short-run relationships between the variables. The results show that the carbon dioxide emission is positively related with the rice yield in the long and short-run as CO_2 is helpful for the plants to carry out photosynthesis. The most important finding of the study is that carbon dioxide (CO2) emissions have favourable long and short-term impacts on rice production in Pakistan (Chandio, Magsi & Ozturk,2019). Nitrous oxide emission has a severe negative impact on rice yield in the long-run as compared to the short-run. In the short-run, temperature increase has positive impacts on the rice yield whereas it negatively affects rice productivity in the long-run. Lastly, rainfall has a positive impact on the rice yield both in the long and the short-run.

Rice yield in Pakistan is significantly higher than that of India. Over the past few years, Pakistan has done considerably well in increasing the level of rice production and has jumped to the fifth position in the list of top rice exporting nations. The same methodology was adopted to analyse the impact of climate change on rice yield in Pakistan and it was found that carbon dioxide emission and rainfall have positive relationships with rice yield both in the long and short-runs. Increase innitrous oxide emission and average annual temperature show negative relationships with rice yield in the long as well as in the short-runs.

The study suggests that India needs to focus on providing adequate facilities and prices to the farmers for their produce. Agricultural subsidy should be provided to each and every farmer of the country and collateral free credit should be made available to the farmers to motivate them to produce more. Additionally,, the government must strengthen and construct a better

irrigation system, and introduce improved weather prediction technology.The concerned authorities and policymakers should be aware of climate change's severe effects on food crops. As a result, legislators should suggest some significant strategies for long-term sustainability through the implementation of new agricultural technologies, food security, subsidies for agricultural inputs, and new seed varieties that absorb the negative effects of climate change and ensure a sufficient supply of food for India's huge population.Unless prompt action is taken, India would have to import large quantity of rice to meet the continuously increasing demand of its huge population.

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Article

Growth and Relative Economic Position: Empirical Insight from Odisha

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Abstract

This paper attempts to study the structural change, economic growth and relative economicperformance of Odisha, a sub-national of India over the last five decades (1971-72-2020-21).The major structural transformation in Odisha started during 19990's. During the post-reformperiod Odisha records a faster growth in output than the pre-reform period. It's the tertiarysector, which remains the major driver of growth of output over the years. The relativeeconomic performance of the Odisha economy has been looked into by looking at the ratio ofper capita income (PCI) of Odisha with respect to other states. The Odisha economy lagsbehind in PCI indicators than the other high- and medium-income states. Hence, though thestate has achieved a faster growth rate during the post-reform period, the other states alsogrow at a faster rate than the Odisha, putting the states behind in the economic front.

Keywords : Growth, Output, Sectors, Structural Change, Relative Economic Position, Odisha

1. Introduction

The structural changesin any economy happenswiththe falling share of income and employment in the primary sector and an increasing share of income in the secondary and tertiary sector. India has witnessed a higher growth rate in the post-reform period as a result of faster growth in the tertiary sector (Eichengreen& Gupta, 2011; Pais, 2014). In the era of the

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competitive world not only the growth of income of an economy is important,but also whether the economy is growing at a faster rate than other economies and hence the relative economic position too is important. Though there are large number of literatures on growth and structural changes at the national level, very few have attempted at the sub-national level (Kumar & Subramanian, 2012). Further, whileexamining the importance of regional studies, Ahluwalia (2002) analysed that the performance of individual states in the post-reforms period has not received comparable attention and yetthere are very good reasons why such an analysis should be of special interest.

Odisha is a state having vast natural resources and has the potential for higher economic growth. The state occupies 4.7 % of the country's total geographical area, 7 % of the forest coverage, 10% of the water resources, and 20% of the mineral reserves of India. Despite having huge natural resources, it has been considered a backward state for decades. Odisha's annual per capita income for the fiscal year 2020-21 is estimated to be [1] 71622.00 in comparison to the all-India average of [1] 86054, which is below the national average. Rajan Committee Report ranks Odisha as the least developed state in India on its index of economic development (Rajan, et.al; 2013). According to the reports of the committee, Odisha scores 0.80 and it tops in the underdevelopment index. From all the above facts, it can be derived that the state of Odisha lags behind, both in income & non-income indicators over the years among the states of India.

2. Review of Literatures and Research Gap

Some of the recent literatures has observed that the relative economic position of Odisha has improved. Samantaray, A. *et al*. (2014) took both the income and non-income indicators (literacy rate, infant mortality rate & maternal mortality rate) to show the improved economic position of Odisha. Their primary survey in three different regions of Odisha shows that the post-reform decade has witnessed occupational mobility and high asset holding among the households of Odisha. Panda(2015) has shown in his paper that Odisha has achieved a higher growth rate in the 2000s, especially after 2003-04, with a faster reduction in poverty and inequality (Panda &Padhi, 2020). *India Today* with the Institute for Human Development (IHD), New Delhi had assessed the all the 30 districts of the state over twodecades on 10 indicators. According to them, Odisha has

transformed from a poverty-stricken state to a front-runner as far as socio-economic development is concerned(Jha, 2017). The above literature mentioned that Odisha has recorded a higher growth rate in the decade of 2000 and its relative economic position has improved. If it is true, it becomes very important to know which are the sectors witnessing a faster growth rate in the state? Is there any major structural break in the NSDP series during the five decades? Has the sectoral composition of output and the relative economic position of the state undergone major changes over these decades?

Very few studies have looked into the sectoral growth rate of Odisha over time. The long-run growth rate of the Odisha's economy during the period 1950-51 to 1997-98 is around 2.7 % (Meher, 2003). According to him, the slowdown in the growth rate of the economy is due to the slower growth of the agricultural sector as it constitutes the major share of the income in the economy. The decade of the 1990's has shown a slowdown in the agriculture growth in Odisha (Pattnaik& Shah, 2010) and an acceleration in mining output growth (Das & Acharya, 2016) in the state. The period after 2002-03 has seen a revival of agricultural growth and the overall growth in output (Panda, 2015). All the above literature is of the opinion that though the state witnessed a lower growth rate for decades, it is after the 2000s that it has recorded a significant growth in income.

Though there are few literatures on economic growth of Odisha, no such attempt has been made to look into the growth, structural change and relative economic position of the state over a long period of five decades.

3. Objectives, Data and Methodology

This study is an attempt to study the structural change in income, sectoral economic growth of Odishaand the relative economic position of Odisha with respect to other states over five decades.

The Net State Domestic Product (NSDP) dataof Odisha atconstant prices and the per capita NSDP dataof major statesand all India has been collected from the State Domestic Product data of Economic and Political Weekly Research Foundation (EPWRF).The period of the analysis is from 1971-72 to 2020-21 for which the NSDP data is available. The whole series is in a common base, i.e.2011-12. The phases of growth can be derived after estimating the structural break in the series. There are various methods for estimation of the single/multiple structural breaks. The Bai & Perron (2003) multiple break

point test has estimated on the overall NSDP series over this five decades. The Bai & Perron (2003) gives us two break points for the NSDP series as 1990-91 and 2006-07and hence the whole period is classified into three periods as 1971-72 to 1989-90, 1990-91 to 2005-06 and 2006-07 to 2020-21.

3.1: Growth rate Analysis

The growth rate calculation is nothing but the output time relation over a period. The growth rate can be estimated using the simple exponential function.

$Y_t = á(1+r)^t u_t$…….. (1)

Where Y_t= output, t=time, a=lná =constant, r=the compound annual growth rate.

g=ln(1+r) and lnu_t ~ IND (0, ó²) i.e. normally distributed with mean zero. which can be linearized as $lnY_t = a + g_t + u_t$ …… (2)

Where lnY_t is the log of income, g is the growth rate, t is the time trend, and u_t is the random disturbance term. The parameter of the growth equation a and g varies from one growth regime to other. The sub-period analysis of growth has been calculated using the dummy variable interaction model. Three dummy has used for the three periods.

$lnY_t = a_0 + a_1D_1 + a_2D_2 + b_0t + (b_1D_1 + b_2D_2)t + u_t$…… (3)

Where D_1 = 1 for the 2nd phase and 0 for others
D_2 = 1 for the 3rd phase and 0 for others

Where a_0 , a_1, a_2, are the intercepts and b_0, b_1, b_2, are the slope coefficients.

The a_0 and b_0 are the intercept and slope coefficient for the base or 1st period.

The slope coefficient for the 2nd period will be – $(b_0 + b_1)$

The slope coefficient for the 3rdperiod will be – $(b_0 + b_2)$

The annual compound growth can calculated r = exponential of (slope coefficient)-1.

3.2: Relative Economic Position of Odisha

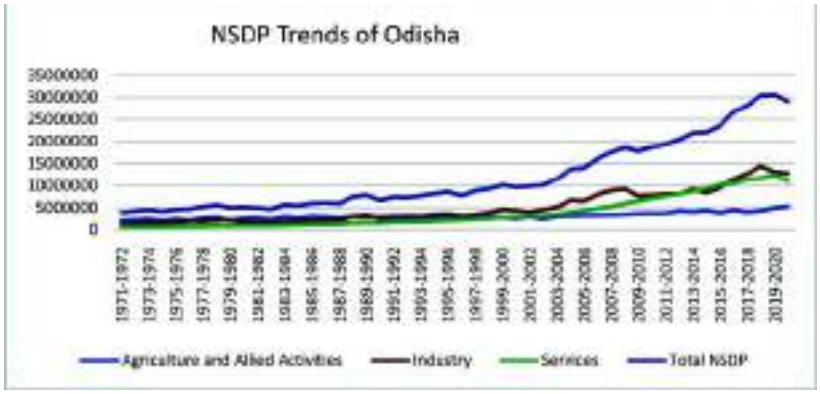
The relative economic position of Odisha can be examined by looking at the ratio of per capita income (PCI) of Odisha with all India and the ratio of NSDP of Odisha with all India , and the ratio of per capita income of Odisha with the other states. The PCI data for the states for the period 1971-72 to 2020-21 has been collected from the EPW research foundation. The states are ranked based on their PCI for the year 1971-72. Then looking into all India PCI the states are classified into lower income states (Below 75% of PCI of all India) , middle income state (75-125 % of PCI of all India) and high income states (125 % and above PCI of all India). The relative economic position of Odisha can be derived by taking the ratio of NSDP and the per capita NSDP of Odisha to all India and Odisha PCI to other state PCI.

4. Structural Transformation& Economic Growth in Odisha

The post-reform period recorded a faster output growth in Odisha (Sahoo & Joshi, 2018).In theirpaper they mentioned that in the post-reform period, Odisha has witnessed a faster reduction in the share of income of the primary sector and a faster rise in the share of income of the tertiary sector while keeping the share of secondary sector constant. Hence, it is important to know whether the structural transformation of the state of Odisha follows the same path as the national level or isit having a different trajectory of growth and structural transformation?The sectoral growth rate of Odisha has been looked in the next section, whereas the composition of income is presented in this section and compared with the all-India level.

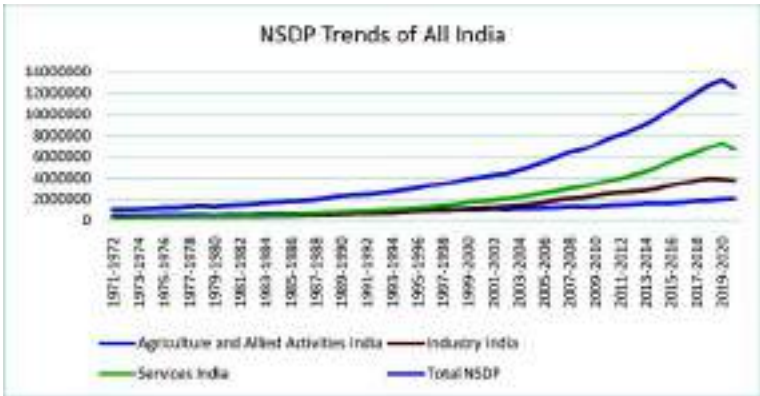
4.1: Structural Transformation in Odisha

Figure 1 Sectoral trends of NSDP of Odisha (In Lakhs).



Source: Authors own calculation from Net State Domestic Product (NSDP) dataset of EPWRF.

Figure 2 Sectoral trends of NDP of All India (In Crores).



Source: Authors own calculation from Net State Domestic Product (NSDP) dataset of EPWRF.

Figure-1 & 2 presents the sectoral trends of NSDP of Odisha and India. From figure-1 it can be seen that the agriculture & allied sector income for Odisha is higher over the industrial and service sector up to 1990-91. It implies that the agriculture & allied sector remains the major source of income of Odisha up to 1990's. It is only after 1994-95, the service sector income crosses the agriculture & allied sector and. It is after 2002-03 the service sector witnessed a faster rise, resulting in a commensurate rise in NSDP of Odisha. From 2008-09 to 2015-16 there is a slowdown in the industrial sector growth in the state. In case ofallIndia, the service sector witnessed a rising trend way back in the 1980's while for Odisha the service sector rises at a faster rate around 1990's and thereafter. Both in Odisha and India it's the service sector, which remains the major driver of the total output during the post reform period. Both at the national level and in the state there is a slowdown in the income rise after 2018-19. Hence, from the above analysis, it can be inferred that though the structural transformation at the allIndia level takes place during the 1980's, in case of Odisha it happens in the late 19990's. Now to have a broad picture of the transformation the income share of sectors is presented in table.1.

Table 1 Sectoral Composition of NSDP in Odisha and India (in percent)

Year	Odisha			India		
	Agriculture and Allied Activities	Industry	Services	Agriculture and Allied Activities	Industry	Services
1971-1972	49.87	33.09	17.03	46.09	24.93	28.99
1990-1991	34.89	42.82	22.28	33.79	29.36	36.85
2006-2007	19.90	49.74	30.36	20.87	32.35	46.78
2020-2021	18.34	43.83	37.83	16.27	30.15	53.58

The percentage contribution of the agriculture &allied andindustrial sector to the total income is higher for Odisha in comparison to all India, whereas the reverse is the case for the service sector. The agriculture sector remains the prime contributor of the primary sector. With the industrial sectorshare accounting for 44% of thestates income in the recent years , it's become an important sector of the state economy followed by services and agriculture. While at the national level it's the service sector which is the dominant sector followed by industry and agriculture.It emerges from the trends that the agriculture &allied sector's income share has been declining throughout while the service sector shares witness rising trends. Though at the initial years the industrial sector witness a rising trends its in the post 2006-07 the sector records a fall in income share. While the decline in the share of the agriculture & allied sector and an increase in the share of service sector is faster in the post-reform period, in comparison to the pre-reform period, for Odisha it is interesting to note that this share is consistent throughout at the national level. But the structural transformation again slowdown after 2006-07 as the declining share of agriculture and industry remain slow and the rise in the share of the service sector.

4.2: Sectoral Growth of Income in Odisha

As discussed earlier, the nature and composition of growth plays an important role in determining the economic development of an economy. To analyze the composition of growth, we have to estimate the growth rate of income among the sectors. It will be of interest to know which are the sectors witnessing faster growth rate in Odisha? Is the economic reform having an impact on the sectoral growth in Odisha?

Table 2 The sectoral growth rate in NSDP of Odisha in pre-reform and post-reform period.

Sector	1st (1971-72 to 1989-90)	2nd (1990-91 to 2005-06)	3rd (2006-07 to 2020-21)
Agriculture and Allied Activities	0.43	1.59	2.20
Agriculture	0.33 *	1.19	0.08 ***
Forestry and Logging	-1.02	0.30 **	2.88
Fishing	4.97	3.79	6.90
Mining and Quarrying	6.39	7.42	4.98
Manufacturing	2.30	4.12	4.63
Construction	2.14	3.07	3.41
Electricity,Gas and Water supply	1.83	1.16 *	2.35 *
Transport Storage and Communication	4.84	9.07	6.68
Transport by other means	4.39	9.01	6.44
Communication	5.80	11.83	8.08
Trade,Hotels and Restaurants	3.09	6.98	7.28
Banking and Insurance	6.83	9.79	8.84
Real Estate, Ownership of Dwellings and Business Services	1.89	3.22	3.95
Public Administration	3.63	4.41	7.11
Other Services	4.43	5.68	4.82
Net State Domestic Product	2.13	4.37	5.47
Primary	1.93	2.49	3.13
Secondary	3.66	5.56	5.54
Tertiary	4.32	6.17	6.81
NSDP	3.32	5.02	5.65

Source: Same as Figure 1

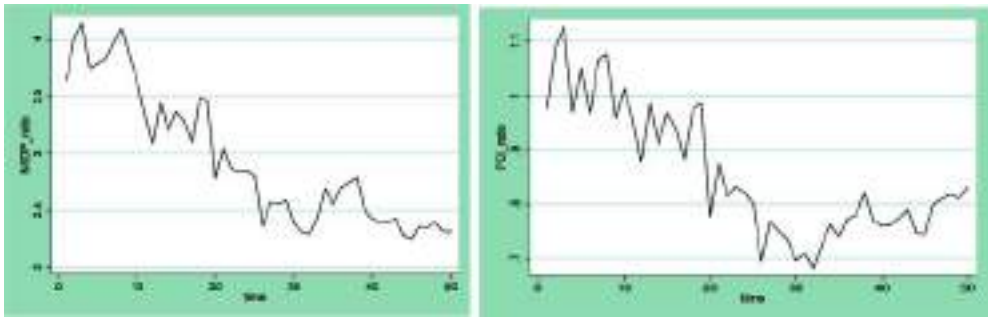
Note –All aresignificants at 1% level, * at 5 % level , ** at 10 % level and *** are insignificants.

The five decades has classified into the pre-reform period consistings of two decades and one period and the post reform period has two periods 1990-91 to 2005-06 and 2006-07 to 2020-21 looking into the break periods. Comparing the pre-reform period, the post-reform period has witnessed a higher growth in Odisha among the three sectors and the overall NSDP. In thetwo sub periods of the post-reform period (1990-91 to 2005-06 and 2006-07 to 2020-21), growth rate is 5.01 and 5.65 subsequently in comparison to a pre-reform period 3.31 percent. All three sectors experiencehigh growth in the post-reform period. Among the sub-sectors,mining & quarrying, trade, hotel & restaurant, transport, storage & communication have achieved a higher growth rate. While the growth of primary, secondary & tertiary sectors over these two decadesof pre-reform period are 1.92, 3.65 and 4.32 percent respectively, the first one and half decades of the post reform period recorded the faster growth rate among all three sectors while the agriculture & allied and service sector recorded a faster growth in income in the 2nd half of the post reform period the industrial growth remain stagnant. The high growth experienced in the post reform period is fuelled by the tertiary sector. The decadal growth analysis and the phases of growth among the sectors in Odisha and the factors affecting the growth has been well explained in the paper Sahoo & Joshi (2018).The paper looks into different phases of growth and the factors affecting the growth rate in the state by taking the decadal growth rate from 1970-71 to 2011-12. The decade of 1980's & 1990's has seen a faster growth in the secondary sector due to rise in growth of the mining sector in the state. Both the decades witness a slow growth in the primary sector due to reduction in the public investment in agriculture during those period, while in post 2000's it is observed that there is a faster growth in the primary and tertiary sectors. The faster growth in the tertiary sector during the 2000's is because of the high growth in transport storage –communication, trade –hotel &restaurants. The revival of the primary sector growth in 2000's is because of the rise in public as well private investment in agriculture. The faster growth in the tertiary sector during the post reform period is causing rise in regional disparities and inequalities of income among the districts of Odisha (Sahoo &Paltasingh, 2019, Sahoo & Senapati, 2020). The political stability in the state also played a role and led to a faster growth in income in the state during the post reform period (Sahu& Panda, 2018).

5: Relative Economic Position of Odisha

The national income and the per capita income of an economy over time reflect its economic performance. An economy having a high income counts as a richer state than an economy having a low income. The relative economic position of Odisha can be looked into by comparing with the per capita income (PCI) of Odisha with the other states. To compare the relative performance of Odisha with other states, the major states are classified into high income, middle income, low-income states taking into consideration, their per capita income. From each group, three states are chosen. Bihar, Madhya Pradesh& Uttar Pradesh are in the lower-income groups, Maharastra, Tamilnadu and Gujurat come under middle -income groups, and Punjab, Kerala, and Haryana come under the high-income groups. Odisha's relative position will be measured in terms of the ratio of per capita income of Odisha to the state's PCI.

Figure 3 Relative economic position of Odisha in comparison with All India



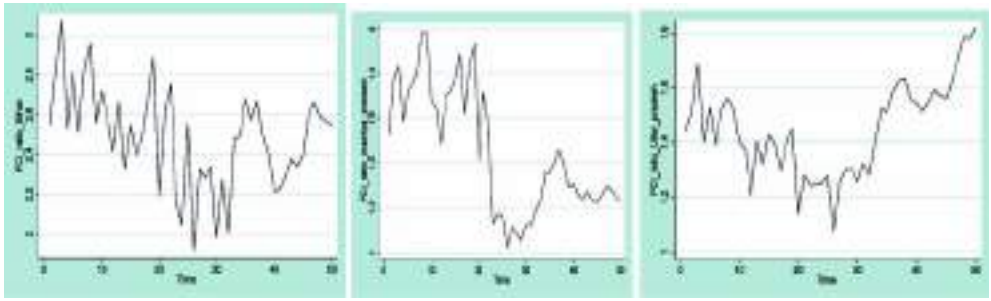
Source : Calculated by Author's from EPWRF NSDP data series.

A close look into the figure 3.1 shows Odisha NSDP share in the national NDP has been declining over the years. The share of NSDP of Odisha to all-India, which was around 3.64 percent in 1971-72, declined to 2.31 percent in the year 2020-21. The per capita income of Odisha and India in the 1971-72 was Rs 18,090 and Rs 18,534 respectively which in the year 2020-21 became Rs 71,622 and Rs 86,054in 2011-12constant prices. The per capita income of Odisha and India were almost same in 1970-71, while over the years the PCI of India increased faster than that of Odisha (Figure.3.2) though the post 2000's Odisha PCI is showing some improvement. It means that most of the states have been growing at a faster

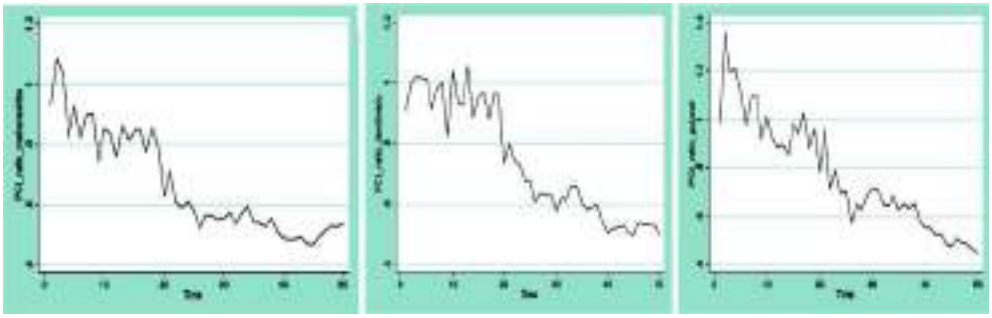
pace than Odisha. It can be inferred that Odisha's relative economic position has worsened over the years. Now the question that needs to be answered is; whether Odisha's relative economic position is better or worse off in comparison to major states over the year which has explained in figure.4.

Figure 4. Relative position of Odisha in comparison to States & All India

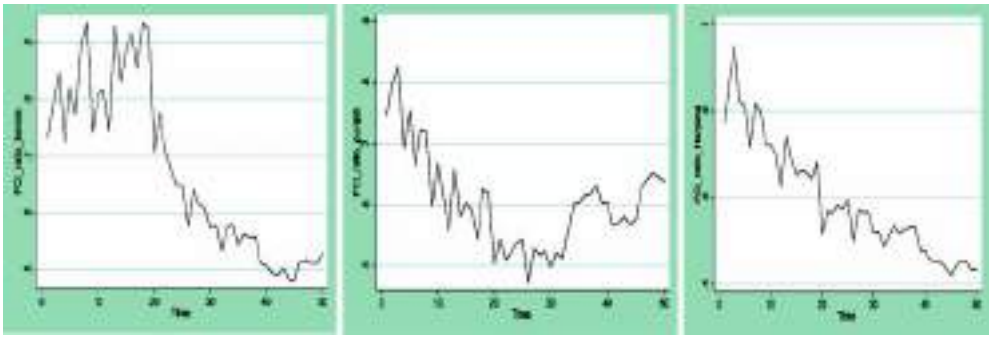
4.1 : Relative to Low Income States



4.2 : Relative to Middle Income States



4.3 : Relative to High Income States



Source : Calculated by Author's from EPWRF NSDP data series.

Figure.4 presents the relative economic position of Odisha in comparison to the major states. The ratio of the per capita income of Odisha to the respective state has plotted. Figure 4.1 presents the relative economic position of Odisha to low-income states. The ratio greater than one implies higher PCI of Odisha in comparision to that state. Even though the state Odisha is having high PCI in comparision to Bihar, Uttar Pradesh & Madhya Pradesh in the year 1971-72, the decline in trens shows that the other lower income states PCI is growing at a faster rate than Odisha. Its only post 2000's the position of Odisha has better up in comparision to the lower income states. Figure 4.2 shows the relative economic position of Odisha to middle-income states. All these three middle-income states Maharastra, Tamilnadu and Gujuratper capita income, is the same as Odisha's PCI in the early 1970s. But these states have seen a faster rise in PCI than Odisha which has reflected by the fall in the ratio of PCI. Figure 4.3 shows the relative economic position of Odisha concerning higher-income states. These states,Punjab, Kerala, and Haryana initial PCI are higher than Odisha, and these are the states which are growing at a faster rate in comparison to Odisha. Hence, from the above, it can be concluded that the economic position of Odisha has improved in comparison to the low-income states and worse-off in comparison to the middle and high-income states. Hence, though Odisha has achieved a higher growth rate its relative economic position has not improved over the year and hence, the it contradicts the result of Samantaray, et.al (2014).

6. Conclusion

The major structural changes in Odisha have taken place during the post reform where the sectors have seen a major compositional shift of income shares. The post reform periodhas recorded higher growth rate than the pre-reform period due to the faster growth of tertiary sectors. While Odisha has achieved a higher growth rate in the post-reform period, its relative position has gone worse in comparison to the all India level and among the major states. Among the major Indian states, Odisha's relative position has improved in comparison to the low-income states only, while there is deterioration in its economic position in comparison to the medium and high-income states. Hence, the state should focus on improving the growth of income by using its available resources to achieve a faster growth rate and better relative economic position in comparison to the other states and all India.

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Article

Empirical Testing of Determinants of Profit of District Central Cooperative Banks in Odisha

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Abstract

This article tries to analyse the effects of different variables on the profitability of a District Central Cooperative Banks (DCCBs) consolidated. Using the methodology of panel regression, seventeen DCCBs have been considered for the analysis of secondary quantitative data and panel datasets from 1993-94 to 2014-15 in Odisha. Here, the explanatory variables are share capital, reserves, owned funds, deposits, borrowings, advances, cost of management, working capital, income, peremployee business, and expenditure. Netprofit is the dependent variable. The Hausman test has been used to analyse the suitable model between the fixed and random effect models. The results suggest that the random effect model is suitable for pooled data for all the DCCBs. In addition, the knowledge of the inter-relationship between macroeconomic variables of the DCCBs in Odisha in this study can be considered for formulating guidelines and policies. The effect of the variables on the net profit will also give insights in this regard.

Keywords: District Central Cooperative Banks (DCCBs); Panel Regression; Hausman test;Fixed Effect and Random Effect Model

1. Introduction

There are two parts tothis article. In the first part, profitability is analysed for the pooled data of all DCCBs using panel data analysis. In the second

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part, we focus on the profitability of one DCCB –the Balasore Bhadrak Central Cooperative Bank.This analysis is a technique of analysing a specific subject within multiple series, from time to time, inspected over a specific period. The analysis includesa regression analysis with temporal and spatial dimensions. The spatial dimension relates to a set of cross-sectional units of observation. These could be groups of people, firms, states, countries, commodities, or individuals. The temporal dimension relates to a set of variables' periodic observations generalising these cross-sectional units over a specific time period Panel data, also named cross-sectional time series data or longitudinaldata, aredata where multiple cases (firms, countries, people, etc) are witnessed at more than two periods. "There are two types of information in cross-sectional time-series data: the cross-sectional information reflected in the differences between subjects, and the time-series or within-subject information reflected in the changes within subjects over time. Panel data regression techniques let you to take advantage of these different types of information" (Stock & Watson, 2003).

There are different types of panel data analytic models. There are constant coefficients, fixed effects, and random effects models.In this article, an effort has been made to analyse the effects of different variables on the profitability of a consolidated DCCB. For the analysis, the methodology used is that of Panel Regression which is pertinent when there are data for a specific period for each of the units being considered. So, it is relevant to the present study as the seventeen DCCBs, which have been considered.

2. Literature Survey on Determinants of Profit in the Banking Sector

The determinants of a bank's profitability have been classified as either internal or external (Hoffman, 2011; Sufian, 2009). Internal determinants can be measured by management henceforth are bank on the quality of judgments made by management (Athanasoglou,Brissimis& Delis, 2006;Javaid et al., 2011). Kosak and Cok (2008) find that larger banks, due to their dimensions,can manipulate economies of scale,leading tomore significant benefits. This increases the bank's financial gain volume (Elsas, Hackethal,&Holzhäuser, 2010). Khrawish, (2011) has observed an important and positive association between profits and bank sizes.

A negative connection has been acknowledged between profitability and credit risk (Miller&Noulas, 1997). Vong and Chan (2009) examined a

negative association between profit and loan loss provision. Several researchers (Hernando & Nieto, 2007; DeYoung & Rice, 2004; Athanasoglou et al., 2008; Chiorazzo,Milani & Salvini, 2008) also find a straight connection between a bank's credit risk and profitability. Articles by Kosmidou et al. (2005) and Alexiou and Sofoklis (2009) reveal that poor expenditure management decreases profitability levels. Effective cost containment paves the way for more significantbenefits(Brock & Suarez, 2000). Oladele,Sulaimon& Akeke(2012) find in their study that functioning expenditure considerably impacted the presentation of the banking sector. Olweny and Shipho (2011) find that the decrease in functioning expenditure significantly impacts the profitability of banks. Molyneux and Thornton (1992) view that employees' expenditure is connected with greater net charge-offs to the whole assets. Banks with more earning bills need larger interest margins to sustain profitability.

Haron and Azmi (2004) debate that if a bank is highly capitalised, the confidence of the consumers or beneficiaries in the bank is improved,which helps attract more deposits. Athanasoglou, Delis &Staikouras (2006) say that the capitalisation of the bank indicates the bank's performance to the market. Athanasoglou et al. (2008) observe a positive association between profitability and capital because capital is a security mechanism in difficult times. Abreu and Mendes (2000) find a negative connection between asset composition and profitability. Researchers (Bashir& Hassan, 2003; Staikouras& Wood, 2004) find an affirmative association. García-Herrero,Gavilá&Santabárbara(2009) view that maintaining a large portfolio of loans is connected with more functioning expenditure. Hassan and Bashir (2003) observe that a more significant loan ratio affects profits negatively.

Another determinant of the profitability of a bank is the interest rate. Ogunleye (2001) discusses that through the adjustment to revenues, a movement in the interest rate influences banks' profitability. Bank lending rate is optimistically associated with profitability (Obamuyi, 2013).

3. Data Sources and Variables

This analysis has been done on secondary quantitative data and on panel dataset covering 17 District Central Cooperative Banks (DCCBs)in Odisha from 1993-94 to 2014-15. The banks are Anugul DCCB, Aska DCCB, Balasore Bhadrak DCCB, Bank DCCB, Berhampur DCCB, Bhawanipatana

DCCB, Balangir DCCB, Boudh DCCB, Cuttack DCCB, Keonjhar DCCB, Khurdha DCCB, Koraput DCCB, Mayurbhanj DCCB, Nayagarh DCCB, Sambalpur DCCB and Puri-Nimapada DCCB. Data has been taken from different annual reports of BBCCB.

Here, the explanatory variables are sharecapital, reserves, owned funds,deposits, borrowings, advances, cost of management, working capital, income, per employee business and expenditure and net profit is the dependent variable. Investment of all the DCCB consolidated could not be included due to the unavailability of data, which was a variable in the time series data analysis of OSCB. On the other hand, new variables like income, per employee business and expenditure of the DCCB consolidated have been included for the analysis.

4. Methodology

The methodology employed for the empirical analysis on this study involves Pooled Ordinary Least Squares (POLS), and panelregression (fixed effect and random effect models).To know the suitable model between fixed effect and random effect model Hausman test has been used in this analysis.

The empirical relationship among share capital, reserves, owned funds, deposits, borrowings, advances, cost of management, working capital, income, per employee business expenditure and net profit is analysed through panel regression analysis usingrandom effect and fixed effect models. In the fixed effect model analysis, the banks are assumed to be heterogeneous,and the period is homogeneous. The random effect model assumes that banks are heterogeneous and the time period is homogeneous. Twelve variables are used for the analysis. The banking indicators are considered the primary pull factors of all seventeen DCCB consolidatednet profits. To have the best combination of explanatory variables for the determinants of net profit, various alternative combinations of variables were taken into consideration.

4.1. Estimation Equation of Pooled Ordinary Least Squares (POLS)

Profit = C (1) + C (2)*Share Capital + C(3)*Reserve + C(4)*Owned Fund + C(5)*Deposits + C(6)*Borrowings + C(7)* Loan and Advances + C(8)*Cost of Management + C(9)*Working Capital + C(10)*Per Employee Business + C(11)*Expenditure + C(12)*Income

4.2. Hausman Test

This test is "a standard technique used in empirical panel data analysis to differentiate between the random and fixed effectmodels.The common setup can be stated as follows: Suppose we have two estimators for a certain parameter â of dimension K×1. One of them, $\widehat{\beta_r}$ is robust, i.e. consistent under both the null hypothesis H_0 and the alternative H_1. The other, $\widehat{\beta_e}$ is efficient and consistent under H_0 but inconsistent under H_1. The dissimilarity between the two is then used as the basis for testing. Hausman (1978) demonstrates that, under proper assumptions, under H_0 the statistic h based on $(\widehat{\beta_R} - \widehat{\beta_E})$ has a limiting chi-squared distribution:

$$h = (\hat{\beta}_r - \hat{\beta}_e)'[\widehat{Var}(\hat{\beta}_r - \hat{\beta}_e)]^{-1}(\hat{\beta}_r - \hat{\beta}_e) \xrightarrow{d} \chi^2_k$$

Suppose this statistic lies in the upper tail of the chi-square distribution. In that case, we reject H_0: If the variance matrix is consistently estimated, the test will have power against any alternative under which $\widehat{\beta_r}$is robust and $\widehat{\beta_e}$is not." (Hausman, 1978)

4.3. Fixed Effect Model Specification

$$\begin{aligned}\text{Net Profi}_{it} = {} & \alpha_i + \beta_1 \text{Share Capital}_{it} + \beta_2 \text{Reserve}_{it} + \beta_3 \text{Owned Fund}_{it} + \beta_4 \text{Deposit}_{it} \\ & + \beta_5 \text{Borrowings}_{it} + \beta_6 \text{Advance}_{it} + \beta_7 \text{Cost of Management}_{it} \\ & + \beta_8 \text{Working Capital}_{it} + \beta_9 \text{Per Employee Business}_{it} \\ & + \beta_{10} \text{Total Expenditure}_{it} + \beta_{11} \text{Income}_{it} + U_{it}\end{aligned}$$

where α_0 is a bank fixed effect term which seizes time-invariant effectsparticular to bank i. where (t) is the period from 1993-94 to 2014-15 and (i) is the index number of i^{th}banks.

4.4. Random Effect Model Specification

$$\begin{aligned}\text{Net Profi}_{it} = {} & \alpha_0 + \beta_1 \text{Share Capital}_{it} + \beta_2 \text{Reserve}_{it} + \beta_3 \text{Owned Fund}_{it} + \beta_4 \text{Deposit}_{it} \\ & + \beta_5 \text{Borrowings}_{it} + \beta_6 \text{Advance}_{it} + \beta_7 \text{Cost of Management}_{it} \\ & + \beta_8 \text{Working Capital}_{it} + \beta_9 \text{Per Employee Business}_{it} \\ & + \beta_{10} \text{Total Expenditure}_{it} + \beta_{11} \text{Income}_{it} + \varepsilon_{it} + U_{it}\end{aligned}$$

where ε_{it} is random effect term.

4.5. Null and Alternative Hypotheses

H0: β_1=0 Vs H1:β_1 ≠0

H0: β_2=0 Vs H1:β_2 ≠0

H0: β_3=0 Vs H1:β_3 ≠0

H0: β_4=0 Vs H1:β_4 ≠0

H0: β_5=0 Vs H1:β_5 ≠0

H0: β_6=0 Vs H1:β_6 ≠0

H0: β_7=0 Vs H1:β_7 ≠0

H0: β_8=0 Vs H1:β_8 ≠0

H0: β_9=0 Vs H1:β_9 ≠0

H0: β_{10}=0 Vs H1:β_{10} ≠0

H0: β_{11}=0 Vs H1:β_{11} ≠0

4.6. Descriptive Statistics

It is seen from Table 1 that none of the variables are symmetric. Profit is the only variable negatively skewed, while other variables are positively skewed. The standard deviation value is very high, meaning the variables have high dispersion.

Table 1: Descriptive Statistics

	Profit	Share Capital	Total Reserve	Owned Fund	Deposit	Borro-wing	Loan and Advance	Cost of Manag-ement	Working Capital	Per Employee Business	Total Expen-diture	Income
Mean	-6.73	1564.42	430.68	1976.31	14061.48	9112.49	16323.25	360.38	28251.45	207.64	2317.06	2313.05
Median	10.68	978.21	115.91	1176.68	7377.19	4836.64	9353.84	237.89	14546.4	112.56	1372.14	1351.23
Maxi-mum	4037	15282.68	8595.8	21381.16	121947.1	101647.4	139392.6	1856.53	248775.3	1292.96	16662.84	16188.22
Mini-mum	-10956.3	91.3	-20.23	114.38	118.45	142.52	113.5	43.48	297.12	7.99	153.32	80.72
Std. Dev.	768.61	2055.43	949.52	2768.6	17910.66	13108.72	20236.35	343.95	37469.67	238.49	2693.9	2676.11
Skewness	-8.42	3.56	4.65	3.66	2.59	3.77	2.85	2.18	2.96	2.07	2.55	2.56
Kurtosis	121.16	18.38	28.82	19.09	11.17	20.58	13.25	8.22	13.69	7.67	10.53	10.74
Jarque -Bera	220204.8	4436.17	11639.33	4833.33	1447.56	5655.41	2126.81	714.06	2308.93	601.02	1277.57	1332.04
Proba-bility	0		0	0	0	0	0	0	0	0	0	0 0
Obser-vations	371	371	371	371	371	371	371	371	371	371	371	371

Source: Author's own calculation

4.7. Pair-wise Correlation

Pair-wise correlation shows the relationship between the two variables. In Table 2, the correlationmatrix presents all possible pair-wise correlations and is symmetric. The figures in the brackets shown are the p-values of the pair-wise correlation tests. It presents whether there is a significant relationship between the variables or not.

Table 2: Pair-wise Correlation

Proba-bility	Profit	Share Capital	Total Reserve	Owned Fund	Depo-site	Borro-wing	Loan and Advance	Cost of Mana-gement	Working Capital	Per Employee Business	Total Expen-diture	Income
Profit	1.00											
Share Capital	0.09 (0.07)	1.00										
Total Reserve	-0.02 0.75	(0.75) (0.00)	1.00									
Owned Fund	0.06 (0.23)	0.98 (0.00)	0.86 0.00	1.00								
Deposit	0.02 (0.63)	0.92 (0.00)	0.74 (0.00)	0.91 (0.00)	1.00							
Borro-wing	0.11 (0.04)	0.96 (0.00)	0.75 (0.00)	0.95 (0.00)	0.93 (0.00)	1.00						
Loan and Advance	0.04 (0.41)	0.96 (0.00)	0.77 (0.00)	0.95 (0.00)	0.96 (0.00)	0.97 (0.00)	1.00					
Cost of Manage-ment	0.01 (0.80)	0.89 (0.00)	0.71 (0.00)	0.89 (0.00)	0.95 (0.00)	0.90 (0.00)	0.94 (0.00)	1.00				
Working Capital	0.06 (0.28)	0.96 (0.00)	0.77 (0.00)	0.95 (0.00)	0.99 (0.00)	0.98 (0.00)	0.98 (0.00)	0.95 (0.00)	1.00			
Per Employee Business	0.07 (0.20)	0.74 (0.00)	0.66 (0.00)	0.75 (0.00)	0.78 (0.00)	0.76 (0.00)	0.75 (0.00)	0.70 (0.00)	0.79 (0.00)	1.00		
Total Expen-diture	-0.20 (0.00)	0.89 (0.00)	0.72 (0.00)	0.89 (0.00)	0.94 (0.00)	0.89 (0.00)	0.93 (0.00)	0.92 (0.00)	0.94 (0.00)	0.74 (0.00)	1.00	
Income	0.07 (0.18)	0.93 (0.00)	0.72 (0.00)	0.92 (0.00)	0.97 (0.00)	0.94 (0.00)	0.96 (0.00)	0.94 (0.00)	0.97 (0.00)	0.76 (0.00)	0.96 (0.00)	1.00

4.8. Pooled Ordinary Least Squares (POLS) Analysis

Substituted Coefficients:

Profit=25.8928887616 - 0.00719736748882*Share Capital + 0.00603727170508* Reserve - 0.0218129249536* Owned Fund - 0.0191829875801* Deposits- 0.00837427277963*Borrowings- 0.0100486681839* Loan and Advances + 0.312903261308* Cost of Management+ 0.0227719948267* Working Capital

+ 0.181181291751* Per Employee Business - 0.946781330257* Expenditure + 0.834103017761* Income

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Share Capital	-0.007197	0.087490	-0.082265	0.9345
Total Reserve	0.006037	0.070632	0.085475	0.9319
Owned Fund	-0.021813	0.076831	-0.283909	0.7766
Deposit	-0.019183	0.010415	-1.841901	0.0663
Borrowing	-0.008374	0.009757	-0.858300	0.3913
Loan and Advance	-0.010049	0.004733	-2.123082	0.0344
Cost of Management	0.312903	0.151516	2.065155	0.0396
Working Capital	0.022772	0.009118	2.497417	0.0130
Per Employee Business	0.181181	0.100922	1.795259	0.0735
Total Expenditure	-0.946781	0.019891	-47.59775	0.0000
Income	0.834103	0.027750	30.05772	0.0000
C	25.89289	26.57997	0.974150	0.3306
R-squared	0.877837		F-statistic	235.1714
Adjusted R-squared	0.874104		Prob (F-statistic)	0.000000
Durbin-Watson stat	1.988493			

Source: Author's own estimation

In the above table, thecoefficient of C is insignificant, implying that therandom effect Model is more suitable. This result is also confirmed in the Hausman Test in the next section.

4.9. Hausman Test

In the first step,a better estimator must be selected between the fixed and random effect models.For this purpose, the Hausman test[1]is toused to select the better model. The Hausman test is also applied to select between fixed and random effect models. The insignificant value of the test indicates that a random effect model is more suitable.

Table 3 : Hausman Test

Chi-Sq. Statistic	3.774280
Prob.	0.9761

Source: Author's own estimation

H0 = the random effect model is consistentlycompared to the fixed effect model. If the p-value of this test is less than 0.05, the H0 will be turned down, whichmeans the Fixed effect model gives better results than the random effect model and vice versa.

H0: random effect model is suitable for estimating the determinants of profit of all DCCBsin Odisha.

H1: Fixed effect model is suitable for estimating the determinants of profit of all DCCBsin Odisha.

4.10. Fixed Effect Model

Table 4: Fixed Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Share Capital	0.009449	0.092014	0.102687	0.9183
Total Reserve	0.015135	0.072395	0.209065	0.8345
Owned Fund	-0.039349	0.079075	-0.497609	0.6191
Deposit	-0.024936	0.011925	-2.091156	0.0372
Borrowing	-0.011436	0.010928	-1.046483	0.2961
Loan and Advance	-0.010680	0.005439	-1.963512	0.0504
Cost of Management	0.286387	0.170272	1.681941	0.0935
Working Capital	0.027741	0.010320	2.688003	0.0075
Per Employee Business	0.236756	0.122064	1.939611	0.0532
Total Expenditure	-0.949463	0.020385	-46.57547	0.0000
Income	0.822054	0.028727	28.61559	0.0000
C	41.34545	30.80161	1.342314	0.1804
R-squared	0.885201		F-statistic	97.95702
Adjusted R-squared	0.876165		Prob(F-statistic)	0.000000
Durbin-Watson stat	2.118122			

Source: Author's own calculation

4.11. Random Effect Model

The outcomes of the random effect model are displayed in Table 5. Note that the coefficients of more than half of the independent variables are highly significant. Moreover, these variables collectively explain nearly 89 per cent(%) of the cross-sectional variation, based on the adjusted R^2 statistic (0.88071).

Table 5: Random Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Share Capital	0.003666	0.089594	0.040913	0.9674
Total Reserve	0.012291	0.071447	0.172029	0.8635
Owned Fund	-0.033559	0.077853	-0.431059	0.6667
Deposit	-0.022447	0.011175	-2.008612	0.0453
Borrowing	-0.010181	0.010345	-0.984186	0.3257
Loan and Advance	-0.010229	0.005078	-2.014260	0.0447
Cost of Management	0.308192	0.160334	1.922185	0.0554
Working Capital	0.025514	0.009732	2.621687	0.0091
Per Employee Business	0.200969	0.109231	1.839854	0.0666
Total Expenditure	-0.948283	0.020086	-47.21207	0.0000
Income	0.828219	0.028103	29.47034	0.0000
C	31.95178	33.39501	0.956783	0.3393
R-squared	0.880710		F-statistic	240.9514
Adjusted R-squared	0.877055		Prob(F-statistic)	0.000000
Durbin-Watson stat	2.066429			

Source: Author's own calculation

As is expected, the coefficient of share capital is positive, but it is not significant even at a ten per cent level. The coefficient of total reserve is positive and insignificant. The value of the coefficient of deposit indicates a negative relationship between deposit and net profit as the coefficient of deposit is significant but negative at ten per cent. However, the value of the coefficient is relativelysmall at -0.022, showing that as the deposit increases by oneper cent, the net profit decreasesby only 0.022 percentage(%) points.

The coefficient of borrowing is positive, but it is not significant even at a ten per cent level. The value of the coefficient of loan, -0.010229, is negative and significant at five per cent. However,to know to what extent this relationship is significant, we must refer to the p-value of independent variables. As shown, thep-value of the loan and advance is0.0447< 0.05.Hence,loan and advance is a significant independent variable for estimatingthe net profit of DCCB consolidated.

The estimated result shows that the coefficient of cost of management is positive and significant at five per cent. So H0 is rejected, and H1 is accepted that there is a significant relation between the cost of management and net profit. This implies that the cost of management has been effective in influencing the net profit of DCCB consolidated. The coefficient shows thata one per cent rise in the cost of management causes to rise in the net profit by 0.308192 per cent (%) on average.

The coefficient of working capital is positive and relativelysmall at (0.025514), whichmeans a one per cent change in working capital will increasethe net profit by 0.025514 percentage points on average. According to t-statistics, we reject the H0 and accept H1 that there is a significant relation between working capital and the DCCB consolidated net profit.

The estimated result shows that the coefficient of per employee business is positive and significant at a ten per centsignificance level. So H0 is rejected and H1 is accepted. There is a significant relation between per employee business and net profit. This implies that per employee business has effectively influenced the net profit of DCCB consolidated. The coefficient shows that a one per cent increase in per employee business causes to rise in the net profit by 0.200969 per cent (%) on average.

The coefficient of total expenditure is negative and significant at one per cent. The coefficient shows that a one per cent rise in total expenditure causes to decrease in the net profit by 0.948283 per cent (%) on average. Therefore, total expenditure has a significant negative relation which negatively affects net profit and is according to the expected sign.

It also founda positive relationship between the income and the net profit of DCCB consolidated. The coefficients have turned out to be statistically significant. So, it is a major determinant of net profit of all the district central

cooperative banks. It is according to the expected sign. Generally, if the income of a bank increases, the net profit increases.

The coefficient of owned fundsis negative and small, and insignificant. It means there is no significant relationship between owned fundsand net profit. Owned Fund has a negative and insignificant relationship with the net profit of DCCB consolidated. We accept the H0. It means that it does not determine the profit.

The estimated outcome indicates that the coefficient of loan and advance is positive and significant. So H0 is rejected and H1 is accepted that there is a significant relation between loan and advance and net profit. This implies that loans and advanceseffectively influenced the net profit of DCCB consolidated. The coefficient shows that a one per cent rise in working capital causes to rise in the net profit by 1.023 per cent (%) on average.

The deposit of the DCCB consolidated is negatively significantat one per cent with a coefficient of -0.013445. It means that the deposit of the bank affects the net profit negatively. The banks have to mobilise the resources efficiently to gain profits. Bank loans and advances are supposed to be the key sources of income and positively affectthe performance of the bank. With other things constant, the more the deposits are converted into loans, the better the interest margin and profits. Nevertheless, if a bank hasto increase risk to obtain a higher loan-to-asset ratio, profits may come down. Moreover, as bank loans are the main sources of revenue, we anticipate that non-interest-bearing assets negatively affect profits. It is consistent with the studies of Samy Ben Naceur (2003).

5. Determinants of Profit of Balasore Bhadrak Central Cooperative Bank

In this section,an attempt is made to know the determinants of profit of the BBCCB using a multiple regression approach.

5.1. Data Sources and Variables

The related data has been taken from the different annual reports of BBCCB from 1989-90 to 2014-15,i.e. 26 years. It has been collected by referring to the annual reports of BBCCB from 1989-90 onwards.The empirical relationship among owned funds, expenditure, cost of management,

loansand advances, borrowings, share capital, income, investment and net profit is analysed through regression analysis. Nine variables are used for the research analysis. Here the explanatory variables are owned funds, expenditure, cost of management, loan and advances, borrowings, share capital, income, and investment, while net profit is the dependent variable. Expenditure and income of BBCCB have been included in this analysis, like data analysis in DCCB pooled data analysis in the first part.

5.2. Methodology

The methodology employed for the empirical analysis on this study involves regression analysis (OLS). Before moving to regression analysis,a pair-wise correlation test among the variables has been done. The banking indicators are considered the major factors for the net profit of BBCCB. To have the best combination of explanatory variables for the determinants of net profit, various alternatives combination of variables were considered and then estimated.

5.2.1. Model Specification

Net Profit = $\hat{a}_o$ + $\hat{a}_1$ Owned Fund+ $\hat{a}_2$ Expenditure + $\hat{a}_3$ Cost of Management + $\hat{a}_4$ Loan and Advance + $\hat{a}_5$ Borrowings $_+$ $\hat{a}_6$Share Capital+ $\hat{a}_7$Income $_+$ $\hat{a}_7$ Investment +å

5.2.2. Descriptive Statistics

It is seen from Table6 that all the variables are positively skewed except profit. The standard deviation value is high, meaningthe variables have high dispersion. The mean of all the variables liesbetween maximum and minimum. According to the probability value of Jarque-Bera, cost of management, loan and advance and profit are likely to be symmetric in nature and other variables are not normally distributed.

Table 6: Descriptive Statistics

	Owned Fund	Expen-diture	Cost of Manag-ement	Loan and Advance	Borro-wings	Share Capital	Income	Invest-ment	Profit
Mean	3834.04	4438.86	756.02	34123.40	19306.23	2850.17	4461.75	15660.26	111.56
Median	1762.87	3499.05	545.21	21540.70	8770.23	1600.48	3724.08	6939.28	177.00
Maximum	15840.65	15852.97	1917.75	122461.10	85759.49	11056.24	16188.22	84818.59	335.25
Minimum	326.03	221.78	77.86	1768.09	1281.51	249.41	180.12	316.24	-269.44
Std. Dev.	4562.11	4470.54	637.69	35313.01	23561.31	3017.23	4523.06	22290.72	172.08
Skewness	1.58	1.24	0.69	1.14	1.57	1.37	1.23	1.81	-0.58
Kurtosis	4.48	3.60	2.04	3.29	4.50	3.99	3.63	5.36	2.12
Jarque-Bera	13.17	7.08	3.07	5.69	13.15	9.16	7.01	20.27	2.31
Probability	0.00	0.03	0.22	0.06	0.00	0.01	0.03	0.00	0.32
Observations	26	26	26	26	26	26	26	26	26

Source: Author's own calculation

5.2.3. Pairwise Correlation Test

Pairwise correlation shows the relationship between two variables. The correlation matrix presents all possible pairwise correlations, has 1.00s on the diagonal, and is symmetric (the values shown below the diagonal also appear above the diagonal). The figures in the brackets shown are the P- values of pair wise correlation test. It presents a significant relation between the variables.

Table 7: Pair-wise Correlation Test

	Owned Fund	Expen-diture	Cost of Management	Loan and Advance	Borro-wings	Share Capital	Income	Invest-ment
Owned Fund	1.00							
Expenditure	0.99 (0.00)	1.00						
Cost of Management	0.90 (0.00)	0.94 (0.00)	1.00					
Loan and Advance	0.99 (0.00)	0.99 (0.00)	0.95 (0.00)	1.00				
Borrowing	0.99 (0.00)	0.99 (0.00)	0.91 (0.00)	0.99 (0.00)	1.00			
Share Capital	0.99 (0.00)	0.99 (0.00)	0.93 (0.00)	1.00 (0.00)	1.00	1.00		
Income	0.98 (0.00)	1.00 (0.00)	0.94 (0.00)	0.99 (0.00)	0.98 (0.00)	0.99	1.00	
Investment	0.82 (0.00)	0.81 (0.00)	0.83 (0.00)	0.81 (0.00)	0.79 (0.00)	0.80 (0.00)	0.80 (0.00)	1.00

Source: Author's own estimation

5.2.4. Multiple Regression of Owned Fund, Expenditure, Cost of Management, Loan and Advance, Borrowings, Share Capital, Income and Investment on Net Profit

The coefficient estimate for the owned fund is negative but insignificant according to t- statistics in Table 8. So it is not a determinant of the profit of BBCCB.

Table 8: Multiple Regression of Owned Fund, Expenditure, Cost of Management, Loan and Advance, Borrowings, Share Capital, Income and Investment on Net Profit

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-17.457	13.827	-1.263	0.224
Owned Fund	-0.001	0.035	-0.032	0.975
Expenditure	-0.953	0.072	-13.149	0.000
Cost of Management	0.107	0.076	1.401	0.179
Loan and Advance	0.011	0.004	2.671	0.016
Borrowings	-0.010	0.003	-3.220	0.005
Share Capital	0.082	0.086	0.963	0.349
Income	0.857	0.065	13.211	0.000
Investment	0.003	0.001	2.992	0.008
R-squared	0.978863	Durbin-Watson stat		2.655919

Source: Author's own estimation

Further, the coefficient estimate for expenditure is negative and significant at one per cent according to t- statistics. Moreover, the result is consistent with the expected sign of the coefficient. The more the expenditure, the less the bank's net profit will be. It means expenditure is a negative determinant of net profit. Expenditure and profit are always negatively related and consistent with our results. The coefficient estimate for the cost of management is positive and insignificant according to t- statistics. So it is not a determinant of net profit of BBCCB.

The estimated outcome demonstrates that the coefficient of loan and advance is positive and significant. It is with the expected sign. It is also consistent

with the result of OSCB. The net profit of BBCCB will positively relatetoloansand advancesprovided.Further, the coefficient estimate for borrowing is negative and significant at five per cent. It is with the expected sign. Thus, the bank's need for more extensive borrowings leadsto lower profitability.The coefficient estimate for share capital is negative and insignificant. So it is not a determinant of the net profit of BBCCB for the study period.

The coefficient estimate for Income is positive and significant at one per cent, according to the t-test. Moreover, the result is consistent with the expected sign of the coefficient. The more income of the bank from various sources, the more profit. The bank can earn more profit with the interest-earning of the loan and advances, which is a significantpart of the income of BBCCB. Hence income of the bank from miscellaneous earningssuch as commissionsis a determinant of net profit.

The coefficient estimate for Investment is positive and significant at five per cent,according to the t-test. Moreover, the result is consistent with the expected sign of the coefficient. The more is the investment; the more would be profit. Hence, investment is a determinant of net profit and is also evident. The bank may be earning its profit from the return of the Loan and Advances, which is an actual scenario of cooperative banks. So, investment is a determinant of the net profit of the BBCCB.

The above analysis shows that the positive determinants of net profit for BBCCB are loans and advances, income and investment for the study period. Borrowings and expenditures are the negative determinantsof profit in BBCCB.

6. Conclusion

Hausman test results suggest that the random effect model is suitable for pooled data for all the DCCBs.As expected, the share capital, reserve and borrowing coefficientsare positive,whereas owned fund is negative. However, the coefficients are statistically insignificant. On the other hand, the coefficient of deposit, loanand expenditure is negative but significant. The coefficient of cost of management, working capital, per employee business and income is estimated to be positive and significant. Further, it is found that the positive determinants of net profit for BBCCB are loansand

advances, income and investment for the study period. Moreover, borrowings and expenditures are negative determinantsof net profit in BBCCB.

This study suggests that the knowledge of the inter-relationship between macroeconomic variables of the District Central Cooperative Banks (DCCBs) in Odisha can be considered for formulating guidelines and policies. The effect of the variables on the net profit will also give insights in this regard.

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(Footnotes)

Article

COVID-19 and MSME Sector in Mayurbhanj District of Odisha: A Linkage between Growth, Investment, Production and Employment

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Abstract

The paper examines the linkages between the expansion of MSME units, investment and production with employment generation in the Mayurbhanj district of Odisha. It also investigates the impact of COVID-19 on MSMEs in the district and the state. Multiple regression is used to analyse secondary data collected from DIC, Mayurbhanj and MSME State profiles of the government of Odisha. It is observed that the growth of MSME units, investment and production have a favourable and significant influence on employment. However, the growthof MSME units in the district has a more significantimpact. The study finds that the incidence of the COVID-19 pandemic hasan adverse impact on unregistered MSME units in the district. The pandemic reduced their number, investment and employment by around 50 per cent. The shutting down of units, non-functioning of some of them and decline in investment during the lockdown has adversely affected employment, which in turn has affected the life of hundreds of individuals working in them. Tribal communities dominate the districtwithout anylarge-scaleindustries to provide employment. The

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lockdown has caused miseryto people depending on MSMEs for their livelihood. The growth prospects of MSMEs are high, and they have the capacity to propel the economy towards development by solving macroeconomic problems like poverty, unemployment, and inflation. We propose that the government should nurture this sector so that MSMEs can drive the economy towards new heights of growth.
Keywords: COVID-19; MSME; Investment; Employment

1. Introduction

Micro, Small, and Medium Enterprises (MSMEs) constitute the backbone of the Indian economy,as the contribution of the sector to the GDP is 30.27 per cent. The manufacturing MSMEs have a share of 33 per cent in the total manufacturing gross value output (GVO) of the country. The sector also contributes 48.1 per cent to the total exports from India (Annual Report 2018-19,Ministry of MSMEs, India). A total of 1109.89 lakh jobs have been created by the MSME sector in the country, of which 844.68 lakhs (76%)workers are males,andthe remaining 264.92 lakhs(24%) are female employees (Annual Report 2021-22, Ministry of MSMEs, India).MSMEs play a strategic role in national economic development (Salim, Susilastuti& Astuty2021) and have been regarded as a major constituent in any viable long-run development strategy. They are considered an engine of socio-economic developmentboth in developed and developing countries since theyhelp maintain an appreciable growth rate and have immense potential for generating employment opportunities. The sector has made significant contributions to the Indian economy regarding job creation, reducing regional inequities, promoting equitable economic growth, and creating the country's export potential, constitutinga vital component of product supply chains.

The World Health Organization (WHO) declared COVID-19as a pandemic on March 11, 2020.To contain the spread of the disease, countries like the United States, Brazil, the United Kingdom, and India declared nationwide lockdowns(Gupta et al., 2022). India declared its first lockdown from March 25, 2020, to May 17, 2020. The government of Odisha declared COVID-19 as a state disaster on March 13, 2020.Data shows that the pandemic killed people through infection while affecting people economically and mentally due to loss of employment and resultant hunger, which became major issues in developing countries (Ghosh, Nundy& Mallick, 2020).The COVID-19 pandemic and the subsequent lockdowns have affected every sector of

Odisha and the Indian economy.The pandemic also had a negative impact on the MSME sector. It posed numerous obstacles and impacted production, supply chains, liquidity, demand, and labour supply.

Againstthis backdrop, this paper tries to investigate the relationships between the growth of MSMEs, investment, production and employment and the influence of COVID-19 on them in Mayurbhanj district of Odisha.The study is divided into eight sections. The second sectioncontains a literature review, the third presents the objectives, and the fourth is the research methodology.The fifth section discusseslinkages among MSME units, investment and production with employment and the impact of COVID-19 on the MSME sectorin Odisha. The sixth and seventh sections present challenges for the MSME sector during COVID-19 and government initiatives to safeguard their interest, respectively, followed by the concluding section.

2. Review of Literature

The COVID-19 pandemichas caused havoc inthe MSMEs sector, with many crippled or on the edge of extinction. Thirty-fiveper cent of MSMEs believe their enterprises have no hope of recovery and have started to shut down their business (Tripathy &Bisoyi, 2021). The pandemic collapsedthe global and domestic supply chains,with no movement of raw materials and finished goods. The economy also experienced demand shocks as spending was limited to essential areas. The impact of COVID-19 was visibleinboth MSMEs and larger firms.The pandemic has severely affected MSMEs worldwide concerning demand, supply and employment (Kadam, 2020). The impact of COVID-19 was severe on trade, manufacturing and the MSME sector. The lockdown affected small firms from the demand and supply side. The sudden collapse of trade and shortage of imported raw materials also affected the MSME sector and the millions employed in it(Sahoo & Ashwani, 2020).

The outbreak of COVID-19 had a significantnear-term hazard and a long-term potential for the MSMEs in the water sector. MSMEs in the water sector had the opportunity to disrupt the market and carve out their place in the industry by introducing cutting-edge technology and methods (Tiwari & Rai, 2020).Several MSMEs, includingthe industrial and retail sectors, temporarily closed their businesses during the statewide lockdown as they

discovered that the relief package was insufficient to compensate business owners of MSMEs in India for their losses(Roy et al, 2020).

The relief package to the tune of 5 lakh crore announced for MSMEs during COVID-19 aimed at helping the sector repay dues owed to them by the central government and the private sector (Magazine & Sasi, 2020). Under the scheme, the MSMEsbenefited if their dues were paid promptly (Ghosh et al, 2020).

3. Objectives

The study has the following objectives:

a. To examine the linkages betweenthe growth of MSME units, investment and production with employment in MayurbhanjDistrict.

b. To study the impact of COVID-19 on the MSME sectorof Odisha in general and Mayurbhanj in particular.

4. Data Sources and Methodology

The secondary data of both registered MSMEs from1985-86 to 2020-21 and unregistered MSMEs from 1999-2000 to 2021-22 in Mayurbhanj district have been collected from the District Industries Centre (DIC), Mayurbhanjand MSME State Profile of Government of Odisha. The number of MSME units (X_1),investment (X_2) and production (X_3)are used as independent variables, whereas employment in MSMEs (Y) is considered a dependent variable.A logarithmic form of each variable is taken to study the relationship among the variables. Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979) and Phillips-Perron (PP) unit root test (Phillips & Perron, 1988) are used to check the stationarityof the variables. The stationary variables have been taken for running multiple linear regressionusing the Ordinary Least Square (OLS) technique.

The multiplelinear regression equation used to study the linkage between number of units, investment, production and employment is as follows.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon_t$$

Here Y= Employment
X_1= Number of MSMEs units
X_2= Investment
X_3= Production
å= Standard Error
â0, â1, â2and â3 are coefficients

5. Result and Discussion

5.1. Registered MSME Units in Mayurbhanj

Table 1: Unit Root Test Result of Registered MSMEs

Test	ADF		PP	
	Level	1st Dif.	Level	1st Dif.
EMP	-2.007 (0.2815)	-4.654*** (0.0016)	-2.162 (0.2246)	-4.653*** (0.0016)
INV	-0.7088 (0.9884)	-4.539*** (0.0028)	-0.5403 (0.8642)	5.664*** -(0.0002)
UNT	-2.0252 (0.2745)	-2.838* (0.0717)	-1.535 (0.4968)	-2.816* (0.0737)
PRDN	-1.088590 (0.7085)	-8.096968*** (0.0000)	-1.92825 (0.3167)	-7.95512*** (0.0000)

Source: Author's estimations.

Note: *, ** and *** represent the significance at 10%, 5% and 1%, respectively. The numbers within parentheses represent P-Values.

Table 1 represents that employment (EMP), investment (INV), number of units (UNT) and production of registered MSME units are not stationary at level I(0). In contrast, they are stationary at the first difference I(1). In such cases, multiple regressions are applied by taking the first difference values of all concerned variables.

Table 2: Correlation Matrix of Variables for Registered MSMEs

Correlation Probability	EMP	INV	PRDN	UNT
EMP	1.00000			
INV	0.399338 (0.0158)	1.00000		
PRDN	0.649221 (0.0000)	0.615436 (0.0001)	1.00000	
UNT	0.826917 (0.0000)	0.165201 (0.3356)	0.412861 (0.0123)	1.00000

Source: Author's estimations.

The results of Karl Pearson's correlation,aspresented in Table 2, describes that the variables of registered MSMEs have a significant positive association. It also demonstrates that the MSME unit's growth has a high degree of positiverelation with employment, while production value has the nextstrongest correlation. On the other hand, investment has the lowest positive relation with employment in registered MSMEs.

Table 3: Multiple Regression Results of Registered MSMEs

Dependent Variable: DEMP (Employment) Method: Least Square			
Variables	**Coefficient**	**t-Statistic**	**Prob.**
C	2.984423	0.305299	0.0000
DINV	0.026286	0.974411	0.0420**
DUNT	0.628780	0.079617	0.0000***
DPRDN	0.070906	2.829512	0.0080***
R-squared	0.803835		
Adjusted R- squared	0.785445		
F-statistics	43.70937		
Prob. (F-statistics)	0.00000		

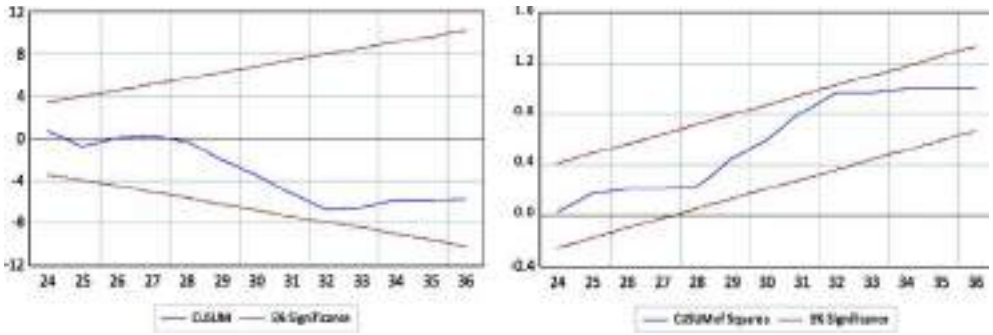
Source: Author's estimations.

Note: *, ** and *** represent the significance at 10%, 5% and 1%, respectively.

As per the results in Table 3, it can be stated that investment significantly and positively affectsemployment in the MSME sector.It shows that a one per cent increase in investment leads to employment creation by 0.02per cent.Regarding the growth of the number of MSME units, the impact is positive and significant ata oneper centsignificance level. Employment in the MSME sector is increased by 0.62per cent due to a one per cent rise in units of MSMEs.Similarly, one per cent increase in production leads to a 0.07 per cent increase in employment in MSME sectors, and its contribution is also significant at a oneper cent level of significance.The value of Adjusted R-squaredis 0.785445, meaning that investment, growth of MSME units, and production together explain 78.54 per cent of employment creation in registered MSME sectors.As per Table 2 estimation, the model is stated as DEMP = 2.983 + 0.026 DINV + 0.628 DUNT + 0.071 DPRDN + $å_t$

5.1.1. Stability Test

Figure 1: CUSUM and CUSUM of Squares Test of Stability



We utilise the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) test methods (Brown et al., 1975) to investigate the recursive residuals as in Figure 1 to confirm the stability of the calculated regressions model. The straight lines represent the critical boundaries at the 5 per cent significance level. The null instability hypothesis is accepted when the CUSUM and CUSUMSQ of the recursive residuals move outside of these two straight lines. The CUSUM and CUSUMSQ, on the other hand, remain within the lines' restricted area, indicating that the regression model is effective with stable recursive residuals.

5.1.2. Residual Analysis

Table 4: Diagnostic Tests of Regression Results for Registered MSMEs

Residual Tests		Prob.
Histogram- Normality Test	Jarque-Bera(0.177350)	0.915143**
Serial Correlation-LM Test	Obs*** R-squared	0.5026**
Heteroskedasticity Test-Breusch-Pagan-Godfrey	Obs***R-squared	0.2936**
Correlogram Q-statistics	Q-Stat	> 0.05**

Source: Author's estimations.
Note: *, ** and *** represent the significance at 10%, 5% and 1%, respectively.

The residual diagnostic test shown in Table 4 shows that this multiple regression model is efficient for this study because there is no serial correlation, no heteroskedasticity, and the residuals are normally distributed and stationary. So it satisfies all the assumptions of OLS and provides an adequate description of the data; therefore, it can be accepted as a suitable regression model.

5.2. Unregistered MSMEs of Mayurbhanj

Table 5: Unit Root Test Result of Unregistered MSMEs

Test	ADF		PP	
	Level	1st Dif.	Level	1st Dif.
EMP-	0.82437 (0.7922)	-3.2415** (0.0316)	-0.9143 (0.7640)	-3.139** (0.0388)
INV	-1.2312 (0.6417)	-5.3176*** (0.0003)	-1.1622 (0.6714)	-5.5759*** (0.0002)
UNT	-0.5903 (0.8538)	-3.0962** (0.0424)	-0.6788 (0.8323)	-3.0962** (0.0424)
PRDN	-1.537136 (0.4966)	-5.720665*** (0.0002)	-1.537136 (0.4966)	-7.849802*** (0.0000)

Source: Author's estimations.
Note: *, ** and *** represent the significance at 10%, 5% and 1%, respectively. The numbers within parentheses represent P-Values.

Table 5 shows that employment (EMP), investment (INV), number of units (UNT) and production (PRDN) variables of unregistered MSMEs are not stationary at level I(0). However, they are stationary at the first difference I(1). This allows us to apply multiple regressions taking the values of the first difference of each variable.

Table 6: Correlation Matrix of Variables for Unregistered MSMEs

Correlation Probability	EMP	INV	PRDN	UNT
EMP	1.00000			
INVST	0.960364 (0.0000)	1.00000		
PRODN	0.878180 (0.0000)	0.901013 (0.0000)	1.00000	
UNITS	0.987143 (0.0000)	0.953109 (0.0000)	0.893299 (0.0000)	1.00000

Source: Author's estimations.

As shown in Table 6, there is a significant and positive association between employment onone hand and investment, production, and unregistered MSMEunits on the other. The number of MSME units and employment have the highest degree of association (0.987143), followed by investment. Furthermore, production in MSMEs has a strong relationship with employment. As a result, variables like the number of units, investment, and production in unregistered MSMEs substantially and favourably impact employmentthere.

Table 7: Multiple Regression Results of Unregistered MSMEs

Dependent Variable: DEMP (Employment) Method: Least Square			
Variables	**Coefficient**	**t-Statistic**	**Prob.**
C	-0.013202	-0.731720	0.4738
DINV	0.201045	2.348183	0.0305**
DUNT	0.610383	5.090460	0.0001***
DPRDN	0.055417	0.765066	0.0454**
R-squared	0.766472		
Adjusted R- squared	0.727550		
F-statistics	19.69280		
Prob(F-statistics)	0.000005		

Source: Author's estimations.

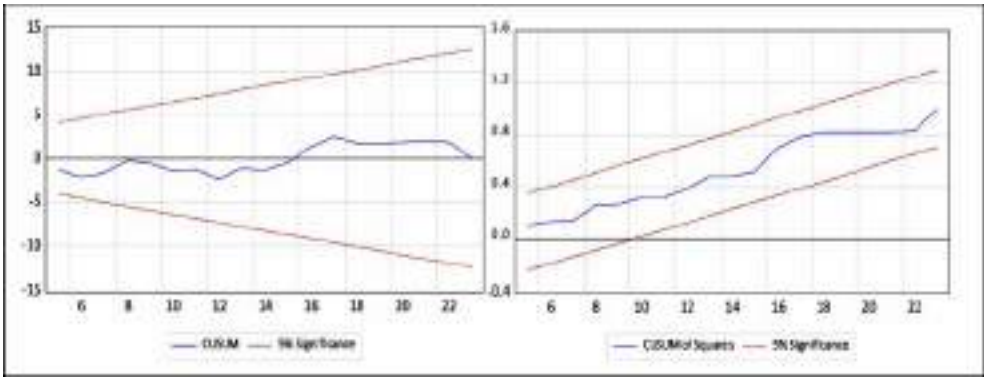
Note: *, ** and *** represent the significance at 10%, 5% and 1%, respectively

A cursory glance at Table 7 reveals that investment in the MSME sectorsignificantly and positively affects employment. The outcome presents that a one per cent increase in investment in the MSME sector leads to employment of 0.20per cent. However, the growth of the number of MSMEshasa significant (oneper cent level of significance) impacton employment generation.It indicates that employment in the MSME sector can be increased by 0.61 per cent due to the one per cent growth of MSME units. Production in the MSME sector also has a significant and positive impact on employment in the MSME sector. It indicates that employment in the MSME sector can be increased by 0.055 per centdue to one per cent growth in production.The value of Adjusted R-squared is 0.72, meaning that investment, growth of MSME units and production valueexplain72.75per cent(%) of employment creation in MSME sectors in the unregistered category.As per Table 7, the model for the unregistered category of MSME sectors is stated as follows;

$$DEMP = -0.0132 + 0.201\ DINV + 0.61\ DUNT + 0.055\ PRDN + å_t$$

5.2.1. Stability Test

Figure 2: CUSUM and CUSUM of Squares Test of Stability



The cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) test methods confirm the stability of recursive residuals of the calculated regressions model, as shown in Figure 2. The null hypothesis of instability is not accepted as the CUSUM and CUSUMSQ of the recursive residuals remaininside critical boundaries at the 5 per cent significance level. Therefore,the regression model is effective with stable recursive residuals.

5.2.2. Residual Analysis

Table 8: Diagnostic Tests of Regression Results for Unregistered MSMEs

Residual Tests		Prob.
Histogram- Normality Test	Jarque-Bera(0.64763)	0.968137 **
Serial Correlation-LM Test	Obs* R-squared	0. 9395**
Heteroskedasticity Test -Breusch-Pagan-Godfrey	Obs* R-squared	0.8844 **
Correlogram Q-statistics	Q-Stat	> 0.05**

Source: Author's estimations.

Note: *, ** and *** represent the significance at 10%, 5% and 1%, respectively

Diagnostic Test Result

From the residual diagnostic test (Table 8), this multiple regression model is efficient as it satisfies all the assumptionsof OLS and provides an adequate description of the data.Moreover,it can be accepted as a suitable regression model for the variables of unregistered MSMEs.

5.3. Impact of COVID-19 on Unregistered MSMEsin Mayurbhanj

Figure 3: Number of Unregistered MSMEs

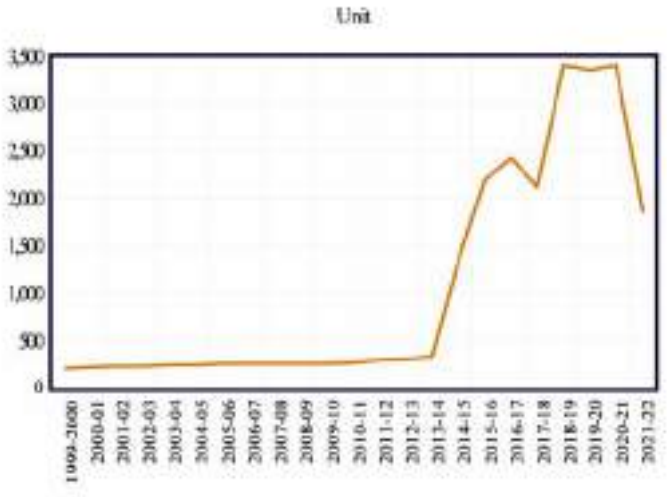


Figure 4: Investment in Unregistered MSMEs

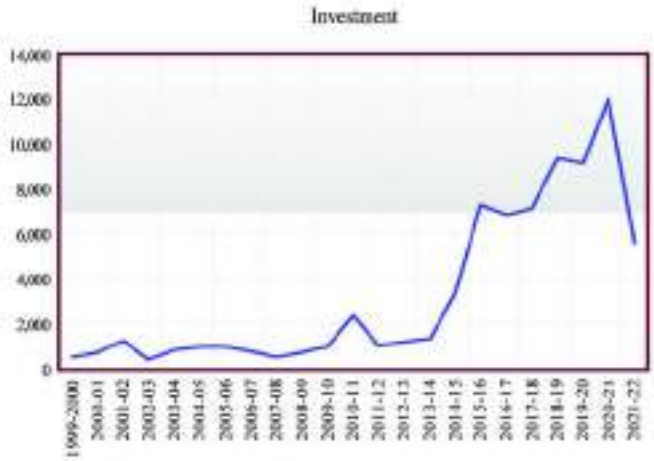


Figure 5: Employment in Unregistered MSMEs

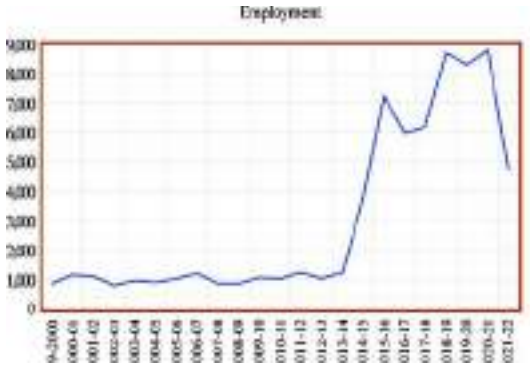
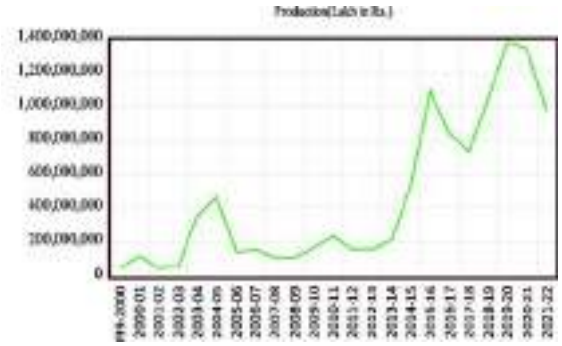


Figure 6: Production in Unregistered MSMEs



Source: DIC, Mayurbhanj District
Note: Investment and production values are expressed in lakhs, and employment values are in number of person

As shown in Figures 3, 4, 5, and 6, the COVID-19 pandemic has had an adverse impact on the unregistered MSME sector in Mayurbhanj District.It is observed that the number of units, investment, employment and productionare consistently growing in the pre-COVID period up to 2019-20. However, thenitexhibits a downward tendencyas units fallfrom 3400 to 1860, investment from 12039.38 lakhs to 5566.78 lakhs, employment from 8769 to 4733 and production is reduced from 13366.97 lakhs to 9781.53 lakhs. It can be inferredthat the nationwide lockdown due to the pandemicshut many MSME units. As a result of these outcomes, growth, investment, employment and productionin unregistered MSMEs have been inversely impacted. Employment in MSME has reduced sharply as the growth of units,investment and production goes downward.

Moreover, it is evident from Table9 that the number of micro-enterprises has decreased from 3385 in 2018–2019 to 1856 in 2021–22. The number of small enterprises declined simultaneously, from 15 in 2019–20 to 4. (2021-22). There is only one medium enterprise in Mayurbhanj district. Both micro and small enterprises are affected by the COVID-19 pandemic. However, micro businesses are more severely affected due to restrictions leading to a fall in demand and non-availability of labour and raw materials.

Table 9: Category-wiseNumber of Enterprises in Mayurbhanj District

Year	Micro	Small	Medium
2015-16	2109	91	0
2016-17	2417	03	0
2017-18	2110	10	0
2018-19	3385	15	0
2019-20	3333	15	1
2020-21	3368	31	1
2021-22	1856	4	1

Source: DIC, Mayurbhanj District

5.4. Impact of COVID-19 on Registered MSMEs in Mayurbhanj

Figure 7:Number of Registered MSMEs

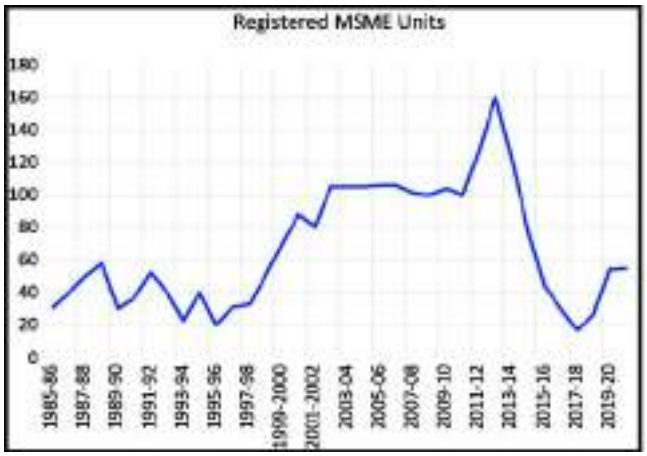


Figure8: Investment in Registered MSMEs

Figure 9: Employment in Registered MSMEs

Figure 10: Production in Registered MSMEs

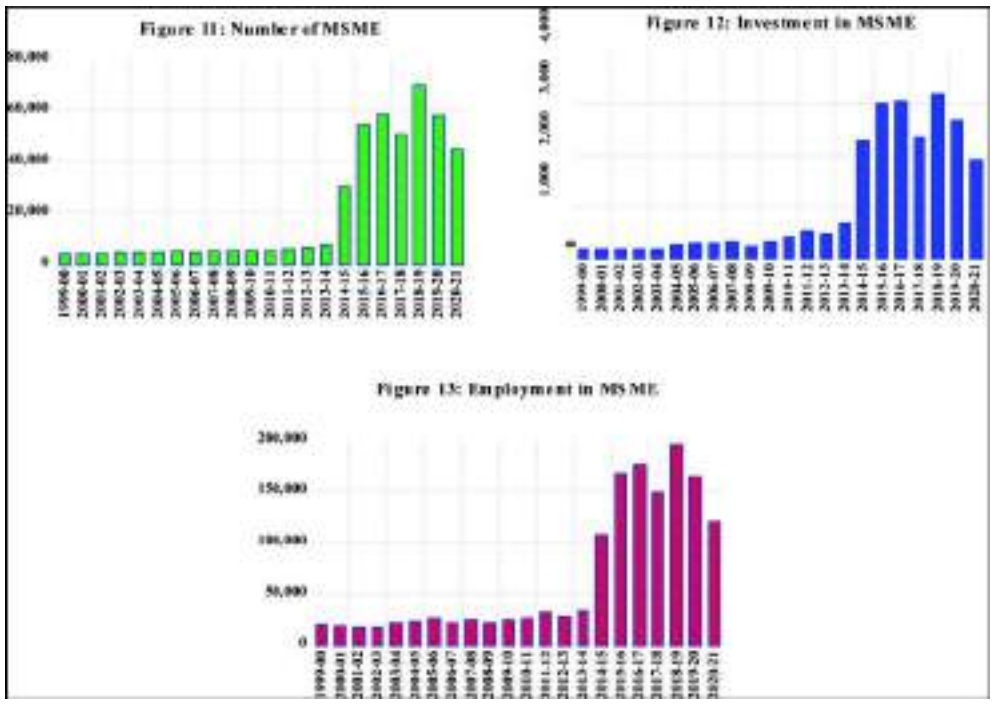
Source: DIC, Mayurbhanj District

Note: Investment and production values are expressedin lakhs, and employment values are in number of persons

The trend line of registered MSME units, investment, and employment from 1985 to 2020 is depicted in Figures 7, 8, 9, and 10. The Figures show that the number of MSME units, investment, and employmenthave declined during the pandemic as units declined from 122 to 55, investment from 507.89 lakh to 101.57 lakh,employment from 936 to 640 and production from 7682 lakh to 6656 lakh.It indicates that the COVID-19 pandemic has also hugely affected the registered MSME units in Mayurbhanj district.

5.5 Impact of COVID-19 on MSME Sector inOdisha

According to Odisha Industries Minister Dibya Shankar Mishra, "During the pandemic, 3,207 MSMEs have closed their operations," (*The Hindu*, 2021).It is represented in the following Figures, which indicate how the pandemic has impacted Odisha's MSME sector.



Source: Economic Survey of Odisha, 2021-22

Note: Investment and production values are expressed in crores, and employment values are in number of persons

Figures 11, 12, and 13 illustrate that the number of MSMEs, investment, and employment in the MSME sector grewsteadily in the pre-COVID period of 2018-19 but then declined due to the pandemic, with MSME units falling

from 69673 to 44273, investment falling from Rs.3196.53 crore to Rs.1887.79 crore, and employment falling from 1.94 lakh to 1.19 lakh.

5.6 Challenges for MSMEs in Mayurbhanj District

The sluggish growth of MSMEs before the pandemic up to 2013-14 may be attributed to inadequate attention given to the sector coupled with a lack of entrepreneurship, non-availability of adequate credit that limits access to technology, unawareness about market opportunities and lack of professionalism and management capability. After that,from 2014-15 to 2018-19, there weresubstantial increases in units, investment and employment. Pandemic restrictions reverted those again.

Mayurbhanj is a landlockedtribal-dominated district with a significantarea covered by hills and forests. Tribal literacy is as low as 59 per cent (%) while that in rural areasis 61 per cent (%) whereas the total literacy rate is 71 per cent (%) (2011 census). The MSME sector of Mayurbhanj district also faced the same problem as the sector at the national level. The low literacy, lack of communication, and lack of awareness about marketing opportunities among the illiterate tribal folk addto the problem. During the pandemic, some entrepreneurs closed their units due to a fall in demand and labour and credit problems. They did not feel confident aboutrenewing their business even after the pandemic. The unavailabilityof adequate and timely credit is also another constraint faced by the sector in the districts.

6. Conclusion

The study reveals that units of registered and unregistered MSME sectors and investment therein highly influence employment in the MSMEs sector in Mayurbhanj District. The shutting down of units, non-functioning of some of them, and decline in investment during the lockdown because of the COVID-19 pandemic haveaffected employment adversely and the lives of the hundreds of individuals working in it. The lockdown in these small firms also impacted domestic demand and supply. Because of the lockdown, more than half of unregistered MSME units have been forced to shut down, and investment, employment and production have suffered in Mayurbhanj district. The district is tribal-dominated, and there are no large-scale industries. The lockdown has caused miseries for people depending on MSMEs for their livelihood. Similarly, the lockdown impacted raw material

and intermediate imports, affecting the supply chain of the MSME sector. If the situation worsens and continues, smaller and smaller businesses may cease to exist since it will be difficult for them to survive and retain their employees and machines. The government should nurture this sector properly so that MSMEs can drive the economy towards new heights of growth.

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Article

Role of School Infrastructure in Shaping Education Outcomes: Evidence from Indian States

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Abstract

School infrastructure plays a significant role in children's enrolment, attendance, completion rate, transition rate and even learning achievements. This study, therefore, aims to investigate both the short and long-run relationships between school infrastructure and educational outcomes at the elementary level of education based on panel data from 18 Indian states from 2005-06 to 2016-17. The study uses infrastructure variables like boundary walls, drinking water, computer facility, electricity, girls toilets, and playground and attempts to find out their relationship with educational outcomesat the transition rate from primary to upper primary. The study employs econometric methods such as panel unit root test, panel cointegration test and panel vector error correction model, and Wald test. Results reveal that there is long run causality running from boundary walls, computer, electricity, girls toilets and play-ground to transition rate. It is also evident that bidirectional long-run causality exists between girls toilets to transition rate. It is also found that there is both long-run and short-run causality running from computer facility to transition rate and girls toilets to transition rate respectively. The policy implication of the study that investments on school infrastructure should be consistently to meet the aspiration of the children and to achieve the Sustainable Development Goal of ensuring quality elementary education to all boys and girls by 2030.

Keywords: Elementary education, school infrastructure, educational outcome, panel data

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1. Introduction and Motivation

School infrastructure is a key element where school learning happens (OECD, 2013). CAF Development Bank of Latin America (2016)reports thatinvestment in school infrastructure has effects on educational quality at least on three aspects: attendance and completion of academic cycles, teacher's motivation and learning results. School infrastructure includes school buildings, boundary walls, playgrounds, classroom, libraries, drinking water facilities, girlstoilets, electricity connection, computer facilities, and facilities (such as ramps) for differently abled students. One of the targets ofSustainable Development Goal - 4 (Quality Education) defined by the United Nations clearly indicates that all countries in the world should "build and upgrade education facilities that are child, disability and gender sensitive and provide safe, nonviolent, inclusive and effective learning environments for all."

As per Unified District Information System for Education Plus (UDISE+) 2019-20, infrastructure facilities have improved in elementary schools in India over time. Some of the major infrastructure developments include the availability of electricity (available in 83.4% of schools in 2019-20, which was 54.6% in 2012-13), girls toilets (available in 96.9% schools in 2019-20, which was 88.7% in 2012-13), computers (available in 38.5% schools in 2019-20, which was 22.2% in 2012-13), and drinking water (available in 97.1% schools in 2019-20, which was 94.9% in 2012-13).

There are number of studies in developing countries showing positive relationship between school infrastructure and educational outcome (Hanushek, 1995). Some studies found that there is positive relationship between school resources and student achievements (Chiu and Khoo 2005, Knoeppel et al. 2007, Duarte et al. 2011, Copper 2017,). Renovated school buildings enhance the academic results of students (Bullock 2007). Female students perform if there is better access to water supply and sanitation at school (Khudadad and Mickelson 2021). United Nation Department of Economic and Social Affairs (2014) reported that electrified schools have better outcomes like less absenteeism, higher enrolments rates, higher completion rate and higher test score. Similarly, a school having playground facilities will have higher attendance rates and lowernumber of dropouts (Sharif,2014). There is strong evidence that high-quality infrastructure facilitates better teaching-learning process, improves educational outcomes and reduces dropout rates, among other benefits (World Bank, 2017). A recent World Bank study shows that safe and efficient infrastructure does have an impact on student learning. (Barrett et al.2019). UNICEF Education Strategy 2019-2030 reported that physical and digital infrastructure such as classroom and connectivity, as well as curricula, textbook and other learning materials are necessary conditions for learning.

Educational outcomespoint to any achievements that can be measured through indicators. In this paper, we have taken a key indicator namely transition rate (from primary to upper primary) as educational outcome. According to the UNESCO Institute of Statistics (UIS), high transition rate indicates a high level of access or transition from one level of education to the next. It is considered as an output indicator when viewed from the lower level of education, whileit constitutes an indicator of access when viewed from the higher level of education,. Transition rate from primary to upper primary level tracks the percentage of pupils enrolled in the highest grade at the primary level (Grade V) who transition to the lowest grade at the upper-primary level (Grade VI) in the next academic year (School Education Quality Index, NITI Aayog, 2019).

The objective of this paper is to examine the relationship between school infrastructure and educational outcome from a panel of 18 Indian states from 2005-06 to 2016-17 using econometrics techniques.

The remainder of this paper is organized as follows: Section 2 presents the review of relevant literature; Section 3 describes the methodology adopted and Section 4 contains the data analysis and presents main findings. Section 5 concludes the study with relevant policy implications.

2. Literature Review

This review of literature mainly focuses on impact of school infrastructure variables, such as availability of electricity, water and toilets, availability of boundary walls, ramps and computer facilities, and classroom status (single classroom school and student classroom ratio) that have an impact on the educational outcomes and provide the motivation on which we build our analysis.

2.1 Relationship between School Infrastructure and Educational Outcome in the World:

To the best of our knowledge, there have been various studies contributing to the understating of relationship between school infrastructure and educational outcome at international level.

Some literature focuses on pupil teacher ratio, trained teacher and class size for educational outcome.Case and Deaton (1999) examined an empirical relationship between school inputs and educational outcomes in South Africa and found that

there are strong and significant effects of pupil teacher ratio on enrolment, on educational achievement, and on test scores. Similarly, a study by Ndlovu (2018) in Zimbabwe using multilevel regression analysis highlighted that well trained teacher and class size improve student achievements.

Osorio and Linden (2009) evaluated the use of computers for education in Columbia using a sample of 97 schools and 5201 children. Their results showed that even though computers have little impact on students test scores, the increase in the number of computers increased the student access to computers.

Picus et. al. (2005) examined the impact of high-quality buildings on students' performance. Their study demonstrates that there is no significant relationship between the quality of buildings and student learning performance. Narucki (2008) provided empirical evidence on the effects of building quality on educational outcomes using a sample of 95 elementary schools in New York City to show that the condition of school building directly hampers children's learning. Lee and Zuze (2011) investigated relationship between school resources and academic performance in the primary schools of four Sub - Saharan African countries and acknowledged that there are strong links between material and human resources and grade 6 students' achievement in reading and mathematics but structural features like school shifts and school size were negatively related to the achievements. Glewwe et. al. (2011) analyzed school resources and educational outcomes in developing countries and stated that schools with better quality roofs, walls, floors, desks, tables, chairs, and libraries were crucial for better student learning.

Khudadad and Mickelson (2021) investigated the relationship between school-built environment factors and student achievement in Pakistan using multilevel modeling. They highlighted that achievement is more from access to electricity and water supply. Further, they also found that male students perform well in school with access to electricity. Similarly, another study conducted by Devnarain and Matthias (2011) used focus group discussions with boys and girls to reveal that inadequate availability of clean drinking water facilities significantly reduced learning opportunities for the girls at the school.

Literature pertaining to availability of toilet in elementary school and educational outcome is a recent area of interest at elementary level of education. Cuesta et. al. (2016) presented a literature review which examined school infrastructure and educational outcomes, with special reference to Latin America focusing on both economic literature and education literature published in peer reviewed journals from

1990 to 2012 and also working papers from 2008 to 2012. They found that school libraries and creation of new schools enhances learning and enrolment, availability of toilets improve student learning, whereas availability of laboratories and drinking water facilities raises enrolment. There is limited evidence to show that schools having roofs, walls, and floors in good condition enhance student learning. Adukia (2017) explored school sanitation and education using District Information System for Education (DISE) data and found that sanitation facilities at schools substantially increases enrolment of both boys and girls and reduces dropout rate. However, there is no evidence of any increase in test score due to availability of latrines in schools. Kim and Rhee (2019) examined the effects of school toilet provisions on the primary school attendance rate in Kenya between 2013 and 2015 using over 4200 school level observation and showed that an increase in school toilet availability raises primary school attendance rate of girls than boys. This study suggests that access to toilets is crucial to reduce gender gap in education in developing countries. Gillani (2021) investigates the association between presence of sanitation facilities and school enrolment by utilizing school level data of over 17000 school from 2013 to 2018 in Pakistan and highlighted that schools with girls toiletsimprove enrolment and educational outcomes as well.

2.2 Relationship between School Infrastructure and Educational Outcome in India

Linden (2008) evaluated the impact of computer assisted learning program on student's math and language scores in 60 schools in four locations in the state of Gujarat, India. When students used the computers in the absence of a classroom teacher inany part of the day, it resulted in significant negative effects at the test outcomes. However, there was a little improvement when students used computer after school as a complement. Banerjee, Cole, Duflo and Linden (2007) studied remedial education using evidences from two randomized experiments (remedial education program and computer assisted learning program) conducted in two cities of India. The results suggest that both programs have positive effects on average test scores and score in mathematics of all the children, but no significant impact on language scores. Chudgar et al. (2015) studied school resources and student achievementdata from rural India. They found that schools having laboratory and library facilities positively impact students' performance. Ray and Datta (2017) used DISE data from 2007 to 2015 and showed that in India there is a positive relationship between separate female toilets in schools and gender parity indices of education (enrolment and participation) at upper primary level for all castes combined. Majhi & Mallick (2019) highlighted the impact of school infrastructure facilities on enrolment in primary schools in Odisha using secondary

data obtained from DISE. Their results from a multiple linear regression model show that physical infrastructure enhances enrolment at primary education level and classroom related factors influence enrolment positively, though not significantly. Naik et al. (2020) evaluated impact of the use of technology on student learning outcomes using a large-scale randomized field experiment in 1823 rural government schools in India and found that there is a positive impact of technology on student learning outcomes. Choudhry and Desai (2021) examined the relationship between piped water and access to liquefied petroleum gas (LPG) and children's educational outcomes in rural India based on the India Human Development Survey (2011-12) and the findings showed that children in the age group of 6-14 years living in households which do not depend on collecting firewood and water have substantially better educational outcomes.

The present study has used infrastructure variables like presence of boundary walls, drinking water, availability of computers, electricity, girls toilets and playgrounds to find their relationship with the transition rate (from primary to upper primary) at elementary level of education. The present study tries to fill the important gap in the literature by assessing the less explored relationship between school infrastructure and educational outcomes in India using econometric techniques.

3. Data and Methodology:

3.1 Data:

This study uses panel data covering a period from 2005-06 to 2016-17 for eighteen Indian states (Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Himanchal Pradesh, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Odisha, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, Uttarakhand and West Bengal) based on data availability.

3.2 Variables Description

Dependent Variable:

The present study considers transition rate from primary to upper primary level (TRPUP) as the dependent proxy variable for educational outcomes in the selected states.

Independent Variable:

The following six indicators, isolated from the literature, are used as independent variables for school infrastructurein our empirical analysis.

School with Boundary Wall (BWALL): The first indicator of school infrastructure is school boundary wall, and the variable is included in the form of percentage of schools having a boundary wall. A boundary wall ensures safety and security of students and is expected to have an association with educational outcome.

School with Drinking Water (DWATER): The second variable is drinking water facility, and the variable is included in the form of percentage of schools having the facility. It highlights the importance of adequate drinking water facilities which are desirable for any school that promote student learning.

School with Computer facility (COMP): This is the third variable included as percentage of schools having computer facilities. This facility is likely to directly improve learning and indirectly increase attendance by making school environment more attractive.
School with Electricity (ELECT): The fourth variable is electricity connection, and the variable is included in the form of percentage of schools with electricity. Provision of electricity in schools may can provide a good classroom environment facilitating teaching using digital technology. It is expected to enhance the educational outcome.
School with Girls Toilet (GTOILET): The fifth variable is presence of girls toilets in the school, and the variable is included as a percentage of schools having a girls toilet. This variable indicates the provision of adequate sanitation facilities, especially for the girl children, which increases student enrolment and reduces dropout rate (Adukia, 2017).

School with Playground (PGROUND): The last variable with respect to school infrastructure is presence of a playground in the school and is included as a percentage of schools having a playground. This is also expected to improve the educational outcome.

Data for all the variables are taken from the U-DISE (Unified District Information System for Education).

3.3 Method Justification

For carrying out the estimation, the educational outcome indicators used in the present study include the transition rate from primary to upper primary level (TRPUP). On the other hand, school infrastructure variables used in the study are – (1) School with

Boundary Wall (BWALL), (2) School with Drinking Water (DWATER), (3) School with Computer facility (COMP), (4) School with Electricity (ELECT), (5) School with Girls Toilet (GTOILET), and (6) School with Playground (PGROUND). The justification for adoption of a panel data approach is that it aidsin minimizing multicollinearity and givesmore degrees of freedom. For identifying the aforesaid relationship, the study adopted three major econometric methods including panel unit root test, and panel cointegration test and finally a panel vector error correction model has been applied to achieve the objective of the analysis.

The choice of panel unit root test compared to a conventional time series approach is because in panel unit root test, finite sample power is significantly greater. At the outset, we assess the order of integration for the variables to check whether school infrastructure and education outcome variables are non-stationary (existence of unit root) or stationary (nonexistence of unit root). For this purpose, various panel unit root tests have been developed in the literature. In this study we use LLC (Levine, Lin & Chu) test which is the most popularly used panel unit root test based on the ADF (Augmented Dicky Fuller) test.

To assess cointegration, Kao cointegration test was employed to check the presence of any relationship between the variables in the long-run. As our panel is a small panel, we have employed Kao residual based cointegration test.

We applied panel VECM to investigate the direction of causal relationship between school infrastructure and education outcome. As panel cointegration result revealed the existence of a long-run relationship among the variables in the system, this necessitates the use of VECM rather than VAR model.

The entire analysis has been done using theEviews software package.

4. Data Analysis and Findings

Our data set is a balanced panel in which each panel member (state) is observed every year. In our baseline model, panel member (N) =18 and periods (T)=12, yielding the 216 (=n) observations.

The following model expresses the relationship between educational outcome and school infrastructure.

$$TRPUP_{it} = \hat{a}_1 + \hat{a}_2 BWALL_{2it} + \hat{a}_3 DWATER_{3it} + \hat{a}_4 COMP_{4it} + \hat{a}_5 ELECT_{5it} + \hat{a}_6 GTOILET_{6it} + \hat{a}_7 PGROUND_{7it} + u_{it}$$

i = 1, 2, …….18 (where i stands for the i^{th} cross-sectional unit, which in this case are the states)

t = 1, 2, …….12 (where t for the t^{th} time period)

Descriptive Statistics:

Descriptive statistics shows the basic features of the data in a study. Table 1 summarizes the most important descriptive statistics for each of the school infrastructure (BWALL, DWATER, COMP, ELECT, GTOILET, PGROUND) variables and the educational outcome (TRPUP) variableusing annual data from U-DISE from 2005-06 to 2016-17 for 18 Indian states.

Table 1: Summary Statistics

	TRPUP	BWALL	DWATER	COMP	ELECT	GTOILET	PGROUND
Mean	87.77116	52.72037	91.63194	21.13194	46.81144	68.34676	55.04167
Median	90.65000	53.80000	94.20000	14.95000	38.17500	76.55000	56.95000
Maximum	100	93.90000	100	74.10000	99.90000	100	87.50000
Minimum	61.5	0.000000	69.50000	0.600000	2.650000	10.10000	0.000000
Std. Dev.	9.228490	20.89245	7.720426	16.76667	29.98237	28.39036	16.52324
Skewness	-0.929121	-0.098740	-0.96076	1.292811	0.373449	-0.469535	-0.334194
Kurtosis	3.135739	2.073589	3.015588	4.095880	1.759778	1.819510	2.593187
Jarque-Bera	31.24340	8.075130	33.23238	70.97750	18.86406	20.47869	5.510153
Probability	0.000000	0.017640	0.000000	0.000000	0.000080	0.000036	0.063604
Sum	18958.57	11387.60	19792.50	4564.500	10111.27	14762.90	11889
Sum Sq. Dev.	18310.48	93846.35	12815.07	60441.07	193272.7	173292.7	58698.77
Observations	216	216	216	216	216	216	216

Source: Authors' calculation from U-DISE data

The summary statistics shows that from the eighteen selected states of India, number of schools with drinking water facility have the highest mean while number of schools with computer facility had the lowest mean value. Around 55 percent of the schools had playground facilities, the highest (87.5 percent) being observed in the state of Maharashtra (in 2014-15) and lowest (20.3 percent)observed in the state of Odisha (in 2005-06). Around 91 percent of schools had drinking water facilities. States like Gujarat, Himanchal Pradesh and Tamil Nadu have achieved 100 percent in providing this facility in the year 2016-17. Around 21 percent of the schools had the computer facilities, the highest (74.1 percent) being observed in the state of Gujarat (in 2014-15) and lowest (0.6 percent) observed in the state of Bihar (in 2007-08). Around 46 percent of the

schools had electricity, the highest (99.9 percent) being observed in the state of Gujarat (in 2016-17) and lowest (2.65 percent) observed in the state of Bihar (in 2005-06). Around 68 percent of the schools had girls toilets, the highest (100 percent) being observed in the state of Gujarat (in 2015-16) and lowest (10.1 percent) observed in the state of Chhattisgarh (in 2005-06). Around 52 percent of the schools had the boundary wall, the highest (93 percent) being observed in the state of Gujarat (in 2016-17) and lowest (12 percent) observed in the state of Tripura (in 2009-10). An interesting feature here is that Gujarat is the only state among 18 selected states where schools had themaximum infrastructure facilities like drinking water, electricity, access to computers, girls toilets and boundary wall. Among all school infrastructure variables, schools with electricity had the highest standard deviation.

Correlation Matrix:

Table 2 presents the correlation matrix. Correlation coefficients are important to know the existence of multicollinearity among independent variables. A correlation coefficient of 0.8 or above indicates the presence of a high degree of multicollinearity. the table below shows that there is no indication of a very high degree of correlation among the independent variables. That allows us to include all the variables in the econometric analysis.

Table 2: Correlation Matrix

	TRPUP	BWALL	DWATER	COMP	ELECT	GTOILET	PGROUND
TRPUP	**1.000000**	0.426920	0.286106	0.578611	0.685217	0.339562	0.428391
BWALL	0.426920	**1.000000**	0.479337	0.524379	0.629096	0.422079	0.367457
DWATER	0.286106	0.479337	**1.000000**	0.436396	0.499114	0.736996	0.373421
COMP	0.578611	0.524379	0.436396	**1.000000**	0.787942	0.488955	0.641378
ELECT	0.685217	0.629096	0.499114	0.787942	**1.000000**	0.506174	0.667102
GTOILET	0.339562	0.422079	0.736996	0.488955	0.506174	**1.000000**	0.396270
PGROUND	0.428391	0.367457	0.373421	0.641378	0.667102	0.396270	**1.000000**

Source: Authors' calculation from U-DISE data

Panel Unit Root Test

Unit root test technique of econometrics confirms the presence of any form of trend and ensures that there is no issue of spurious regression. While analyzing panel data,

panel unit root test is performed to know whether the variables that are considered for the empirical analysis are stationary or nonstationary. If a series/variable is stationary, it implies that its mean and variance are time invariant. On the other hand, if a series is nonstationary, its mean and variance are time variant.

If a series has unit root, it means that it is nonstationary. Since we are dealing with panel data, we have used panel unit root test in order to confirm whether the series/ variables haveunit roots. There are many methods to run a panel unit root test. As our data set is a balanced panel, we have used Levin, Lin & Chu method for the analysis. Null Hypothesis (H_o):The panel has a unit root

Alternative Hypothesis (H_1): The panel does not have a unit root.

Table 3 shows the panel unit root test results applied to each series/variable.

Table 3: Panel Unit Root Test

Test Type: Levin, Lin, Chu (LLC) (Individual intercept and trend) **Test for Unit Root in:** Level				
Variable	**Statistic**	**Prob.**	**Stationary status**	**Order of Integration**
TRPUP	-9.84967	0.0000	stationary	I (0)
BWALL	-5.40340	0.0000	Stationary	I (0)
DWATER	-13.1013	0.0000	Stationary	I (0)
COMP	-6.67172	0.0000	Stationary	I (0)
ELECT	-9.22406	0.0000	Stationary	I (0)
GTOILET	-7.93665	0.0000	Stationary	I (0)
PGROUND	-12.4080	0.0000	Stationary	I (0)

Source: Authors' calculation

Based on the result reported in Table 3, it is clear that the probability value of unit roots of variables like TRPUP, BWALL, DWATER, COMP, ELECT, GTOILET and PGROUND are less than 5 per cent. We can reject null hypothesis and can accept the alternative hypothesis. Hence, we can say that the test results indicate that these variables do not have unit roots, that is, these variables are stationary. This also implies that they are integrated of the same order. When the variables are integrated of the same order, we can run the cointegration test.

Panel Cointegration Test

After testing panel unit root test and ensuring that the variables are integrated of same order, the next step is to apply the panel cointegration test. Cointegration technique of econometrics confirms whether there is a long-run relationship among these variables. As our panel is a small panel, we have employed Kao residual based cointegration test. The details of Kao residual cointegration test results are reported in Table 4.

Table 4: Kao Cointegration Test

Kao Residual Cointegration Test

Series: TRPUP BWALL DWATER COMP ELECT GTOILET PGROUND		
Sample: 1 216		
Included observations: 216		
Null Hypothesis: No cointegration		
Trend assumption: No deterministic trend		
	t-Statistic	**Prob.**
ADF	-6.616	0.0000
Residual variance	23.43282	
HAC variance	14.56496	

Source: Author's calculation

From Table 4, the probability value (0.0000) suggests that we can reject the null hypothesis and accept the alternative hypothesis, and conclude that the series are cointegrated. The presence of cointegration indicates a long-run relationship among the variables. Thus, we can say that the transition rates of children from primary to upper primary classes have a long-run relationship with availability of boundary wall, drinking water facility, computers, electricity, separate girls toilets and playground in the school.

Panel Vector Error Correction Model

After finding out that the variables are cointegrated as confirmed by the panel cointegration test, we can now run the Panel Vector Error Correction Model to explore the existence and direction of long run equilibrium relationship between school infrastructure and educational outcome.

Relationship between TRPUP and BWALL:

First, we check taking TRPUP as a dependent variable and BWALL as an independent variable. The results are as reported in Table 5 and Table 6.

Table 5: Panel Vector Error Correction Model

Vector Error Correction Estimates

Sample: 1 216 Included observations: 162 Standard errors in ( )& t-statistics in [ ]		
Cointegrating Eq:	CointEq1	
TRPUP(-1)	1.000000	
BWALL(-1)	-0.119515	
	-0.09056	
	[-1.31979]	
C	-82.01676	
Error Correction:	D(TRPUP)	D(BWALL)
CointEq1	-0.154344	0.033027
	-0.03561	-0.051
	[-4.33377]	[0.64762]
D(TRPUP(-1))	-0.222212	0.453891
	-0.07205	-0.10317
	[-3.08422]	[4.39945]
D(TRPUP(-2))	-0.124338	0.308105
	-0.05892	-0.08437
	[-2.11024]	[3.65171]
D(BWALL(-1))	0.026871	-0.251024
	-0.05118	-0.07329
	[0.52502]	[-3.42514]
D(BWALL(-2))	-0.039195	-0.139306
	-0.04553	-0.06519
	[-0.86094]	[-2.13689]
C	1.148891	1.538216
	-0.32281	-0.46225
	[3.55902]	[3.32765]

Source: Author's calculation

Table 5 shows the output for the Vector Error Correction Model. It automatically converts the variables into their first difference such as D(TRPUP) and D(BWALL). In this case, there is no probability value for knowing the causality.

Table 6: Panel Vector Error Correction Model

Estimation Method: Least Squares

Sample: 1 216
Included observations: 162
Total system (balanced) observations 324

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.15434	0.035614	-4.333768	0.0000
C(2)	-0.22221	0.072048	-3.084221	0.0022
C(3)	-0.12434	0.058921	-2.110244	0.0356
C(4)	0.026871	0.051181	0.525024	0.5999
C(5)	-0.0392	0.045526	-0.860937	0.3899
C(6)	1.148891	0.322811	3.559018	0.0004
C(7)	0.033027	0.050998	0.647616	0.5177
C(8)	0.453891	0.10317	4.399447	0.0000
C(9)	0.308105	0.084373	3.65171	0.0003
C(10)	-0.25102	0.073289	-3.425141	0.0007
C(11)	-0.13931	0.065191	-2.136888	0.0334
C(12)	1.538216	0.462252	3.327653	0.001

Determinant residual covariance 307.1382

Equation: D(TRPUP) = C(1)*(TRPUP(-1) - 0.119515374158*BWALL(-1) - 82.0167596255) + C(2)*D(TRPUP(-1)) + C(3)*D(TRPUP(-2)) + C(4) *D(BWALL(-1)) + C(5)*D(BWALL(-2)) + C (6)

Observations: 162

R-squared	0.199324	Mean dependent var	0.81284
Adjusted R-squared	0.173661	S.D. dependent var	3.927855
S.E. of regression	3.570546	Sum squared resid	1988.813
Durbin-Watson stat	2.039659		

Source: Author's calculation

In Table 6, C(1) represents the error correction term or the speed of adjustment towards long-run equilibrium. As per the procedure, when C(1) is negative in coefficient and significant, then we can say that there is a long-run causality running from independent variable to dependent variable or in other words, the adjustment takes the variables towards equilibrium.

Long-Run Causality:

On the basis of the results we can say that there is a long-run causality running from the availability of boundary wall (BWALL) to the transition rate from primary to upper primary (TRPUP) because C(1) is negative in coefficient (-0.15434) and the p value (0.0000) is significant.

Short-Run Causality:

To know the short-run causality between BWALL and TRPUP, we ran the Wald Testusing the coefficient associated with BWALL (reflected in Table 6). Accordingly, we set the null hypothesis as:
H_0: C(4) = C(5) = 0 (meaning that there is no short run causality running from BWALL to TRPUP).
The Wald test results are reported in Table 7.

Table 7: Wald Test

Wald Test:

Test Statistic	Value	df	Probability
Chi-square	1.28958	2	0.5248
Null Hypothesis: C(4)=C(5)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)	Value	Std. Err.	
C(4)		0.026871	0.051181
C(5)		-0.0392	0.045526

Source: Author's calculation

Wald test result (Table 7) clearly shows that the as the p-value (0.5248) is more than 5 per cent, we have to accept the null hypothesis and conclude that there is no short-run causality running from the availability of boundary wall (BWALL) to the transition rate from primary to upper primary (TRPUP).

Next, we examine the causality between the transition rate from primary to upper primary level (TRPUP) and the existence of a boundary wall (BWALL) by taking BWALL as the dependent variable and TRPUP as the independent variable. The results are presented in Table 8 and Table 9.

Table 8: Panel Vector Error Correction Model

Vector Error Correction Estimates

Sample: 1 216		
Included observations: 162		
Standard errors in ( )& t-statistics in [ ]		
Cointegrating Eq:	**CointEq1**	
BWALL(-1)	1.00000	
TRPUP(-1)	-8.367124	
	-1.75883	
	[-4.75720]	
C	686.2444	
Error Correction:	**D(BWALL)**	**D(TRPUP)**
CointEq1	-0.003947	0.018447
	-0.0061	-0.00426
	[-0.64762]	[4.33377]
D(BWALL(-1))	-0.251024	0.026871
	-0.07329	-0.05118
	[-3.42514]	[0.52502]
D(BWALL(-2))	-0.139306	-0.039195
	-0.06519	-0.04553
	[-2.13689]	[-0.86094]
D(TRPUP(-1))	0.453891	-0.222212
	-0.10317	-0.07205
	[4.39945]	[-3.08422]
D(TRPUP(-2))	0.308105	-0.124338
	-0.08437	-0.05892
	[3.65171]	[-2.11024]
C	1.538216	1.148891
	-0.46225	-0.32281
	[3.32765]	[3.55902]

Source: Author's calculation

Table 8 shows the results of VECM after converting the variable into first difference, D(BWALL) and D(TRPUP). In this case, there is no p-value for knowing the causality.

Table 9: Panel Vector Error Correction Model

Estimation Method: Least Squares
Sample: 1 216
Included observations: 162
Total system (balanced) observations 324

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.003947	0.006095	-0.647616	0.5177
C(2)	-0.251024	0.073289	-3.425141	0.0007
C(3)	-0.139306	0.065191	-2.136888	0.0334
C(4)	0.453891	0.10317	4.399447	0.0000
C(5)	0.308105	0.084373	3.65171	0.0003
C(6)	1.538216	0.462252	3.327653	0.001
C(7)	0.018447	0.004256	4.333768	0.0000
C(8)	0.026871	0.051181	0.525024	0.5999
C(9)	-0.039195	0.045526	-0.860937	0.3899
C(10)	-0.222212	0.072048	-3.084221	0.0022
C(11)	-0.124338	0.058921	-2.110244	0.0356
C(12)	1.148891	0.322811	3.559018	0.0004

Determinant residual covariance 307.1382

Equation: D(BWALL) = C(1)*(BWALL(-1) - 8.36712437247*TRPUP(-1) + 686.244428413) + C(2)*D(BWALL(-1)) + C(3)*D(BWALL(-2)) + C(4) *D(TRPUP(-1)) + C(5)*D(TRPUP(-2)) + C(6)

Observations: 162

R-squared	0.212483	Mean dependent var	1.583951
Adjusted R-squared	0.187242	S.D. dependent var	5.671328
S.E. of regression	5.112877	Sum squared resid	4078.075
Durbin-Watson stat	2.069025		

Source: Author's calculation

In Table 9, C(1) represents the error correction term or the speed of adjustment towards long-run equilibrium.

Using the same logic as applied in the previous case, we can say that there is no long-run causality running from the transition rate from primary to upper primary (TRPUP) to the availability of boundary wall (BWALL) as C(1) is negative in coefficient (-0.003947) with an insignificant p-value (0.5177).

Short-Run Causality:

Toexplore the short-run causality between the variables, we run the Wald Test, taking the coefficient attached with TRPUP (from Table 9). Accordingly, we set the null hypothesis:

H_0: C(4) =C(5) =0 (meaning that there is no short-run causality running from TRPUP to BWALL)

The results of the Wald test are reported in Table 10.

Table 10: Wald Test

Wald Test:

Test Statistic	Value	df	Probability
Chi-square	25.20528	2	0.0000
Null Hypothesis: C(4)=C(5)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)	Value	Std. Err.	
C(4)		0.453891	0.10317
C(5)		0.308105	0.084373

Source: Author's calculation

The results clearly say that the p-value (0.0000) is less than 5 per cent. Hence, we reject the null hypothesis. This implies that there is short-run causality running from thetransition rate from primary to upper primary (TRPUP) to the availability of boundary wall (BWALL).

Exactly in a similar method, we proceed to find out the relationship between other variables like the availability of drinking water facility (DWATER), computer facility (COMP), electricity (ELECT), girls toilets (GTOILET), and playground (PGROUND) with the dependent variable as transition rate from primary to upper primary level (TRPUP) and the results are presented in Table 11.

Table 11: Panel Vector Error Correction Model

Dependent Variable	Independent Variable	Error Correction Term	Coefficient	Prob	Long run causality	Wald Test (P Value)	Short run causality
TRPUP	BWALL	C(1)	-0.15434	0.0000	Yes	0.5248	No
BWALL	TRPUP	C(1)	-0.00395	0.5177	No	0.0000	Yes
TRPUP	DWATER	C(1)	-0.00019	0.9124	No	0.9136	No
DWATER	TRPUP	C(1)	-0.2696	0.0000	Yes	0.5834	No
TRPUP	COMP	C(1)	-0.15134	0.0000	Yes	0.0183	Yes
COMP	TRPUP	C(1)	0.00297	0.0923	No	0.4531	No
TRPUP	ELECT	C(1)	-0.20577	0.0000	Yes	0.0629	No
ELECT	TRPUP	C(1)	-0.01727	0.0584	No	0.1001	No
TRPUP	GTOILET	C(1)	-0.01097	0.0176	Yes	0.0359	Yes
GTOILET	TRPUP	C(1)	-0.19649	0.0000	Yes	0.1979	No
TRPUP	PGROUND	C(1)	-0.17226	0.0000	Yes	0.779	No
PGROUND	TRPUP	C(1)	-0.02266	0.2407	No	0.8863	No

Source: Author's calculation

The results can be summarized as under:

(i) There is a long-run causality running from the ***existence of boundary wall of the school*** (BWALL) to the***transition rate*** (TRPUP)but there is no evidence of a short-run causality. Also, there is no long-run causality running from TRPUP to BWALL though a short-run causality is indicated.

(ii) There is neither a long-run nor a short-run causalityrunning from the***availability of drinking water in the school*** *(DWATER)*to the ***transition rate*** (TRPUP).There is only a long-run causality running from TRPUP to DWATER but no short-run causality is indicated.

(iii) There areboth long-run and short-run causalities running from the***availability of computer facility in the school (COMP)*** to the***transition rate*** (TRPUP). But there is neither a long-run nor a short-run causality running from TRPUP to COMP.

(iv) There is a long-run causality running from the***availability of electricity in the school (ELECT)*** to ***transition rate*** (TRPUP), but there is no short run causality. However, here is neither a long-run nor a short-run causality running from TRPUP to ELECT.

(v) There are long-run and short-run causalities running from the ***availability of girls toilets in the school (GTOILET)*** to ***transition rate (***TRPUP). On the other hand, there is only a long-run causality running from TRPUP to GTOILET.

(vi) There is a long-runcausality running from the ***availability of play ground in the school (PGROUND)*** to ***transition rate (***TRPUP) but the data does not indicate any short-run causality. There is neither a long-run nor a short-run causality running from TRPUP to PGROUND.

5. Conclusion and Policy Implications

In this paper, we have attempted to investigate the relationship between school infrastructure and educational outcome in 18 Indian states from 2005-06 to 2016-17. We have applied the panel unit root test and to examine cointegration among variables, we used the Kao cointegration test. The cointegration result ensured the presence of long-run associations among availability of boundary wall (BWALL), drinking water facility (DWATER), computer facility (COMP), electricity (ELECT), separate toilets for girls (GTOILET), playground (PGROUND) and the transition rate from primary to upper primary (TRPUP) in the selected states. Estimation of the panel vector error correction model revealed that there is long-run causality running from the existence of boundary wall, computer facility, electricity, separate girls toilets and play ground to the transition rate. It is also evident that a bidirectional long-run causality exists between the availability of separate girls toilet facility to the transition rate. We also found that there are long-run and short-run causalities running from the availability of computer facility and girls toilet to the transition rate respectively.

India has made significant strides in improving access to education in terms of Net Enrolment Ratio (NER) and Gross Enrolment Ratio (GER), which has reached near about 100 per cent. However, Report No 312 of Parliament of India, (Demand for Grants 2020-21 of the Department of School Education & Literacy on the basis of UDISE 2017-18), highlighted that in India only 56.45 per cent schools have electricity facility, 56.98 per cent schools have playground facility and 60.12 per cent schools have boundary walls. Meanwhile, in Odisha 27.11 per cent schools have playground and 30.13 per cent schools have electricity. This shows huge critical infrastructural gaps across the states of India.

Many states have performed well in infrastructure facilities such as provision of drinking water, and separate toilets for boys and girls.But the provision of electricity, computer facilities and playgrounds continue to be a distant dream. Hence, the way forward is to make all schools electrified to take the advantage of digital technology by providing computers which can result in better educational outcomes.

Adequate infrastructure facilities in schools will also facilitate implementation of the National Education Policy, 2020 so far as school curriculum is concerned. It will help the children to achieve better learning outcomes, help the teachers to coach better in the classroom and will motivate the parents to send their children to schools.Therefore, investments in infrastructure facilities in schools is the need of the hour to meet the aspiration of children and to achieve the Sustainable Development Goal of quality primary education for all by 2030.

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Article

Coupling Strategies for Climate Change Adaptation: A Study of Small and Marginal Coastal Farmers in Kerala

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Abstract

Traditional rice-prawn culture practices undertaken by local communities in the coastal wetlands of Kerala have declined significantly due to climate change and the failure of farmer associations and state agencies to assure the prompt supply of public goods to complement mitigation and adaptation. As a result, cultivating traditional varieties of paddy and prawn culture practices has turned out to be highly risky and unfeasible. Under such circumstances, farmers typically opt for various coupling strategies to speed up their transition from non-viable land uses to climate-resilient cultivation practices and crop selections. However, the choice of suitable coupling strategies depends on the availability of cost-effective technologies, ecological changes brought in by climate change and institutional incentives. This paper tries to identify major determinants of adaptation strategies and describes how small and marginal coastal farmers combine these strategies to make a living. The study wasconducted on 160 primary producers from 42 producer associations and four local state institutions from the Ernakulam District of Kerala. Multi Nominal Logit Regression (MNLR) is used to understand how various determinants influence the coupling of adaptation strategies. The

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results reveal that farmers choose different combinations of adaptation strategies to sustain ecosystem services and livelihoods. The study noted that the interlinking of adaptation strategies enabled farmers to improve collective management of wetlands, water, crops, on-farm diversification, farm operations and risk management. We recommend that location-specific mitigation measures are necessary to promote autonomous adaptation of coastal agriculture. A combination of climate-smart technologies and modern climate risk management institutions is essential to confront extreme climate events and develop climate-smart wetland agriculture in coastal Kerala.

Keywords: climate change, adaptation, coupling strategies, coastal agriculture, multinomial logit regression

1. Introduction

Evolving climate-resilient agriculture along the coastal eco-zones continues to haunt policymakers and development agencies. (Intergovernmental Panel on Climate Change, 2007; Crooks, Herr, Tamelander, Laffoley& Vandever, 2011; Bunting & Little, 2015; Rajith & Zacharia,2015; Pound,Lamboll, Croxton, Gupta & Bahadur, 2018;Padhy, Dash& Bhattacharya, 2021). Despite opting for several precautions to manage climate change impacts at global and regional scales, coastal ecosystems have been portraying progressive signs of degradation, making coastal communities more vulnerable. The quality of coastal wetlands declined significantly as a consequence of sea level rise, intensive storms, tidal surges, changes in river flow regimes and sediment transport (Poff, Brinson & Day, 2002). Development agencies, social activists and scientists have also raised concerns about the declining capabilities and slow pace of autonomous adaptations of coastal communities to sustain livelihoods in developing countries in the growing context of climate change. (Food and Agricultural Organisation, 2020; International Union for Conservation of Nature, 2010; Gopalakrishnan et al., 2019; Singh, Anand, Singh & Khan,2019). Climate change scenarios of coastal agriculture in Kerala, India, also affirmed that coastal commons and communities link various adaptation and mitigation options to overcome the impacts of climate change with support from the state and development agencies.

The decline of coastal agriculture in Kerala is the product of state and market failures. Wrong development strategies, growth of international

markets, liberalisation and climate change have also influenced the deceleration process. Newly built international container transhipment terminals, railway networks, massive land reclamations and special economic zones for oil and natural gas businesses have all added to the progression of ecological degradation, soil erosion, displacement of local communities and loss of livelihoods in the region (Nambiar &Raveendran, 2009; Thomson and Berkes, 2006; Thomson,2011; Krishnani et al.,2011; Antony *et.al.,* 2014; Agency for Development of Aquaculture Kerala; 2015). Although the state has been trying to reverse trends and revive the food-producing capabilities of coastal communities through various institutional reforms, management plans and economic incentives, very little progress has been achieved in bringing back farmers who left traditional farming. The failure of formal institutions to coordinate collective actions to integrate autonomous and planned adaptation of local communities has been hindering the transitions of coastal communities and farmers. The paper examines how coastal farmers choose coupling strategies to manage climate change adaptation.

2. Review of Literature and Research Gap

Rice-fish/ prawn cultivationin low-lying flood-prone wetlands has been one of the major forms of rural livelihoods in several countries of the world (Suloma & Ogata, 2006). These systems are still prevalent in several Asian countries (Sevileja, 1992; Koesomadinata& Costa-Pierce, 1992; Gupta etal.,1998; Ohem*eet.al.,* 2007; Cagauan,1995; Ali,1990; Kim, Kim &Kim,1992).In India, even today, coastal farmers in Goa, Karnataka, Kerala, Orissa, and West Bengal are engaged in paddy cultivation in saline wetlands. The age-old *gazni* system, unique to Goa, gazani lands in coastal Karnataka, *Bheries*in the Sunderbans ofWest Bengal are the living examples of this traditional rural culture in the South Asian region(Salagrama, 2014; Thomson,2003; Bhat, Chandran & Ramachandra, 2010;Unnithan, 2009). The gaznifarming system is estimated to be around 18,000 hectares, of which about 12000 hectares are utilised for rice cultivation(Manjunath et al., 2009). The bheries of West Bengal extend to a total area of 32,930 hectares (Guguloth et al., 2013). In Kerala, the pokkali farming system lying around the catchment of Vembanad declined from 25,000 hectares to 9000 hectares in the 1990s and was further reduced to 5,000 hectares in the (Shyna & Joseph,2000; Panikkar,1937; Menon, 1954)

Determinants of Adaptation

Recent studies revealed that climate change has progressively imposed severe impacts on the social-ecological organisation of pokkali farming activities in Kerala and demanded immediate assistance from formal regulatory agencies to mitigate climate change impacts to accelerate adaption (Thomson, 2018; Berman et al., 2020). Social scientists and economists conducted studies to identify the major determinants of climate change adaptation and to estimate their relative influences. Hassan and Nhemachena (2008) and Gbetibouo (2009) used multinomial logit and Heckman probit models and found that household size, farming experience, wealth, access to credit, access to water, tenure rights, off-farm activities and access to extension services enhance the adaptive capacity of farmers. They suggested that the government should design policies to improve these factors to increase the adaptive capacity of farmers. Deressa, Hassan, Ringler, Alemu and Yesuf (2011) also reached similar conclusions in their study of the Nile Basin of Ethiopia. Abid, Scheffran, Schneider and Ashfaq(2014) observed that major determinants of adaptation are education, farm experience, household size, land area, tenancy status, ownership of tube wells, access to market information, information on weather forecasting and agricultural extension services. Menike&Arachchi (2016) concluded that social, environmental, institutional and economic structures influence Sri Lankan farmers' choices of adaptation to climate change. The size of the household, income, education, accessibility to climate information through television and radio, membership in farmers' associations, location of land, crop variety, access to formal loans and distance to input markets significantly affected adaptation. Gebreeyesusand Templeet al.(2017) observed that farm-level choices of adaptation strategies of farmers in Central Kenya are influenced by household characteristics, resource endowments, institutional variables and climate information. The strong correlation between socio-institutional variables and adaptive capacity indicated the need for establishing and strengthening micro-finance and extension.Begum and Mahantam(2017) used a probit regression model and found that among the main determinants affecting the adaptation choices of farmers in Assam, India, the most important ones are income, extension activities and credit availability. A study by Jha and Gupta (2021) found that critical socio-economic variables such as the farmer's age, gender, household size, education level, off-farm income and farm-size influence farmers' adaptation decisions in rural India. The study helped to identify the critical household characteristics that might be integrated into future policy

formulation and implementation of successful adaptation futures in Bihar. A recent study by Padhan and Madheswaran (2022) revealed that education, family size and the size of landholding are the main determinants of ex-post adaptation strategies, whereas age, size of landholding and family income are the major determinants of ex-ante coping strategies in the coastal districts of Odisha.

Coupling of adaptation-mitigation for sustainable livelihoods

Studies surveyed so far have identified the determinants of adaptation strategies of farmers to climate change in various regions. Recent studies observed that farmers, of late, combine various adaptation options and mitigation strategies to overcome the stress and strains of climate change impacts and claimed that these linkages vary according to local conditions, social-ecological parameters and the nature of climate and non-climatic drivers. Farmers typically adopt coupling strategiesto manage multiple stresses and benefit from adaptation choices (Stankovski, Pereira, McClintock & Stefanovska, 2019). Gebru, Ichoku and Phil-Eze (2020) identified determinants of adaptation and examined how farmers link adaptation strategies to climate change in the Eastern Tigray Region of Ethiopia. The majority of farmers in the study region were found to combine different adaptation strategies as they experienced diverse socio-economic and institutional barriers. Reyes-García, Salpeteur, Calvet-Mir, Serrano-Tovar, & Gómez-Baggethun(2013) pointed out that traditional knowledge systems and local institutions could act as valuable complements to modern science and technology to create successful adaptive strategies and sustain food security in the semi-arid tropics. Lemaire and Franzluebbers*et al.* (2014) examined strategies to achieve synergies between agricultural production and environmental quality. They observed that developingintegrated crop-livestock systems to increase food production at farm and regional levels is essential for future food security and environmental sustainability. Su, Chang, Li, Fahad and Ozturk (2023) simulated coupling coordination relationships under diverse livelihood and land use modes in southern Shaanxi Province and concluded that *"it is necessary not only to flexibly adjust the farmer's livelihoods and land use modes but also to optimise the allocation of various resources to promote sustainable development of farmers"*. The survey revealed that coupling appropriate adaptation strategies and identifying diverse determinants influencing these movements are essential for planning efficient adaptation actions.

3. Objectives of the Paper

The paper aims to identify major determinants of the coupling of adaptation actions to climate change and describes how small and marginal coastal farmers combine these strategies for making a living.

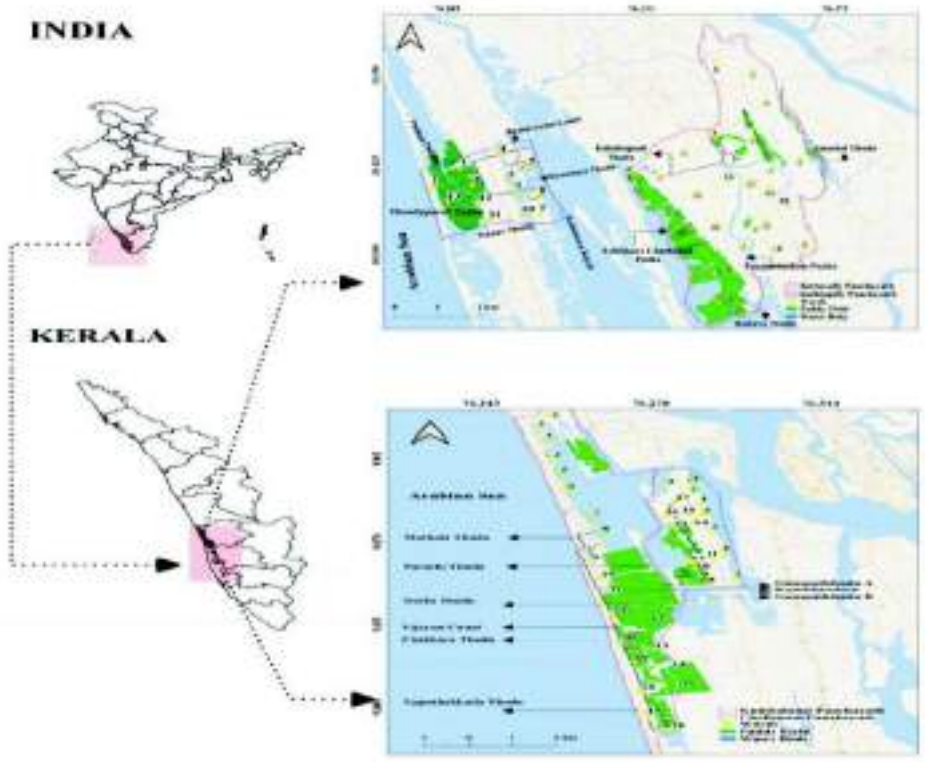
4. Methodology and Data

Location of Study Area

Since coastal agriculture is widespread in three districts of Central Kerala, the study selected four coastal villages of Ernakulam District for detailed examination. Among these, two Panchayaths – Kuzhuppuily and Kottuvally – are located on the northern side and two –Chellanam and Kumbalangi – on the south side. Kuzhupuiily and Chellanam Panchayaths are located close to the sea, while Kottuvally and Kumbalangi are a little far from the sea on the banks of the Cochin estuary. (See location map). Three per cent of the population in Ernakulam district and around seven per cent of its cultivators live in the study villages (District Census Hand Book Ernakulam, 2011).

Kuzhupilly is a small coastal panchayat with a total population of 23,858. Out of the 5,797 households in the panchayath, 718 are still active in agriculture and cultivate 232.72 hectares of wetland under the banner of 16 farm associations. Paddy fields of this Panchayath are interconnected through 20 sluice gates, which draw water from the nearby canals and other local inlets. Kottuvally Panchayath, located about 17 kilometres east of Kuzhuppilly, has a population of 42,922 and 10,671 households. Two hundred seventy-seven households under eight farm associations cultivate 293 hectares of wetland using 59 sluice gates. Chellanam Panchayat has a population of 14,928 and 3,446 households, of which only 1,196 practise agricultureon 841.00 hectares under the banner of 12 associations. Sixteen sluice gates interconnect paddy fields. Kumbalangi, located about 15 kilometres from Cochin Bar mouth, has a population of 42,367 with 10,034 households. Agriculture is practised on 249.80 hectares under the banner of five farm associations (District Census Hand Book Ernakulam, 2011).

Figure 1.1 Map of the study area in Ernakulam District, Kerala



The pokkali rice cultivation in Kerala typically begins with the preparation of land in the summer monthsof April- May, just before the commencement of monsoon. Farmers prepare land first by draining excess salt by washing the soil with the monsoon rains and later by draining salt water into the main channels. Two salt-tolerant seed varieties popular in this region are locally known as *pokkali, chettivirippu,* and*vytilla 4* and *6.* The crop matures in 120 days. Harvesting is done in October. Wooden sluice gates are used to regulate the flow of water into the fields. Since the tidal flow makes the soil fertile, seedlings grow naturally without using additional chemical fertilisers or manure (Sasidharan, Abraham& Rajendran, 2012). After harvesting, the land is used for aquaculture activities with the active mediation of respective farmer associations. Agricultural fields are converted to prawn culture farms from November to April (Ranjith,Karunakaran, Avudainayagam & Samuel, 2019).

Rice cultivation in the study region, which relied mainlyon the ecological services of the estuarine ecosystem, has already been experiencing severe

pressure due to climate change, sea level rise and tidal variations (Thomson,2018).

Table 1: Summarises the Nature of Property Rights and How Farmers in the Study Villages Draw Water and Ecosystem Services.

Name of site	Main Canal	Ownership details
Kuzhupilly	Veeram Puzha,	Common Property
Kottuvally	Veeram Puzha,	Common Property
Chellanam	Vijayam Canal	Panchayath
Kumbalangi	Dewaswom Chira and Nattu Thodu	Cherai Sree Varaham Temple Trust

Source: Field Observations

Transformations of wetland agriculture in the region commenced during the mid-seventies with increased demand for prawns in international markets (Ranga, 2006). Commercialisation drivers compelled several farmers to lease out their lands for aquaculture. Several other factors also influenced the transition of paddy fields to full-time fish culture. For instance, Ranjithet al. (2019),Joy (2013) andRoshni (2016) mentioned the potential environmental impacts of the Vallarpadaam Transhipment Container Terminal on wetland conversion and displacement of local farmers. These pressures further escalated the ecological and economic crisis that prevailed in the region. High cost of labour, lack of wastewater management, institutional inadequacies, and disputes between resource users were reported as reasons forthe deceleration of rice cultivation in wetlands. Today, farmers have become more reluctant to grow rice because the impacts of extreme climate events and the subsequent ecological crisis escalated the farming costs, which arebeyond their means and capabilities to manage.

Sources and Nature of Data

The study used both primary and secondary data for assessment. A total of 160 farmers, 40 samples each from four study stations, were selected and interviewed using semi-structured questionnaires. Based on insights from

a survey of literature on adaptation and adaptive capacity-building studies in different parts of the world and our experiences with village communities, 24 variables representing natural, physical, human and socio-economic capital were collected. These variables are summarised in Table 2 below. The study then selected one variable from each category to represent the combined effects of the respective capitals influencing adaptive capacity and adaptation actions.Several researchers have used this approachto represent local adaptation scenarios and conditions and improve the model specifications and estimationsGebreeyesus*et.al.,* (2017). Following this approach, this study selected "*Productivity* (X_3)" to represent the influence of natural capital, "*Access to Road* (X_4)"and "*Access to Sluice-gate* (X_5)" to denote physical capital, "*Farm Experience*(X_1)" to represent human capital and "*Level of Income* (X_2)" to represent socio-economic capital. These variables were purposefully selected based on farmers' responses on their relative importance over other determinants and according to a detailed preference ranking analysis. Dummy variables are limited to a minimum, as including more variables can reduce the accuracy of the results and predictability.

Table 2: Determinants of Adaptation Choices, Model Variables and Scale

SL No	Type of capital	Determinants	Variable selected in the study	Scale
1	Natural capital	Types of Ownership, Area under cultivation, Decision capacity over land management and Productivity	Productivity (X3)	Ordinal
2	Physical capital	Access to the sluice gate, Access to Road, Access to storage facilities, Access to electricity and Access to market	Access to Road (X4) Access to Sluice gate (X5)	Dummy variable
3	Human capital	Age, Education, Farm experience, Knowledge of seeds, Early warning, Medium of receive	Farm Experience (X1)	Cardinal
4	Socio economic capital	Family participation in farming, Participation in farmer associations, Partnerships in farming, Disputes, Non-farming income, lease amount, income level, sources of money and number of other income sources.	Level of Income (X2)	Cardinal

Source: Primary Data

Identifying Factors Coupling Climate Change Adaptation Using Multi Nomial LogitRegression (MNLR) Model

Adaptation involves passive, reactive or anticipatory adjustments for managing vulnerbility, variability and extreme climate change events. (Smit, Burton, Klein &Street, 1999; Smit, Burton, Klein& Wandel,2000).Climate change adaptation is broadly classified as autonomous and planned. Autonomous adaptation implies that individuals and communities design and carry out actions independently without any external assistance and interventions by the state (IPCC, 2007). Planned adaptation, on the other hand, is the result of a deliberate action by the state to maintain or achieve a desired state of transition through a policy decision (Smit &Pilifosova, 2003).

Specification of the Model

The multinomial Logistic Regression (MNLR) model is used to analyse the influence of various factors on the climate change adaptation choices of farmers (Peng& Nichols, 2003).

Table 1 shows the major adaptation paths examined through the MNLR model.

$$AP2/AP1 = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4, \alpha_5 X_5, + \varepsilon 1 \quad \text{--- (1)}$$

$$AP3/AP1 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon_2 \text{ ----- (2)}$$

$$AP4/AP1 = \lambda_0 + \lambda_1 X_1 + \lambda_2 X_2 + \lambda_3 X_3 + \lambda_4 X_4 + \lambda_5 X_5 + \varepsilon_3 \text{---- (3)}$$

$$AP5/AP1 = \gamma_0 + \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X3 + \gamma_4 X_4 + \gamma_5 X_5 + \varepsilon 4 \quad \text{-(4)}$$

X_1= Farm Experience X_2= Level of Income; X_3= Productivity; X_4= Access to Road

X_5= Access to Sluice gate

$\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ and $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \lambda_0, \lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \gamma_0, \gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5$ are regression coefficients to be estimated

To estimate the model, we assume (i) *"Non-Adaptation Strategy to Climate Change- AP1"* as the reference category for analysis, (ii) Adaptive movements to AP-2, a strategy combining paddy cultivation during April to November and later leasing out these lands to aquaculture activities, (iii) Adaptive movements to AP-3, a strategy of using lands to aquaculture during November to April and income from paddy farm activities at limited scales, (iv) Adaptive movements to AP-4, a strategy of using lands to only intensive

aquaculture during November to April or intensive aqua farming round the year and (v) Adaptive movements to AP-5, a strategy of using lands to aquaculture during November to April and undertaking agriculture during April and November. The regressions capture the influences of six major variables in the adaptation decision-making process of coastal farmers.

5. Analysis and Findings

The following tablepresents the percentage distribution of different adaptation strategies in the study area.

Table 3: Major Adaptation Paths of Farmers in the Study Region

Adaptation Options	Farms Near sea	Percent	Farms away from the sea	Percent
AP-1 Non-Adaptation	0	0	4	5
AP-2 Paddy +Lease out the farm for culture	35	43.75	48	60
AP-3 Aquaculture with Non-farm Income	29	36.25	11	13.75
AP-4 Intensive Aquaculture round the year	9	11.25	9	11.25
AP-5 Aqua- Agri farming	7	8.75	8	10
Total	**80**	**100**	**80**	**100**

Source: Classificationbased on Primary surveys

Estimation of the Model

Estimation of the model was made by assuming "no adaptation strategy to climate change" as the reference category for analysis. The results are presented in Table 4.

Adaptation Movement from Reference Category to Strategy 1

In (AP2/AP1) = -8.502 (-0.95) X_1 -15.957 X_{2+} 12.253 X_{3+}18.273 X_{4+}14.956X_5

The results indicate that X_1 and X_2 influence the movements inversely while X_3, X_4 and X_5 influence positively. In other words, traditional farm experiences and level of income do not have any positive influence on

movement from AP 1 to AP2 (Own farming +*Lease out farm for culture)* in the study area, while productivity, access to road and sluice gates did exert influence on adaptation decisions significantly. This is not surprising as this category of farmers leases out farms to outsiders after they harvest paddy from farms. Similarly, road access would increase the relative log odds of adaptation movement from reference category to strategy 2 by 18.25,than a household without access to a road. In the case of access to sluice, the relative log odds of adaptation movement from reference category to strategy 2 would increase by 14.96 if a household has access compared to a household having no access.

In (AP3/AP1)=(-9.077)+(-0.81) X_1 (-0.89) X_2+11.972 X_3 +18.654 X_4 +16.609 X_5

Results indicate that X_1 and X_2 influence the movements inversely while X_3, X_4 and X_5 influence positively. In other words, traditional farm experiences and level of income do not have any positive influence on the adaptation choices of farmers in the study area, whileproductivity and access to road and sluice gates did exert influence on adaptation decisions significantly. Road access willincrease relative log odds of adaptation movement from reference category to strategy 3 (*Aquaculture with non-farm income)* by 18.65 if a household has road access than one with no access to the road. In the case of access to sluice, relative log odds of adaptation movement from reference category to strategy 3((*Aquaculture with non-Farm income)* would increase by 16.61 if a household has access than a household with no access. See Table 4 for details.

The third category of adaptive movement from "no adaptation action" as a reference point to strategy 4 is estimated and presented in the equation below.

In (AP4/AP1)= - 12.059 (- 0.44) X_1+0.016 X_2+12.193 X_3+19.287 X_4 +15.620 X_5

The results indicate that X_1 influences the movements inversely while X_2, X_3, X_4 and X_5 influence choices positively. In other words, traditional farm experiences do not have any positive influence on the adaptation choices of farmers in the study area, whereas the level of income, productivity, and road access positively influence adaptation decisions significantly. The relative log odds adaptation movement from reference category to strategy 4(intensive aquaculture round the year) access to the road will increase by 19.287 if a household has access to the road [Road = 1.00] than a household

without access to a road. [Road = 0.00] Adaptation movements of the fourth category of households from the reference point to strategy 5 are estimated and presented in the equation below.

$$\text{In (AP5/AP1)}=(-13.663)+(-0.48)\ X_{1+}\ 0.268\ X_2+12.674\ X_3+18.143\ X_4\ +15.543\ X_5$$

Table 4: Estimated Values of the Model

Combination of adaptation strategies	Variables	Co-efficient	Significant (SE)
Adaptation Movement from Reference Category to Strategy 2	Intercept	-8.502	0.00*(2.055)
	Farm experience X_1	.095	0.00**(063)
	Level of income X_2	-15.957	.665(.333)
	Productivity X_3	12.253	0.00*(.184)
	Access to Road=0 X_4	18.273	.000*(.798)
	Access to Road=1	0[b]	
	Access to Sluice gate=0 X_5	14.956	.996(3257.246)
	Access to Sluice gate=1	0[b]	
Adaptation Movement from Reference Category to Strategy 3	Intercept	-9.077	0.00*(2.131)
	Farm experience	-0.81	.214(.428)
	Level of income	-0.89	.835(.205)
	Productivity	11.972	0.00*(.065)
	Access to Road=0	18.654	0.00*(.894)
	Access to Road= 1	0[b]	
	Access to Sluice=1	16.0690	.00*(3257.246)
	Access to Sluice=0	0[b]	
Adaptation Movement from Reference Category to Strategy 4	Intercept	-12.059	0.00*(2.370)
	Farm experience	-0.44	0.51(0.67)
	Level of income	.016	0.972(.447)
	Productivity	12.193	0.00*(.215)
	Access to Road=0	19.287	0.000*(1.072)
	Access to Road=1	0[b]	
	Access to Sluice gate=0	15.620	0.996(3257.246)
	Access to Sluice gate =1		
Adaptation Movement from Reference Category to Strategy 5	Intercept	-13.663	0.00*(2.497)
	Farm experience	-0.48	.488(.069)
	Level of income	0.268	.564(.464)
	Productivity	12.674	0.00*(0.00)
	Access to Road=0	18.143	.000*(0.00)
	Access to Road=1	0[b]	
	Access to Sluice gate=0	15.543	.996(3257.246)
	Access to Sluice gate=1	0[b]	

Source: Tabulation from primary surveys

Notes: b. This parameter is set to zero. Degree of freedom =1

X_1= Farm experience X_2= Level of income; X_3= Productivity; X_4= Access to RoadX_5= Access to the sluice gate

Results indicate that X1 influences movements inversely while X_2, X_3, X_4 and X_5 influence choices positively. In other words, traditional farm experiences do not have any positive influence on the adaptation choices of farmers in this category, whereas the level of income, productivity, and access to road and sluice gates positively influence adaptation decisions significantly. Access to the road increases relative log odds of adaptation movements from reference category to strategy 5 (*Aqua- Agri farming*) by 18.14 in the case of households with access to the road than households without road access.

Coupling Current Adaptation Strategies of Coastal Farmers: Implications for Management

Households affected by climate change are trying their best to overcome the stresses by adapting to the challenges through individual and collective choices. The study noted four broad channels opened to local farmers.

i. Modifying farmland uses and introducing new water management strategies

The first option is to devise a set of management reforms on the uses of water and farmland. **Table 5** summarises the major actions of farmers towards managing excess water and wetland uses. Intensive transitions towards aquaculture in the northern study sites are clear from the table. Almost everyone here has shifted to aquaculture. The proportion is between sixty to seventy per cent in the southern sites. The tendency to reduce the area under paddy cultivation and even keep lands fallow by abandoning cultivation are equally strong throughout study sites. Few farmers lease out lands to aquaculture, while another section (five per cent) identified ideal locations outside their village and shifted to aquaculture. Finally, those who could not manage anymore sold their lands forever.

Table 5 Percentage Distribution of Households Undertaking Water Management and Changing Farmland Uses to Adapt to Climate Change

Adaptation strategies	Chellanam	Kumbalangi	Kuzhuppuily	Kottuvally
The reduced area under paddy cultivation	52.5	52.5	82.5	100
Stop paddy cultivation and keep land fallow	52.5	10	0	10
Leasing out the land for aquaculture	2.5	2.5	0	14.5
Moving to other locations to undertake aquaculture	0	5	5	5
Deepening wetlands for aquaculture	60	67.5	100	90
Sale of land	0	5	5	5

Source: Tabulated from Primary surveys

ii. Farm operations management

Several measures are employed by local farmers to improve the operations of farms facing climate change threats. Some of these actions are listed in Table 6.

Table 6: Selective Measures of Farm Operations Management Strategies to Manage Climate Change Impacts

Adaptation strategies	Chellanam	Kumbalangi	Kuzhuppuily	Kottuvally
Using new rice varieties	37.5%	62.5%	69%	67.5%
Changing sowing time	82.5%	85%	82.5%	80%
Marginal changes in crop				
rotation	25%	52.5%	47.5%	62.5%
Replanting damaged				
seeds/ sprouts	27.5%	52.5%	47.5%	62.5%

Source: Primary Survey

First, 80 to 85 per cent of households havealready changed their sowing time to adjust to changing variations in precipitation. Similarly, 40 to seventy per cent of farmers have replaced traditional rice varieties

(chettivirippu and pokkali) with modern salt-resilient varieties (Vytila 6 and Vytila 8) developed by the Rice Research Station. There is a severe shortage of quality seeds resilient to climate change. Farmers alleged that seeds supplied by Krishi Bhavan are of poor quality and cannot resist climate variation. Farmers purchase additional seeds from outside the district to supplement and replant their fields damaged due to extreme climate variability due to continuous downpours of heavy rain lasting three to five days. Climate change inspired farmers to implement marginal informal changes in traditional crop rotations in several study sites. Crop rotations range from 5to 63 per cent in the eastern region and 25 to 53 per cent in the western zone.

iii. Risk sharing

Although climate risks have been rising in the coastal belt of Kerala, local communities and the state are not groomed enough to manage them to date. The state government has formed a district-level disaster management authority to manage emergencies due to climate extremes. However, the lack of risk governance strategy at the farm level still seriously affects farmers' adaptation choices. Our fieldwork identified a few strategies at the local level. Risk sharing and crop insurance are the most popular measures adopted in the region. Farmers share risks with their respective producer associations at the farm level, followed by relatives and friends. 7.5 per cent of houses internalise risks with family support and 13 per cent with the help of friends and relatives in the western study sites. This pattern of risk sharing is successful among farmers undertaking both farming and aquaculture. Although the state government has approved a crop insurance scheme forpaddy, banana, pepper, turmeric, coconut, pineapple, ginger, sugarcane, cardamom and areca nut, none of the coastal farmers in the study area received such assistance during the study period.

iv. Diversification toward non-farm activities

Income from paddy cultivation alone is insufficient to run the family; therefore, all farmers undertake alternative jobs. Forty-nineper cent combinedagriculture and aquaculture, while the remaining households chose non-farming adaptation choices. Farmers doing business and aquaculture can see more in Kottuvally(27.5%) and Kuzhuppuily. In Kumbalangi, 17.5% are working as an employee. In the Chellanam region, farmers working for their non-farming livelihood strategies, causal workers are more than 29%.

6. Summary and conclusion

The study examined adaptation strategies of coastal communities in central Kerala during the past 30 years and observed that climate change has exerted mixed responses on the choices of adaptation strategies of coastal farmers in the study area. Paddy cultivation has reduced significantly due to climate change, and local farmers seek alternate modes of income generation by combining diverse forms of farm and non-farm activities. Local paddy cultivation is becoming non-viable due to the high costs of infrastructure development, expenditure on climate mitigation and erosion of collective action and local farmers' search for optimal and viable adaptation strategies. Some farmers have decided to leave agriculture by selling lands, and a few others are struggling hard to sustain farming by combining adaptation strategies. The study revealed that there exists no single stable adaptation behaviour in the study area. The diverse choices are exceptionallydecided by climate variability, institutional support for mitigation, and planned and autonomous adaptation capacities. Traditional water management institutions are not capable enough to manage such macro-level externalities. Modern state-level institutions are also not in place to manage climate variability and support the adaptation of local communities. Under these circumstances, communities use different strategies based primarily on their indigenous agrarian knowledge systems and technologies, which unfortunately do not yield the desired outcomes like sustainable agriculture and livelihoods. Traditional production methods, even today, are fully labour-intensive and costly. Newly introduced agricultural technologies do not push agriculture production and productivity.

The study noted that adaptation strategies will not be sustainedwithout formal state support. A major proportion of respondents undertaking paddy cultivation today are old farmers, and the involvement of the younger generation is very low. Although traditional farm management practices tend to reduce the escalating cost of production, farmers find it extremely difficult to manage returns with uncertain and irreversible cost escalations under climate variance. Further, limits of macro-level governmental policies to influence climate shocks and energise local agriculture have slowed down autonomous adaptations. Autonomous adaptation alone cannot guarantee climate-smart agriculture in the coastal areas of Kerala. Therefore, we recommended that location-specific mitigation measures are necessary to

fasten autonomous adaptation to sustain agriculture. A combination of climate-smart technologies and modern climate risk management institutions is necessary to manage extreme climate events and develop climate-smart wetland agriculture in coastal Kerala.

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Comments/Research Note

CUET and UG Admissions: A Case Study

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Abstract

The Common University Entrance Test (CUET) was introduced in 2022 to provide equal opportunities to all students across India irrespective of their Class XIIBoard examination marks, regions and gender. In this paper, a fast finding out attempt is made to assess the impact of CUET on undergraduate admissions in the University of Delhi. A case study of a leading college reveals that this Test has not put an end to the culture of high cutoffs. And it has led to decline in the admissions of girls even as it has favoured the high intake of CBSE students.

I. Background

Prior to 2022, admission to undergraduate (UG) and postgraduate courses in universities across India was done in a variety of ways. Admission in 12 central universities was done through CUCET (Central University Common Entrance Test) conducted by Central University of Rajasthan. Some prestigious universities like Banaras Hindu University, Jamia Millia Islamia, Jawaharlal Nehru University and Aligarh Muslim University had conducted their own entrance examinations. A few universities like the University of Delhi conducted admissions directly on the basis of Class XII Board examinations.

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In 2021, NTA (National Testing Agency) was given responsibility of conducting CUET (Common University Entrance Test). This was a revamped version of the earlier CUECT. In its debut edition of 2022 UG entrance examination, around 90 universities participated out of which around 40 were central universities. In 2002, nine central universities, out of which 8 in North-East region of the country and one in Uttarakhand, were exempted from CUET due to operational difficulties. In its second edition scheduled for May 2023, the number of universities has increased to 123, where 43 are central universities, 20 state universities, 12 deemed universities and 48 are private universities (cuet.samarth.ac.in). This CUET is mandatory for UG admissions to all central universities for academic session 2023-2024. According to UGC and Ministry of Education, it will provide a common platform, wide outreach and equal opportunities to candidates across the country, especially those from rural and other remote areas.Moreover, it is expected to break the pressure of very high cutoffs resulting from reliance on Class 12 Board examinations.

The admission in central universities for all undergraduate programmes is to be done solely on the basis of CUET score from 2022-2023 session. For postgraduate programmes, the central universities are expected to ultimately use the CUET score. Other higher education institutions including private,-state or deemed-to-be universities can use CUET scores for UG and postgraduate admissions.

CUET is a computer-based test and is conducted in 13 languages - English, Hindi, Gujarati, Assamese, Bengali, Kannada, Malayalam, Marathi, Odia, Punjabi, Tamil, Telugu and Urdu. It will not affect the reservations policies of the central universities, though (Hindustan Times,2022). It is not mandated for state universities. Many of themare expected to adopt it. But many like Jadavpur University, Calcutta University, Osmania University, Kerala University, University of Madras, and Andhra University are reluctant to do sofor various reasons. A concern is regarding the quality of students coming through the MCQ-based CUET. Another serious concern is the time taken in the process and inability to ensure timely admissions. For instance, in 2022, there were numerous delays in conducting CUET and declaring results. In University of Delhi, the admission process, which usually happens in June/July, was delayed to November/December due to teething problems of implementation. The second edition in 2023 is expected to overcome this drawback.

CUET is mainly based on the CBSE syllabus which is much more advanced compared to those in thestates.There are widespread apprehensions that "where these state board students study, particularly the rural/regional medium, they are not in a position to compete with urban and convent school students" (*Indian Express*, 2022); that admissions are insensitive to local contexts; and that diversity in terms of educational curriculum in various regions is ignored. Equity in the last stage of the game i.e., "one nation-one entrance exam" cannot be ensured when there is no equity in the initial stages of the game. Government has to provide common syllabus, common access, common quality in various regions and then only go for CUET after some time.

Some central universities like Aligarh Muslim University and Jamia Millia Islamia too are reluctant to fully participate CUET as it undermines the individual admission process and requirements of these universities. They have stated that CUET UG will be adopted only for a limited number of courses, and that they will conduct their own entrance tests for all the remaining courses to ensure timely admissions (Indian Express,2023). The UGC chairman has said that it is mandatory for all central universities to adopt CUET UG, even if they offer seats on minority quotas, though.

In this context, we look at the data from Shri Ram College of Commerce (SRCC) in admission to B.A. (Hons) Economics to analyze introduction of CUET and its impact of some key areas like gender, diversity and equity.

II. Case Study Introduction and Methodology

The University of Delhi marked its centenary in May 2022. It has come a long way from 750 students in 1922 to over six lakh students in 2022. It is a premier central university and draws students across India. It adopted CUET and a centralized common seat allocation system (CSAS) for admissions in UG and postgraduate programmes for the first time during 2022-2023. Earlier, for admissions to UG programmes, best of four (BFS) from Class 12 Board marks (including one language) was calculated and individual cutoff for various colleges was declared. The Board exam score was reduced to a qualifying exam in 2022. CUET was supposed to end the culture of high cutoffs and act as an equalizer for students from all Boards. The anomaly that arises with students of a particular board filling up a number of seats due to inflation of marks was to end too.Even for admission to supernumerary seats, CUET is mandatory.

This study looks at data from SRCC,a top Delhi University (DU) college, for one of the top sought after courses i.e., B.A.(Hons.) Economics. It looks at some aspects of admission data from 2019 to 2021 (with use of Board exam marks) and detailed admissions data for 2022.

Whereas there are many newspaper articles published around this topic, no study has analyzed actual data from a DU college, as we have done here. Simple percentage, percentage change, correlation and regression have been used for the analysis and discussion of results. Gender, student diversity and social category impacts of CUET are thereby revealed.

III. Gender

DU has come a long way in terms of gender gap. It has an excellent gender ratio. With just 82 girls in 1930, it now has 3,24,067 girls – more than 50% of the total student population. It gives 1% relaxation to female students in many of its constituent colleges to boost female participation. The gender ratio gets even better in the top DU colleges with SRCC having a gender ratio in favour of women (more than 50% till CUET was introduced).

In a sample set of roughly 200 to 230 students over four years (2019 to 2022) as seen in Table 1, the percentage of girls in total has gone down from roughly just below 60% (in 2019, 2020 and 2021) to 45% in 2022. The three years 2019, 2020 and 2021 had admissions to this course based on best of four subjects ((BFS) percentage of Board exams. In 2022, this percentage drops to 45%. This result raises many worries and questions. This fall in percentage of girls in 2022 in the data set was not due to less registration of female candidates. In fact, more female candidates have registered for undergraduate programmes as compared to males (*The New Indian Express*, 2022).

The percentage of girls had surpassed that of boys in recent few years in SRCC and many other Delhi university colleges. This is not indicative of a reversal of gender education gap, though the gap between girls and boys in higher educational institutes seems to be narrowing as 49% of students in colleges are now girls (AISHE,2019-20). The approximate 60% enrollment of girls in this college in previous years is about 10% higher than all India percentage.

Table 1: Female vs Male Students (%) Admitted by Year

	2019	2020	2021	2022
Female (%)	59	57	58	45
Male(%)	41	43	42	55

This may be indicative of a better performance of girls than boys in Class 12 Board exams which was the criterion for admission in DU till 2022. In 2019, girls on average scored 1.3% higher marks than boys in BFS percentage. In 2021, itwas approximately 0.5% higher on average (Table 2). In 2022, though the girls scored roughly 1% higher than boys on average in BFS of Board exams, their CUET scores were lower.

Table 2:Trends in BFS Percentage

BFS (Average)	2019	2021	2022
Female	96.26333	97.98707	95.99757
Male	94.96175	97.4519	95.01

It is a known fact in India that girls perform better than boys in the Class 12 Board exams. Every year when Board exam results are declared, this fact is highlighted in many newspaper articles (Mint, 2022). Just like in the Board exams, girls scored better than boys in CUET-UG despite lesser number of them registering and appearing. Most of the newspaper articles have highlighted the top performers where 60.5% of top scorers were girls. There is lack of information in these articles on average performance of girls versus boys in CUET. In our limited data set of around 230 students in B.A. (Hons.) Economics in SRCC, boys have performed slightly better than girls onaverage in CUET.

As Table 3 shows, CUET score of girlson average is roughly 1.5 times lower than boys. This difference may seem insignificant but it indicates that boys might have performed better than girls in CUET at least in this data set. It reverses the performance gender gap in favour of girls which was existing in the past few years. This could be a cause of worry in future. It maybe premature to draw any definitive conclusions, however, as the data we have is only for the year 2022-23.

Table 3: Average CUET Score vs BFS Percentage

2022	CUET(average)	BFS(average)
Female	683.6074	95.99757
Male	685.1039	95.01

IV. Student Diversity byHigher Secondary Board

We look at the profile of students entering DU in terms of the various higher secondary Boards(Table 4).This university admits students from all the higher secondary Boards spanning various states and union territories. The CBSE Board has historically been the dominant Board in admissions in this university. Our data set shows that CBSE is the dominant Board with the rise in percentage from roughly 65% to just over 75% from 2019 to 2021, the years for which admission was Board exam cutoff based. The difference between CBSE and other Boards has widened even more in 2022. The percentage of students from CBSE is 91.6% in 2022 for B.A. (Hons.) Economics in SRCC, thereby indicating a capture of seats by CBSE. The little representation observed of stateBoards is primarily in the reserved categories. For the unreserved category there is almost a complete capture of seats by CBSE. Over 50% of the total students admitted in 2022 belong to NCR (National Capital Region of India)of which 38%are from Delhi. Before the introduction of CUET, Kerela Board (8.3% in 2021) and Telangana Board (7.7% in 2020) were becoming significant players. In fact, in the last year before CUET, there was a lot of hue and cry about the students from state Board of Kerala making it to DU. This did not sit well with the administration and a nine-member panel was constituted by the DUVice chancellor to look into it. The committee showed that the highest intake was from the CBSE Board (37,767) followed by theKerala Board (1890) (see Outlook, 2021).This small number of students from Kerala Board as compared to CBSE Board refutes the claim that Kerala Board students are in huge numbers. Kerala Board only led the chart of outstation DU admissions but the numbers from this Board were still insignificant as compared to CBSE Board.(*The Hindu*, 2022). After CUET, Kerala Board students go from second highest to seventh at DU in overall admissions. In our data set of SRCC, with CUET introduction,these two Boards have totally vanished with no Boardstudent admitted from Kerala or Telangana. With CUET, the expectation was to have objectivity in admissions. The bias in

CUET in favor of CBSE could be due to CUET being officially based on the NCERT curriculum which puts other state Boards at a disadvantage. The dominance of students from NCR could be dueto the mushrooming of coaching industry in NCR. This would potentially increase the financial burden on less privileged sections of students and help the already privileged students. The last two statements are, of course, conjectures which need further study and research.

Table 4: Student Diversity by Higher Secondary Board

Boards	2019	2020	2021	2022
CBSE	124 (65.26%)	153 (73.5%)	157 (76.5%)	209 (91.6%)
ICSE	26 (13.68%)	16 (7.7%)	20 (9.75%)	12 (5.26%)
ISC	17 (8.9%)			
Kerala Board	8 (4.2%)	10 (4.8%)	17 (8.3%)	
AP Board	5 (2.6%)	1*		
Maharashtra board			1*	2*
West Bengal board		1*		1*
MP Board Telangana Board	10 (5.26%)	16 (7.7%)	4 (2%)	1*
IB Board				1*
Rajasthan Board		1*		
Haryana Board		6 (3%)		
Karnataka		1*		
HP Board		1*		
J & K		2*	1*	2*
Directorate of Results & Certificate			1*	
Republic of South Sudan National Examinations Coucil			2*	
TOLO E AFTAB			1*	
Other			1*	

*Percentage less than 1%

V. Social Category

DU's reservation criterion is based on the provisions laid by the Constitution of India. It follows the central government policies for admission to include SC, ST, OBC- NCL, EWS and PwD categories of students. In admissions during 2022, 20 to 30 % extra students were admitted in most of these categories in B.A. (Hons.) Economics at SRCC. These extra students across categories were not due to CUET perse but due to the admission process. It was a DU decision to admit 30% more students in the SC and ST categories and 20% extra in OBC category. For instance, in SC category, 29 students were admitted as compared to 23 students in previous years and 11 in PwD category as compared to 8 in previous years. The extra seats allocated in unreserved category was much less as compared to reserved categories. The credit for this goes to university administration and their social diversity affirmation drive and not to CUET. Another cause of worry in reserved categories is that the registration of female students is less than that of male students. An interesting thing for further study would be the percentage of students in reserved categories which joined coaching centres if this data was available. This would create divide within the reserved categories as those who are financially better off relative to others will have an advantage.

VI. CUET Scorevs Class 12Board Marks: Analysis

The claim that CUET will put an end to the culture of high cutoffs in DU was not entirely fulfilled. The BFS percentage was not substantially different in 2022as compared to previous 2-3 years. For females, the average BFS in 2019 was 96.26% which marginally dropped to 96% in 2022. For males, the BFS average was approximately the same at around 95% in 2019 and 2022.

For the same group of 228 students of the B.A.(Hons.) Economics students of SRCC, who took admission in2022, a strong positive correlation (0.77) between CUET score and Class 12 BFS marks was found. This impliesthat students who had performed well in Class 12, alsoperformed better in CUET. Also, boys had performed better than girls in CUET.

To formally test these hypotheses, we have used the following simple model:

$CUET_i = \hat{a}_1 + \hat{a}_2 BFS_i + \acute{a}Gender$

Where Gender is a dummy variable taking value 1 if female and 0 for male. BFS represents Best of four subjects' marks in Class 12 Boards.

Regression analysis (Table 5) shows highly significant positive BFS coefficient(at 1%) and highly significant negative gender coefficient (at 5%). An increase of 1% in BFS leads to increase of 17.35 in CUET score. Gender dummy coefficient of -18.63 represents differential impact of being a female student. Expected CUET score of female students was 18.63 lower than that of males.

Previous research has shown that girls are typically less engaged with multiple choice questions(Livingston and Rupp, 2004). Girls tend to prefer questions which require more analysis and varied solutions whereas boys are more likely to just state their answers (Griseida, 2021; HBR, 2013). Therefore, it is apt to say thatCUET has negatively impacted the admission prospects of female students.

Table 5: Regression Results

Regression Statistics

Multiple R	0.770239
R Square	0.593268
Adjusted R Square	0.589653
Standard Error	59.04121
Observations	228

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	1144027	572013.7	164.0952	1.11E-44
Residual	225	784319.5	3485.864		
Total	227	1928347			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-963.7403	91.17387	-10.57036	1.83E-21	-1143.404	-784.0764	-1143.404	-784.0764
BFS	17.35443	0.958013	18.11503	7.72E-46	15.4666	19.24225	15.4666	19.24225
Gender	-18.63533	7.91362	-2.354843	0.019391	-34.22962	-3.04104	-34.22962	-3.04104

VII. Conclusion

This short pioneering paper has shown quickly, in the new Indian context,that there seems to be a direct causality between Class 12 Board marks and CUET score. There is fall in percentage of girls admitted to B.A (Hons,) Economics in SRCC in 2022 when CUET was introduced for the first time as compared to previous few years when admission was based on Board exam-based cutoffs. If this trend continues in future, it would be a major concern.

CBSE is the major gainer of CUET introduced in 2022. Itsearlier domination inthe intake of students in DUfurther increased in 2022 too. We wonder if this is a desirable situation as, after all, Kerala is a state with best educational indicators and DU is a central university.

In terms of reserved categories, not much can be done by the constituent colleges and the DU administration, as the reservation percentages are fixed by the Central Government. All one can do is have special drives or increase the number of seats in these categories, as was done in 2022.

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The Economics of Biodiversity: The Dasgupta Review

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The Chancellor of Exchequer, Government of the UK. Commissioned a study in spring 2019 under the leadership of Sir Partha Dasgupta and was supported by an advisory panel drawn from the fields of public policy, science, economics, finance, and business. The report was submitted in February 2021in three versions: (i) the main report with 610 pages. (ii) the

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abridged version with fewer technicalities in 103 pages, and (iii) for the general audience, the report's headline messages in 10 pages.

Before the industrial revolution in the UK and around the world, the burden of humanity on the planet earth was substantially low. It was well within the carrying capacity of the planet earth. However, with the rapid industrialisation of the economies around the world, the extraction of resources and release of pollutants into the atmosphere has increased exponentially. In the conventional economic literature, it was assumed that Nature has unlimited capacity to supply natural resources and process pollutants. However, since the late twentieth century, there has been a general realisation that Nature has limited capacity. Moreover, the economic literature confines the analysis to the well-being of the human species and ignores the well-being of other species. However, it is now realised that human well-being depends on the well-being of other species. The carrying capacity of planet earth depends on the diversity of the species. In this context, the Economics of Biodiversity: The Dasgupta Review is a timely publication highlighting the importance of rich biodiversity for human well-being.

The report is divided into three parts and 21 chapters. Chapter 0 provides a historical account of the planet earth in terms of geology, economic growth, and biological diversity. Over the past 12 thousand years, the economic prosperity of the human civilisation on the planet earth has flourished at the cost of biological diversity. The chapter, however, misses the role of wars and international politics and the dark side of capitalism in the form of colonization in destroying biodiversity.

Chapter one introduces the fundamental concepts of economics in the understanding of conservation. Nature is considered an asset while keeping in mind the transactional Nature of the assets. Dasgupta has argued that biodiversity supports economic growth; thus, conserving biodiversity is a wise economic decision. Another central argument of this chapter is that humanity and biodiversity are embedded in biodiversity. Our roles as a species will determine the future of biodiversity, and similarly, biodiversity will affect our future economic development.

Chaptertwo provides an outstanding analysis of the problems one faces while viewing biodiversity from the economic lens and current world trends.

Dasgupta emphasises that there are many externalities when one considers Nature as an asset since Nature is free and open source. The chapter highlights the institutional failure to protect biodiversity. The failure arises due to the gaps in the standard models of development that do not consider the biosphere explicitly. Dasgupta recommends insurance for biodiversity and other resources.

Chapter three introduces the concept of "tipping points," derived from conservation ecology. The closer is an ecosystem judged to be near a tipping point, the more urgent the case for conservation measures. The report explains that restoration of biodiversity is costlier than maintenance, other things remaining equal. Similarly, pre-emptive moves to conserve ecosystems are less costly than waiting and investing in restoration only when they have deteriorated badly.

Chapter four provides a beautiful cost-benefit analysis of how economic prosperity has come up with a price in terms of biodiversity loss and the failure of the market and the institutions in sustainable use of resources and Nature. It also highlights the pressure on the planet with the increase in the human population. The incumbent national accounting method fails to calculate biodiversity loss as it only considers economic success measures in terms of GDP.

Chapter five discusses the risks associated with biodiversity loss and climate change. Individuals can play a vital role in preventing biodiversity loss. The idea is to have a layered global risk pool system. The insured country would bear the first layer of loss itself, giving it an incentive to work on nature conservation and restoration projects. The other proposed solution is the use of insurance where the premium for the country could be partly related to a country's ecological footprint to provide an incentive to reduce its demands on the biosphere.

Chapter six is centeredon the idea of trust and social capital and its role in biodiversity conservation. To build trust, two conditions should be satisfied: (a) at every stage of the agreed course of actions, it would be in the interest of each party to plan to keep his or her word if all others were to plan to keep their word; (b) at every stage of the agreed course of actions, each party would believe that all others would keep their word. (a) and (b) represent the Nash equilibrium. It is challenging to create institutions where

conditions (a) and (b) are fulfilled. Hence, laws and norms as social institutions may not be adequate to create conditions for fulfilling these two conditions for biodiversity conservation.Dasgupta uses successful examples of developing societies in biodiversity conservation but does not talk about the differences in global North and South values. There is also neglect of differences existing in civil society over biodiversity conservation.

Chapter seven shows how international trade is leading to unidirectional externalities, and developing countries are subsidising the rich countries in terms of biodiversity loss- *as developing countries depend significantly on the export of primary products, there is a hidden transfer of wealth from them to importing countries, many of which are rich (p. 191)*. The cost of biodiversity loss in developing countries is not reflected in export prices. Pigouvian taxes and subsidies, Coase theorem, and Payments for Ecosystem Services have been discussed with their limitations to solve the problem of unidirectional externalities. The Review also suggests how regulatory policies and quantity restrictions can help solve the problem of 'tragedy of commons. Nevertheless, the report does not talk about the global political economy and the role of transnational corporations in giving rise to unidirectional externalities.

The chapter describes the importance of common pool resources (CPRs), especially for low-income groups. CPRs are a source of additional income for communities close to these resources. Therefore, CPRs immune communities from the risk associated with failure of crops.
Government and non-government organisations (NGOs) need to help build or rebuild local institutions through which communities could realise the advantages of informed collective management under changing times (*p. 212)*. The report raises concern that *the global subsidies for harvesting the biosphere are more significant than we spend on its conservation.*

Chapter nine explains how our preferences are socially-embedded (especially in the context of reproductive behaviour) and how they could be modified to conserve biodiversity. The report argues that reproductive preferences are socially-embedded (and not just influenced by private desires) and how media could modify these preferences. The reduction in world population is linked to sustainable development. This shifts the responsibility and blame for biodiversity loss away from capital

accumulation to developing countries. The issue of global inequity has not been dealt with adequately.

Chapter ten mentions that *well-being across the generations is the (possibly discounted) sum of the well-being of all who are here today and all who will ever be born (p. 254)*.Chapter eleven discusses the quantitative and qualitative measures of well-being. Three psychological theories explain why contact with Nature and connectedness with Nature are crucial for human well-being. There is enough evidence that repeated contact with Nature contributes not only to long-term hedonic well-being but to life satisfaction as well.

Chapter twelve explains alternative methods such as contingent valuation and revealed preference methods for valuing biodiversity. However, with these methods, one cannot measure the sustainability of Nature.Hence, Chapter thirteen introduces the concept of "Inclusive wealth" to measure human well-being over time, including produced capital, human capital, and natural capital. It is the accounting value of an economy's stock of manufactured capital (produced capital), human capital, and natural capital. A country's inclusive wealth is the social value of all its capital assets, including produced capital, human capital, and natural capital.

Chapter fourteen discusses the interactions and feedback loops through which thebiosphere can exacerbate societal inequalities. Evidence shows that ecosystem services can significantly contribute to poverty alleviation, but including ecological indicators is not standard practice in povertyassessments. This suggests that ecosystem management and poverty alleviation policies should go together.

Chapter fifteen describes how trade influences production and consumption patterns around the world and therefore impacts the biosphere. Dasgupta recommends the following for helping international trade to reduce the impact on the biosphere: (i) Border Adjustment Taxes and Non-Discriminatory Regulations, (ii) Trade Agreements and Liberalizing Trade, (iii) Supply Chain Policy Development, and (iv) Aiding More Sustainable Trade.

Chapter sixteen presents the current status and prospects ofnatural capital providing provisioning services. It shows shocking pictures ofthe

deterioration of natural capital. It recommends the followingfor the reversal: Use of new technologies such as using genetically modified crops, application of precision agriculture, vertical farming method, and use of plant-based meat in place of animal-based meat.

Chapter seventeen explains that biodiversity loss has macroeconomic and financial implications for businesses and financial institutions. Nature-related financial risks are financial risks that arise from changes in either the stock or condition (or combination of both) of natural capital and from societal responses to changes in the state or quality of natural capital. Nature-related risks include climate change and other environmental and financial risks. For example, reduced commodity yields, disrupted supply chains, output losses due to natural disasters such as droughts, and the loss of potential new sources of products and services, such as medicines and other pharmaceutical products, leads to a loss in business and financial institutions. In order to reduce the nature-related financial risks, Dasgupta suggests increasing the investment on Nature related projects.

Chapter 18 justifies biodiversity conservation and recommends place-based and species-led conservation. It is suggested that collaborating government and non-government agencies with the local communities can ensure better biodiversity conservation. Chapter 19 suggests the following methods for restoring Nature: rewilding, nature-based solutions, participatory approach, and technological solutions. In Chapter 20, Dasgupta recommends using both public and private finance to restore and conserve biodiversity.In the last chapter, Dasgupta outlines how to make our planet earth a better place. There is a need for transformative change in our modeof thinking and acting. Usheringtransformative change requires action by governments, businesses,intergovernmental organisations, and communities. We need more than institutions of lawsand social norms to curb our excesses. We need to learn to practice self-restraint.

Professor Dasgupta and his team have done a tremendous job by considering every aspect of biodiversity in detail. The report gives more importance to the provisioning services of natural capital, but three other vital services (regulatory, supporting, and cultural) are left behind. It would be more useful if all the services were taken into account in detail separately and showed their interconnectedness. It has been stated that trade liberalisation and specialisation can also lead to the spread and adoption of technology

that enables a more efficient production process, reducing the demand on the biosphere. Although these arguments are substantiated with examples they are not explained in great detail. This may create some confusion in the reader's mind. The report provides uniform suggestions fordeveloping and developed countries, which is problematic. The Review gives primacy to market fundamentalism in conserving biodiversity. Nevertheless, this is a great report and needs wider publicity to raise awareness of the urgency for biodiversity conservation.

Book Review

Becoming a Farmer: Women in Rural West Bengal, India

by Raktima Mukhopadhyay, Itishree Pattnaik and Kuntala Lahiri-Dutt, Orient BlackSwan, Hyderabad, 2023), pp. 230.

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In the last few decades more and more women have replaced men in agricultural work. This is a global phenomenon and India is also witnessing it. In the book reviewed here, it has been studied with respect to Bankura and Dakshin Dinajpur districts of West Bengal.The authors write about the socio-economic conditions of these districts as the background. Around 90 per cent of the surveyed families have less than an acre of agricultural land and generally it is about one-fourth of an acre. These marginal lands have low soil fertility and lack assured sources of irrigation. Many of these small landholdings remain fallow when the monsoon fails. In Dakshin Dinajpur around 72.5 per cent women and in Bankura 74.5 per cent women are engaged in agriculture against the state average of 55 per cent.

The diverse agro-climatic and economic development of the two districts was the major factor for the authors to choose them to study changes in women's role in their agriculture.Wide fluctuations in the yields of crops is a feature of Bankura's agricultural economy which leads to seasonal migration. There are differences in the destinations of migrants. Approximately 50 per cent men migrate to other districts of the state as agricultural labourers, while 20 per cent migrate within the district as non-farm casual wage labourers. In Dakshin Dinajpur virtually all households have at least one member migrating each year for varying periods of time. About 70 per cent men migrate to cities and towns in other states and 30 per centtravel to other districts of the state. The average daily income of

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the migrant workers in both the districts ranges from Rs. 200-250 per day. Two-thirds of the women below 30 years have their husbands migrating between five and more than ten years in Bankura, whereas it is as high as 80 per cent for Dakshin Dinajpur. The authors have not accounted for this difference satisfactorily.

The primary data were collected by the authors through a survey of 95 female-headed households, followed by in-depth interviews and focus group discussions. They say, "These focus group discussions and in-depth interviews enabled the researchers to gain insight into and explore the perceptions, needs,and challenges of women farmers" (p. 84). Government publications like census reports, departmental reports, gazetteers, NSS rounds, etc., have also been consulted. Thus, the authors have tapped varying sources.

Traditionally the Indian society has been patriarchal. Men have dominated the families both at home and outside, while the women have remained indoor and engaged in household chores. But in the last few years, menhave been migrating and the left-behind women, apart from attending the household duties, are required to engage in worknormally done by their family members including agricultural work.Even the Government of India declared the Rashtriya Mahila Kisan Diwas in 2017 and formally recognized the contribution of women farmers to Indian agriculture.In the two districts under study, the high proportion of Dalits and tribals in the total population explains why the share of female agricultural workers and cultivators is higher than the state average. The authors add, "… in Bankura, virtually all the women surveyed had taken up some new activities since male outmigration began, with around half of them taking up more than five new farming activities. In Dakshin Dinajpur, around one-third of the respondents had taken up more than five new activities" (p. 100).

The book discusses these and related issues. However, additional work load of women does not necessarily mean their greater control over productive assets. Important decisions like purchase of land, cattle, household items and so onare largely delayed until the return of the male migrants. But the caste of the families is also a determining factor. For the lower caste women, workload, management responsibilities and autonomy of action are greater as against high caste women owing to social factors.The authors remark, "The study establishes that women's participation in agriculture is higher

when family and agriculture are less advantageous for livelihood, and women's ownership of land does not necessarily influence their overall level of participation in agriculture" (p. 28). They believe that the result is not so much of 'faminisation of agriculture' as'faminisation of poverty.' Sometimes this phenomenon is called de-agrarianisation.On the whole, they refer to "… an untenable financial situation in many rural areas, where female-headed households cannot achieve subsistence-level agriculture, where women generally are overworked and underpaid, and the remittances sent by outmigrated men are insufficient to compensate" (pp. 16-17).

However, the average monthly income reflects that notwithstanding migration, families live in straightened circumstances. The irregularity in receiving remittances,sometimes because of alcoholism,has compelled women to look for additional sources oflivelihood. While women have been engaged in different agricultural operations, ploughing is traditionally a social taboo for them and it is the only agricultural activity from which they are barred. The authors mention, "Upper-caste Hindu and Muslim women normally never work in the fields even if their households possess land, but are engaged in the post-harvest management of crops at the household level. However, among the SCs and STs, both male and female members work in the fields" (p. 40). They add, "Compared to Bankura, women in Dakshin Dinajpur have to rely more on remittances, even though a majority has livestock sources and petty business as income options. But the productivity of livestock is generally poor, resulting in poor return to income" (p. 99).On the whole, women outnumber men in doing non-farm work and they use the money (as well as incur debts), inter alia. to pay for large items and school fees.

There has been all along an under-enumeration of women agricultural workers due to the exclusion in employment surveys of women engaged in subsistence agriculture as a part oftheir household activities. Thus, they suffer from economic invisibility in a society with strong patriarchal norms. All in all, the increased labour force participation of women has boosted the growth rate and made development inclusive. Migration has also improved the quality of life of the households.Nevertheless, when women are at the helm, there is a greater frequency in the incidence of crop damage. There are delays in arranging inputs, inadequate knowledge of crop management, extension of fallow land, increase in multiple crop rotations

and so on.Agricultural machinery (like a tractor) is generally suitable for use by men rather than women. Agricultural and cooperative institutions aremore prone to cater to the needs of men rather thanwomen. The latter tend to be excluded from extension and input services. The authors believe, "Age-old practices and traditional knowledge used in agriculture were 'common property resources', passed down through generations by both men and women. By contrast, new technologies, such as farm machinery, fertilisers and pesticides, and irrigation pumps, have become 'private property', usually held and controlled by men who have access to information, training, and the outer world"(p. 105). They also quote the National Policy for Farmers, 2007 to the effect that "… women especially need women friendly implements/tools which can reduce drudgery, save time, enhance output and can be handled comfortably" (p. 111).Male migration may also leave an adverse impact on the health and education in the household. The authors point out, "At the same time, there is a dramatic decline in the proportion of women cultivators as marginal workers, which, at face value, suggests a professionalization of the cultivator role among those women still engaged in it" (p. 21).

The authors deal with the emerging scenario too. As the women farmers depend mostly on the informal networks of neighbours, friends and relatives rather than on extension workers, it is necessary to develop a strong network and building their capacity to deploy social capital to exercise informed choices. There is a need to increase their decision-making power because household items, children's education, health, agricultural inputs, labour payments, social relations and so on involve expenditure which are incurred by them. Studies reveal that landownership results in their empowerment bringing greater family welfare. Steps need to be taken in these directions.

The book has some weak points too. There is a general tendency to attribute many problems of India to the colonial rule. Our authors also comment, "Moreover, by separating public and domestic labour through large-scale, market-based production systems, colonial rule put at the centre of household labour, subsistence production, and reproductive activities" (p. 8). These conditions had prevailed in the pre-colonial times also and so it is not fair to attribute them to the British rule. On p. 84 they say that they used secondary sources of data also but the examples of the secondarysources which they give are inappropriate as some of them are actually primary data sources although published like census reports. The

book contains statistical data in a mechanical way which is not meaningful and hardly contribute to our understanding of the issues. Much of the discussion of the subject is not with respect to the two districts but for India. But then, what might have happened in the country as a whole or even in the state ofWest Bengal might not be necessarily true for the two districts.It contains statements which appear to be too sweeping to be true. On p. 79, they say, "Overall, as a result of the large outflow of labour, and of rural men in particular, Bankura and Dakshin Dinajpur generally lack scope for diversification away from agriculture." On p. 103 they write, "… there has been an increasing trend among the farmers to shift toward vegetables and cash crops. However, in many cases, families that grew vegetables earlier have stopped growing them now."The two sentences are somewhat contradictory.

On the whole, not much literature is available on this emerging but important subject and the book has contributed to the filling up a vacuum in our understanding of it. It discusses the triumphs and travails of rural women. It will interest scholars of gender studies, sociology, anthropology and public policy. Government policies have to recognize and adapt to the reality of female-headed households in rural areas to be fully effective. Additional studies on these lines will be welcome.

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Book Chapter

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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)

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