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The Institute was registered as an autonomous Non-Profit Society under the Public Societies Registration Act 1350F with registration No.5/1953 dated 7th March 1953. It was also notified as an Educational Research Institution by the erstwhile Government of Hyderabad vide notification No. 33/5 dated June 1953 issued by the Secretary to Government in the Education Department.

The Institute has carried out about 200 Research Studies and Surveys in Economics sponsored by the then Government of Andhra Pradesh, various Ministries of the Government of India, the Indian Council of Social Science Research, New Delhi, and Public and Private Sector Organizations during the last seven decades. The Institute also organizes, at regular intervals, seminars and conferences on themes of contemporary significance.

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From the Editor's Desk...

This Issue brings together a comprehensive array of empirical studies that illuminate the complex interplay between macroeconomic forces, institutional dynamics, grassroots resilience and pathways towards sustainable development. Spanning India, Nigeria and broader Asia, the papers presented here offer both analytical rigor and practical policy insights across themes of financial stability, agricultural transformation, gender empowerment, migration, climate adaptation and fiscal policy.

Kundan Kumar and Rajendra N. Paramanik's cross-country analysis underscores the intricate linkages between financial cycles, business cycles and economic policy uncertainty (EPU). While financial shocks boost economic activity in both developed and developing nations in the long run, EPU emerges as a dampener - particularly in the long term. These findings highlight the stabilizing role of financial access and the need for proactive policy responses in uncertain times.

Sifat Fatima and Md. Zulquar Nain's district-level panel study of Uttar Pradesh for the period 1990-2021 using the Simpson Index Diversification (SID) reveals uneven patterns of crop diversification across regions. While Bundelkhand has recently outpaced other regions in diversifying toward high-value crops, infrastructural deficits - especially in roads and irrigation - constrain broader progress. Their findings call for targeted public investment in logistics, cold storage, irrigation and region-specific resource management to foster inclusive rural development.

Shibinu S. et al. explore the transformative effects of male out-migration on the capabilities of left-behind Muslim women in Malappuram district of Kerala. Utilizing a capability approach, they show how migration and remittances empower women through increased financial autonomy, mobility and decision-making. The study underscores the need for institutional support to consolidate these gains and foster women's empowerment.

Rekha and Nirmala examine the limited accessibility of social security benefits for informal sector migrant workers from Kerala employed in Gulf countries by using the data collected from a random sample of 569 migrant households. Despite permanent employment in many cases, contractual irregularities and exploitative practices persist. The study urges stronger bilateral labour agreements and legal literacy initiatives to ensure migrant rights are protected and social security is made accessible.

Sai Sailaja Bharatam et al. provide a critical assessment of Net Zero pledges among Indian firms and cities, revealing inconsistencies between stated commitments and actual progress. The study warns against greenwashing and emphasizes the need for robust fiscal strategies, carbon financing and verifiable climate action to align with global decarbonization goals.

Ojogho and Olisakwe's structural-conduct-performance (SCP) analysis of indigenous weaning food markets in Benue State, Nigeria, exposes high price markups and concentrated market power despite an overall unconcentrated market structure. Their findings reveal significant inefficiencies and highlight the role of market structure in determining food affordability for vulnerable groups.

Sadiq et al. investigate the role of eco-innovations in bolstering climate resilience among small-scale wheat farmers in northern Nigeria. While adoption rates are relatively high, extension gaps and limited advisory services hinder broader uptake, particularly in risk-related areas like crop insurance. Their research emphasizes tailored information dissemination and adaptive technology design for enhancing sustainable rural livelihoods.

Diksha Kumari and Arun Kumar Giri provide compelling evidence that remittances significantly contribute to poverty reduction across Asian nations, aligning with SDG Goal. Using robust econometric methods, they highlight the multiplier effects of remittances on health, education and fixed capital formation, particularly in countries like Bangladesh, India, and the Philippines. Their findings support policy action to reduce remittance costs and facilitate labour migration.

Sankarganesh and Shanmugam explore the productivity implications of corporate income tax on Indian manufacturing firms. Their findings confirm that higher tax rates suppress total factor productivity, especially for public sector and younger firms. The paper underscores the importance of preserving tax deductions, incentivizing R&D and crafting targeted tax relief measures to foster industrial dynamism.

Investigation of Nexus among Business Cycle, Financial Cycle and Economic Policy Uncertainty in a Global Context

Kundan Kumar¹ and Rajendra N. Paramanik²

Abstract

This paper investigated and compared the nexus among Business Cycle, Financial Cycle and Economic Policy Uncertainty for developed and developing countries using the Panel Vector Auto regression and Panel Autoregressive Distributed Lag method from 1998 Q1 to 2021 Q4. Results from panel VAR indicate that shocks to the financial cycle positively influence the business cycle both in developed and developing countries. Additionally, shocks to economic policy uncertainty negatively affect the business cycle across both groups of countries, while they positively impact the financial cycle in developing economies and negatively impact it in developed ones. The findings from panel ARDL reveal that the financial cycle has a negative effect on the business cycle in the short run but exerts a positive and significant influence in the long run. In contrast, economic policy uncertainty has a significant negative impact on the business cycle in the long run while there is no impact in short run.

Keywords: Business Cycle, Financial Cycle, Uncertainty

JEL Classification: E30, E44, E61

1. Introduction

The Global Financial Crisis (GFC) opened up debates on the effects of macroeconomic shocks and how they have caused significant drop in real activity in a number of nations since 2007. According to Cesa-Bianchi, Pesaran, and Rebucci (2014), the recent GFC significantly increased macroeconomic and financial uncertainty in the United States. The GFC has raised questions about the traditional causes of Business Cycle (BC) fluctuations (Caldara et al., 2016). Recent studies have identified economic uncertainty as a potential factor in BC fluctuations (Bloom, 2009; Bloom et al., 2018; Choudhry et al., 2020; Colombo, 2013; Ludvigson et al., 2021). Jurado et al. (2015) claim that the 2007–2009 recession is the most notable instance of increased uncertainty after World War II. According to bloom (2014)

¹ Kundan Kumar, Faculty of Economics, Bennett University, Greater Noida-201310, India. Email: kundan.kumar@bennett.edu.in; Phone: 7297958577

² Rajendra N Paramanik, Faculty of Economics, Department of Humanities and Social Sciences, Indian Institute of Technology Patna-801106, India. Email: rajendra@iitp.ac.in; Phone: 8290870537

uncertainty abruptly increases during recessions and are countercyclical with economic activities. As a result, it might both be a cause and/or a consequence to BC fluctuations. Theoretical literature suggests that in times of high uncertainty, because of lower personal income and corporate profitability, households postpone consumption, companies are reluctant to make costly decisions, slow hiring and investments, resulting in a deceleration in economic growth. This can result in a decline in the demand for goods and services, leading to a decrease in output, employment, and potentially a recession (Baker et al., 2015; Jurado et al., 2015).

Recent literature has defined Financial Cycle (FC) as fluctuations in different financial indicators. High levels of uncertainty can make financial markets more volatile and cause FC's to be more prominent. The volatility in the financial market can increase the cost of capital, decrease investment, and make it more challenging for firms to access funding. Overall, a high level of uncertainty can negatively impact both the BC and the FC.

Many researchers have examined the deep connection between BC and FC, specially in the wake of the GFC of 2008. During periods of economic expansion, credit demand often rises as businesses and individuals incur more debt to finance investment and spending. This results in a credit boom in the financial sector, as banks and other lending institutions become more willing to extend loans. This, in turn, can stimulate additional economic growth by supplying businesses and households with the capital they need to invest and spend. Even though there is controversy in the literature regarding the nature of the nexus between these two cycles, there is a growing consensus among researchers that they have a strong relationship.

While analysing the influence of policy uncertainty shocks on BC and FC, majority of the prior literature contributes to the literature by concentrating on either the United States or advanced economies, as well as emerging market economies. The literature on comparison of the impact of uncertainty on BC and FC in developed and emerging economies is limited. Therefore, the primary goal of this study is to re-examine this nexus in light of developed and developing countries. The remaining of the paper is organised as follows: pertinent empirical literature review is presented in section 2. In section 3 data and Panel-VAR methodology have been presented. Section 4 presents the empirical findings of Panel- VAR model. Section 5 illustrates the method of Panel- Autoregressive Distributed Lag (ARDL). The final section offers the concluding remarks.

2. Literature Review

According to numerous studies any significant shock to a leading economy for example USA is likely to exert a spillover effect on other developed and emerging market economies'

macroeconomic variables and financial markets. Using the structural Vector autoregression (VAR) method, Colombo (2013) investigated effect of the policy uncertainty in the US on the Euro area and found that one standard deviation shock to the EPU in the US caused a 0.12% reduction in European index of industrial production (IIP). Nyawo and Wyk (2018) studied how the Indian economy was affected by the shock of US policy uncertainty. They found that a one standard deviation shock to the US economy causes a decline of -0.294% in Indian industrial production. Choudhry, Hassan and Shabi (2020) investigate the impact of U.S. economic uncertainty on the BC's of 12 European Union nations prior to and during the GFC. When the crisis period is taken into consideration, their findings offer enough of support for the linear and non-linear causality between U.S. economic uncertainty and the European Union's BC. Caggiano, Castelnuovo, and Figueres (2020) investigated the impact of US EPU shocks on the Canadian BC using a non-linear VAR technique. They discovered that during economic downturns, Canadian unemployment reacted more strongly to uncertainty shocks.

EPU can have a substantial effect on the FC. Recessions that occurred post-1982 have their origin in the financial market (Ng and Wright, 2013). Brogaard and Detzel (2015) argued that EPU can be used to predict future returns in the stock market. Returns are lower in times of high uncertainty compared to low uncertainty periods (Pastor and Veronesi 2012). Policy uncertainty along with stock returns can also affect volatility as it can predict market shocks (Aye et al., 2018). Policy uncertainty has a negative relationship with bank credit growth (Bordo, Duca, and Koch, 2016). Uncertainty related to future policy constraints bank financing and hence can reduce bank credit growth. According to Phan et al. (2021), a unit standard deviation rise in EPU decreases financial stability by 2.66% to 7.26% of its sample mean. Overall, Policy uncertainty has a negative effect both on BC and FC.

Although there are numerous studies on the relationship between EPU, the BC, and the FC in developed and developing nations, relatively few have compared this relationship in context of developed and developing nations. Therefore, this study investigated and compared the nexus among BC, FC and EPU for developed and developing countries by using the Panel VAR method. The next section describes the data and methodology used in this paper.

3. Data and Empirical Model

This paper investigated the dynamic and endogenous relations among business cycle, financial cycle, and economic policy uncertainty by using a panel VAR model in a generalized method of moments (GMM) framework. This data set contains economic indicators for six developed nations (Australia, Canada, Japan, Korea, the United Kingdom, and the United States) from 1997 Q1 to 2021 Q4 and three developing nations (Brazil, India, and Mexico) from 1998 Q1

to 2021 Q4. Financial and macroeconomic variables include broad money, nominal effective exchange rate, share price, GDP, and the index of EPU. All variables have been initially de-seasonalized and then standardised. Using the following formula, all variables have been standardized.

$$\text{Standardized variable} = \frac{\text{variable value} - \text{mean value}}{\text{standard deviation}}$$

Using principal component analysis, a financial index from the variables like broad money, nominal effective exchange rate, and share price is constructed. Using the Hodrick and Prescott (1997) time-series technique, the FC is extracted from the financial index. Similarly, the BC is extracted from gross domestic product (GDP). The index of EPU is available on a monthly basis, so it is converted into quarterly frequency, seasonalised and standardised, and used as a proxy for economic policy uncertainty. To analyze the dynamic relationships between variables over time and across countries, the Panel VAR method is used.

The panel VAR model constructs an endogenous system and handles every variable without restriction, which is more suitable when the variables are strongly correlated. As literature suggests in regressions of BC, FC and EPU, there is possible existence of bidirectional causality between them. One major advantage of panel VAR model is its ability to account for changes in the variability of shocks over time. The panel VAR model of this study can be specified as follows.

$$Y_{i,t} = a_0 + \sum_{k=1}^p a_k Y_{i,t-k} + \mu_i + \varepsilon_{it} \quad (1)$$

where Y_i , represents a vector of three dependent variables that serve as proxies for the business cycle, financial cycle, and economic policy uncertainty. a_0 is the intercept coefficient. a_k is the coefficient vector to be estimated. Individual heterogeneity is captured by μ_i . ε_{it} denotes idiosyncratic errors, with $E(\varepsilon_{it}) = 0$, $E(\varepsilon'_{it}\varepsilon_{it}) = \Sigma$, and $E(\varepsilon'_{it}\varepsilon_{ij}) = 0$, for $t > j$.

Due to the presence of the lagged dependent variables, μ_i are correlated with the regressors. As a result, applying the standard mean-differencing method to eliminate them would result in a biased coefficient estimate. In order to maintain the orthogonality between transformed variables and lagged regressors, following Arellano and Bover (1995), this paper employs the forward mean-differencing method. Lagged regressors can then be employed as instruments, and a system of GMM can be used to estimate the coefficients. Each equation of the system

treats the endogenous variables as first-difference (Δ), and the precise form with one lags for the exogenous variables and no constant is described as-

$$\Delta Y_{i,t} = \theta_1 \Delta Y_{i,t-1} + \varepsilon_{it} \quad (2)$$

4. Empirical Results of Panel VAR Model

Panel unit root test

There are several tests to identify the suitable unit root tests in the panel data, including the Cross-sectional Augmented Dickey-Fuller (CADF), Im-Pesaran-Shin (IPS) unit root test, Cross-sectional Im, Pesaran, and Shin (CIPS) unit root test (Pesaran, 2007) and Levin-Lin-Chu (LLC) unit root test. IPS and Levin, Lin, and Chu (2002) panel unit root tests are employed in this study in order to verify the stationarity of the variables. The outcomes of the panel unit root tests for the variables are presented in Table 1. The standardized t statistics and the associated significance values are presented. Both the LLC and IPS tests indicate that all variables are statistically significant. The unit root tests demonstrate that all variables are stationary at level.

Table 1 : Panel Unit Root Test Results

Developed Countries				
	LLC test T-statistics	p-value	IPS Test T-statistics	p-value
BC	-3.3629	0.0004	-7.3361	0.0000
FC	-4.3831	0.0000	-2.2528	0.0121
EPU	-4.4725	0.0000	-7.0190	0.0000
Developing Countries				
BC	-0.0841	0.4665	-2.8421	0.0022
FC	-2.7503	0.0030	-2.4622	0.0069
EPU	-1.7923	0.0365	-3.0934	0.0010

Source: Authors' calculation

Table 2 : Determination of the Optimal Lag

Sample 1 (Developed Countries)						
lag	CD	J	J p value	MBIC	MAIC	MQIC
1	.9551809	73.06129	4.06e-06	-98.27089	19.06129	-26.71815
2	.9643871	28.71716	.0519472	-85.50429	-7.282838	-37.80246
3	.968724	11.14826	.2656835	-45.96247	-6.851744	-22.11156

Sample 2 (Developing Countries)						
lag	CD	J	J p value	MBIC	MAIC	MQIC
1	.9227746	40.46636	.04631	-110.9894	-13.53364	-52.65429
2	.9368187	15.42823	.6323837	-85.54226	-20.57177	-46.6522
3	.9378922	8.886445	.4478217	-41.5988	-9.113555	-22.15377

Source: Authors' calculation

Determination of the Optimal Lag for the Model

The optimal lag number (p) is necessary for the estimation of the VAR model. First-order panel VAR is the preferred model since it has the shortest Modified Schwarz's Bayesian Information Criteria (MBIC) as evidenced by the results presented in table 2. This approach relies on the three model selection criteria proposed by Andrews and Lu (2001).

Results of Panel VAR Model

Table 3 presents the estimated panel results for both developed and developing nations. According to developed country estimates, BC and FC lagged by one period increased BC. BC lagged by one period exerts a negative impact on FC, whereas FC lagged by one period has a positive impact on FC.

In the case of developing countries, BC and FC lagged by one period exhibit a statistically significant positive effect on BC. FC is significantly and negatively impacted by BC's one-period lag, whereas FC is positively impacted by FC's one-period lag. BC is significantly and negatively impacted by EPU's one-period lag. For both the developed and developing economies, EPU is positively and significantly impacted by EPU's one period lag. Results show that BC and FC do not have a significant impact on EPU for both the developed and developing countries.

Forecast Error Variance Decomposition

The forecast error variance decomposition (FEVD) at the panel level is presented in table 4. Based on the FEVD estimations, it is found that 5% of the variation in BC can be explained by FC and 1% by EPU in developed countries. EPU and BC, on the other hand, account for 0% and 13%, respectively, of the variation in FC. Only 1% of the variation in EPU is explained by BC, while 5% is explained by FC.

According to FEVD estimates, for developing nations, FC and EPU account for 4% and 1%, respectively, of the variation in BC. On the other hand, BC and EPU account for 18% and 2%, respectively, of the variation in FC. Both BC and FC account for 4% of the variation in EPU. The result suggests that a positive shock to EPU has an insignificant or minor impact on BC and FC. Given that EPU does not result in FC and BC in developed nations, these findings are clear and consistent with the causality tests.

Table 3 : Results of Panel VAR Model

Sample 1 (Developed Countries)			
Dependent Variable	BC	FC	EPU
BC L1.	.7737077* (0.000)	-.2064112* (0.000)	.1301857 (0.396)
FC L1.	.0347792* (0.002)	.9292409* (0.000)	.0058016 (0.929)
EPU L1.	-.0082884 (0.188)	-.0133491 (0.114)	.77926* (0.000)
Sample 2 (Developing Countries)			
Dependent Variable	BC	FC	EPU
BC L1.	.7872795* (0.000)	-.1173451* (0.000)	-.1188991 (0.466)
FC L1.	.0608979* (0.012)	.9382985* (0.000)	-.0404596 (0.845)
EPU L1.	-.0079704* (0.013)	.0045269 (0.270)	.8266475* (0.000)

Source: Authors' calculation

Table 4 : Global Variance Decomposition

Response variable and Forecast horizon						
	Developed Countries			Developing Countries		
	Impulse variables					
	BC	FC	EPU	BC	FC	EPU
BC						
0	0	0	0	0	0	0
1	1	0	0	1	0	0
2	.997097	.0020138	.0008893	.9975563	.0014574	.0009863
3	.9911503	.0062656	.0025842	.9926863	.0045601	.0027536
4	.9830254	.0122361	.0047385	.9861751	.0089724	.0048524
5	.9736065	.0193349	.0070586	.9787365	.0143149	.0069486
6	.9636992	.0269797	.0093211	.9709707	.0202051	.0088242
7	.9539598	.0346628	.0113774	.9633426	.0262929	.0103645
8	.9448613	.0419915	.0131472	.9561797	.0322849	.0115355
9	.9366953	.0487003	.0146045	.9496842	.037957	.0123588
10	.9295985	.0546412	.0157603	.9439556	.0431561	.0128883

Response variable and Forecast horizon						
	Developed Countries			Developing Countries		
	Impulse variables					
	BC	FC	EPU	BC	FC	EPU
FC						
0	0	0	0	0	0	0
1	.0062679	.993732	0	.0218829	.9781171	0
2	.0059566	.9929873	.0010561	.0125532	.9868507	.000596
3	.0162127	.9811905	.0025969	.0207949	.9771399	.0020653
4	.0321078	.963796	.0040961	.0398745	.9557632	.0043624
5	.0503644	.9442941	.0053415	.0645572	.928095	.0073478
6	.0689533	.924763	.0062837	.0912217	.8979337	.0108447
7	.0866991	.9063535	.0069474	.1175822	.8677427	.0146751
8	.1029785	.8896379	.0073836	.1423225	.8389981	.0186794
9	.1175129	.8748398	.0076473	.1647758	.8125002	.022724
10	.1302329	.8619797	.0077874	.1846859	.7886118	.0267023
EPU						
0	0	0	0	0	0	0
1	.0210075	.0592205	.919772	.0240468	.0326467	.9433065
2	.0176891	.0590537	.9232572	.0278449	.0334395	.9387156
3	.0154893	.0586791	.9258316	.0311861	.0343041	.9345098
4	.0141245	.0581926	.9276829	.0340099	.0352078	.9307823
5	.0133412	.0576746	.9289842	.0363076	.0361216	.9275708
6	.0129338	.0571844	.9298818	.038109	.0370212	.9248698
7	.01275	.0567588	.9304913	.0394687	.0378868	.9226445
8	.0126857	.0564151	.9308992	.0404544	.0387034	.9208422
9	.0126766	.0561559	.9311675	.0411372	.0394604	.9194024
10	.0126866	.0559744	.931339	.041585	.0401511	.9182639

Source: Authors' calculation

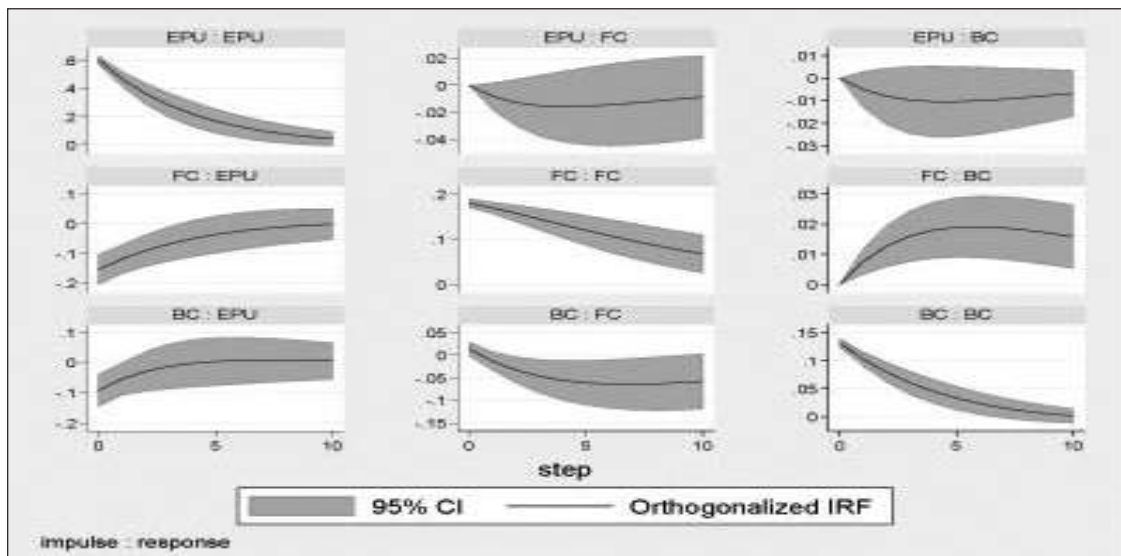
Impulse Response Analysis

This section presents the impulse response functions (IRFs) accompanied by 95% confidence intervals, which were obtained using 200 Monte Carlo simulations. The Panel VAR (PVAR) satisfies the stability requirements, as shown by the stability graph in figure 3. If every element of the associated matrix is strictly less than one, the VAR model is considered as stable. Hence, the VAR model is considered stable if all eigenvalues lie inside the unit circle. The global and regional eigenvalues derived from the roots of the companion matrix lie within the unit circle, confirming the stability of the PVAR model and indicating that the results are reliable for forecasting and policy recommendations.

The BC, FC, and EPU impulse response functions for developed nations are shown in Figure 1. It demonstrates that shocks to FC will have a positive effect on BC. A shock to EPU will have a negative effect on FC and BC.

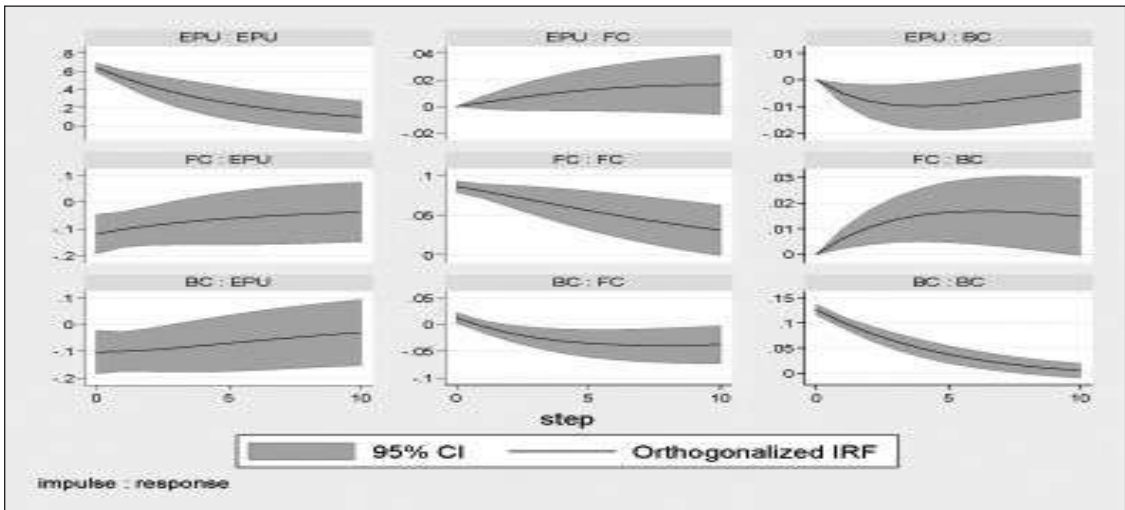
The BC, FC, and EPU impulse response functions for developing countries are depicted in Figure 2. It demonstrates a positive impact of shocks to FC on BC. Also, a positive impact of shocks to EPU on FC and a negative impact on BC. It is believed that the development of financial sector in developing economies has mitigated the negative impact of uncertainty on FC.

Figure 1 – Impulse response functions of developed countries



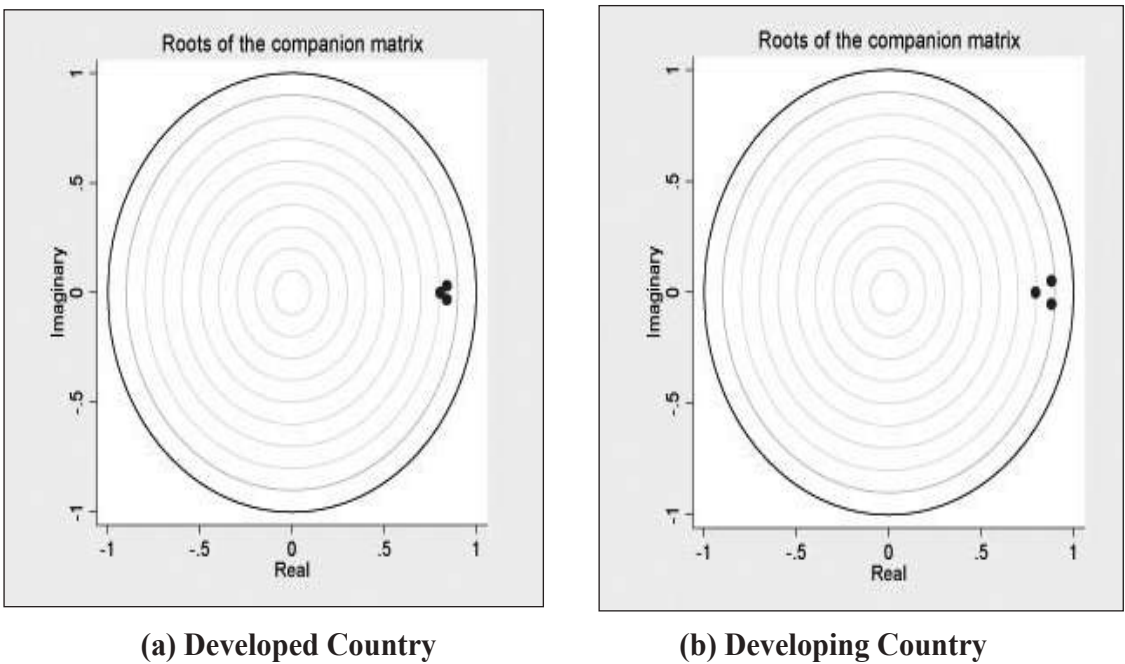
Source: Authors' calculation

Figure 2 – Impulse response functions of developing countries



Source: Authors' calculation

Figure 3 – Global stability graph



(a) Developed Country

(b) Developing Country

Source: Authors' calculation

Causality Test

The results of the panel Granger causality test are presented in Table 5. Granger causality analysis is employed to establish the direction of causality among BC, FC, and EPU. This confirms the causality patterns previously indicated in Table 3. As seen in Table 5, there is a bidirectional association between BC and FC in developed nations at the usual confidence levels, while in developing countries, EPU also granger causes BC in addition to the bidirectional relationship between BC and FC.

This paper investigated the nexus among BC, FC and EPU using quarterly data from in 6 developed and in 3 developing economies from 1997 Q1 to 2021 Q4. To examine the nexus among these variables, this study relies on Panel-VAR method. The analysis reveals that in both developed and developing countries, shocks to FC have a positive effect on BC. Additionally, it is observed that shocks to EPU have a negative impact on BC in both developed and developing economies. However, EPU shocks have a positive influence on FC in developing countries and a negative effect on FC in developed countries.

The empirical evidence suggests that the advancement of financial systems is highly influential in mitigating the adverse impacts of uncertainty on the economic performance of developing nations (Lensink, 2000; Karaman & Karaman, 2019). This suggests that in countries possessing more sophisticated financial infrastructures, uncertainty has a lesser impact on both investment and consumption. Higher levels of financial development enable greater access to capital and liquidity, improved resource allocation, and decreased cost of external financing. As a result, it is probable that financial development will alleviate the negative effects of EPU. This study makes a significant contribution to the existing literature by highlighting that the impact of uncertainty is not consistent across nations; instead, it varies depending on the level of financial development within a country. This implies that other institutional and structural aspects of an economy may either magnify or alleviate the consequences of uncertainty.

Table 5 : Panel Granger Causality Results

	Developed Countries			Developing Countries		
	BC	FC	EPU	BC	FC	EPU
BC	---	14.296* (0.000)	0.719 (0.396)	---	12.390* (0.000)	0.533 (0.466)
FC	9.771* (0.002)	---	0.008 (0.929)	6.333* (0.012)	----	0.038 (0.845)
EPU	1.737 (0.188)	2.492 (0.114)	---	6.163* (0.013)	1.218 (0.270)	----
ALL	11.912* (0.003)	16.225* (0.000)	0.807 (0.668)	24.711 (0.000)	14.330* (0.001)	0.644 (0.725)

Source: Authors' calculation

One potential reason for this outcome could be attributed to the limited number of panels available. Consequently, this paper re-evaluated the empirical findings by employing the panel ARDL method on a single panel encompassing all nine countries.

5. Panel ARDL Model

To examine both the short and long run effects of FC and EPU on BC, this paper empirically estimated the panel ARDL model. This model employs three distinct types of estimators: the Mean Group (MG), the Pooled Mean Group (PMG), and the Dynamic Fixed Effects (DFE) estimators.

Empirical Results of Panel ARDL Model

It is necessary to investigate the stationarity of the sample variables before estimating the ARDL model. Therefore, firstly the summary statistics and the test of panel unit root for all variables is estimated. Simple VAR should be estimated if the series are I(0); however, if the series are I(1) or a combination of I(0) and I(1), Panel ARDL model should be estimated taking the level of the series into account. Table 6 shows the summary statistics of respective variables. IPS and LLC test is performed to check the stationarity of the variables. Both tests assume that cross-sections are independence. Table 7 presents the results of unit root test that shows variables of interest have property of both stationary and non-stationary. Both unit root test results show that FC is stationary at first difference. The BC and EPU are stationary at level according to both unit root test. There is a combination of I (0) and I (1) variables. Therefore, the use of panel ARDL model will be appropriate.

Table 6 : Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
BC	864	-.0008316	.1776805	-1.549331	.5895372
FC	864	-.0041584	.3600915	-1.260438	1.734342
EPU	864	.0539673	1.004596	-1.578015	.265948

Source: Authors' calculation

Table 7 : Panel Unit Root Tests

	IPS Test		LLC Test	
	Constant	Constant & Trend	Constant	Constant & Trend
Tests in levels				
BC	-9.5523 *	-9.5638 *	-7.5273*	-7.5175*
FC	-0.8898	-0.9195	-0.9494	-0.1570
EPU	-6.3952*	-8.4993*	-4.5446*	-5.8206*
Tests in first differences				
BC	-21.1496*	-21.1570*	-20.9520*	-22.0001*
FC	-16.2898*	-16.3841*	-13.5347*	-14.2477 *
EPU	-21.4083*	-21.4161	-21.6192*	-22.8207*

*, **, *** denote the rejection of the null of a unit root for 99%, 95% and 90% respectively

Source: Authors' calculation

Firstly, the appropriate lag of the ARDL (p, q, q) model is identified. The outcomes of the MG, PMG, and DFE, are then attempted to be interpreted. Table 8 shows the ideal lags for the sample of nations. The most frequent lags between nations is chosen. More specifically, for each variable and across all nations, the most frequent number is selected. The ARDL (1, 0, 0) is chosen.

To check the existence of a long-run relationship, it is necessary to perform a cointegration test. Table 9 reports the findings of Pedroni cointegration test. Results show that statistics are significant and the absolute value is greater than 1.96. Therefore, there exists a cointegrating relationship.

Table 8 : The Optimal Lag Selection

Variables	BC	FC	EPU
ARDI (p,q,q)			
Countries			
Brazil	1	1	0
India	1	0	0
Mexico	1	0	0
Australia	1	2	0
Canada	1	0	1
Japan	1	0	0
Korea	1	0	0
UK	1	0	0
USA	3	2	0

Source: Authors' calculation

Table 9 : Cointegration Test

Test stats	Panels	Group
v	5.509	
rho	-9.464	-10.19
t	-7.082	-8.336
ADF	-5.062	-5.732

Source: Authors' calculation

Table 10 presents the outcomes of the effects of FC and EPU on BC of MG, PMG and DFE estimators in short run and long run. At a 1% level of significance, negative and statistically significant error correction term (adjustment coefficient) supports the presence of a long-term relationship. Hausman test allows to choose between MG or PMG and PMG or DFE. It is found that Hausman test is statistically insignificant, therefore to interpret results this paper focus on PMG estimator that allow to analyse the long-run effects. It is found that PMG estimator is more efficient and consistent. The results show that FC has a positive and significant impact on BC in the long-run whereas it has a negative impact on BC in short run at 10% level. Existing literature on BC and FC is limited and literature as of now being scanty does not offer any proper explanation for this SR anomaly. This itself offer up a new vista for further research, however our understanding is that the over liquidity can be a major factor where deposits are dominated by short term deposits. Also, the high information asymmetry is another feature of the underdeveloped financial system that prevents banks from effectively financing the private sector, which reduces the short-term benefits to the economy.

The impact of EPU on BC is found to be negative and significant in long-run while EPU has no significant impact on BC in short run.

Table 10 : MG, PMG and DFE Estimators: Empirical Results

	BC (dependent variable)			
	Variables	MG	PMG	DFE
Long-run coefficients	FC	.1318975 (0.1979998)	.2245147* (.0431907)	.2222494* (.0345191)
	EPU	-.0140919 (0.0178186)	-.0164139** (.0070182)	-.0397923** (.0127882)

	BC (dependent variable)			
	Variables	MG	PMG	DFE
Short-run coefficients	D(FC)	-0.2198435 (0.1953558)	-0.2828657*** (0.1514296)	-0.020295 (.0293639)
	D(EPU)	-0.0074987 (0.0094643)	-0.0076047 (.0108779)	-0.009716 (.0071099)
	Constant	.0006669 (0.0015242)	.0014216 (.0014353)	.0012188 (.0043716)
Error Correction Term		-0.3952131* (0.0747829)	-0.3596979* (0.0581838)	-0.3762585* (.0266348)

Number in parentheses represent the standard error; *, **, *** shows 1%, 5% and 10% of significance level

Source: Authors' calculation

6. Conclusion

This paper investigated the nexus among BC, FC and EPU using quarterly data for 6 developed and in 3 developing economies from 1997 Q1 to 2021 Q4. The results of panel VAR suggest that both in developed and developing countries, shocks to FC has a positive impact on BC. It is also found that Shocks to EPU have a negative impact on BC both in developed and developing economies whereas it has a positive impact on FC in developing countries and negative impact on developed countries. It is believed that the development of financial sector in developing economies has mitigated the negative impact of uncertainty on FC. This study again estimated the empirical results using panel ARDL for a combined panel of 9 economies. The findings showed that while FC has a short-term detrimental impact on BC, it has a long-term positive and significant influence on BC. The impact of EPU on BC is found to be negative and significant in long-run while there is no impact in short run. The findings of this paper recommend policymakers that accessibility of liquidity and credit, especially in times of mounted uncertainty will help to strengthen the financial sector of an economy and restore confidence in the economy.

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Trends and Determinants of Crop Diversification in Uttar Pradesh: A District-wise Panel Data Analysis

Sifat Fatima¹ and Md. Zulquar Nain²

Abstract

This study examines regional and district-level trends in high-value crop diversification in Uttar Pradesh from 1990-91 to 2020-21. Using the Simpson Index of Diversification (SID), crop diversification is measured across all 75 districts. To identify the factors influencing diversification, a fixed effects panel regression model is applied to 46 original districts, which were later subdivided, to maintain consistency in the dataset. The results reveal a shift from traditional to high-value crops, though the transition is uneven across regions. Gross irrigated area, fertilizer use, rainfall, and population negatively affect diversification, while road density has a positive effect. Cropping and market intensity are statistically insignificant. The study highlights the need for region-specific policies focusing on infrastructure, credit access, and agricultural inputs to promote balanced diversification and enhance rural livelihoods.

Keywords: *Simpson's index, crop diversification, fixed effect model, Uttar Pradesh*

1. Introduction

In India, agriculture production is shifting from food grains based to high-value crops and livestock-based systems in response to a shift in consumer preferences toward meat, fruits, and vegetables (Behera *et al.*, 2007; Sharma and Jain, 2011). A change in consumption patterns away from staple foods such as wheat, rice, and coarse grains and toward high-value food products such as dairy products, poultry, and fruits are being brought on by continued economic expansion, growing urbanization, and increasing per capita income (Behera *et al.*, 2007; Dasgupta and Bhaumik, 2014; Sonawane *et al.*, 2022). This movement in consumer preferences toward high-value food products illustrates a continuous trend of diversification

¹ Sifat Fatima, Guest Faculty, Dr. B.R. Ambedkar University Delhi and Research Scholar, Department of Economics, Aligarh Muslim University, Aligarh-202002, India. Email: sifatshahwaz123@gmail.com; Phone: 8077624085.

² Md. Zulquar Nain, Assistant Professor, Department of Economics, Aligarh Muslim University, Aligarh-202002, India. Email: alignain@gmail.com; Phone: 9492062286. Corresponding author

in agriculture (Rao *et al.*, 2008; Jha *et al.*, 2009). Crop diversification is the process by which farmers move from growing traditionally low-profitable crops to growing highly profitable crops (Vyas, 1996; Behera *et al.*, 2007). The farmers have used crop diversification as one of their agricultural diversification techniques to boost their farm revenue and lessen their sensitivity to the risks and difficulties associated with agriculture (Singh *et al.*, 2006; Kumar and Singh, 2019).

In developing countries, diversification is a prerequisite for fostering economic development since the cultivation of food grains like cereals and pulses alone cannot support economic growth (Kumar and Mittal, 2003). The diversification from subsistence to commercial crops is a vital approach that can raise agricultural revenues, lower crop failure risks, and increase the potential for foreign exchange gains (Singh *et al.*, 2006). Additionally, diversification can aid in alleviating poverty, generating sustainable employment, and preserving the environment (Pingali and Rosegrant, 1995; Kumar and Gupta, 2015).

Agriculture contributed around 23 percent to the gross domestic product of Uttar Pradesh in 2019-20. Almost 60 percent workforce in this state is directly engaged in agriculture. Further, about 80% and 12% of total landholdings are operated by marginal and small farmers, respectively. Additionally, there was a significant decrease in the average size of holdings, from 0.86 hectares in 1995-96 to 0.73 hectares in 2015-16 (India, 2021). This is perhaps the most prominent aspect of the Uttar Pradesh rural economy, which essentially provides a context for crop diversification (Gulati *et al.*, 2021; Verma *et al.*, 2017).

Crop diversification was highly unusual in India before the 1960s when new agricultural technology was introduced. As a response to the advancement of water-seed-fertilizer technology, there has been a significant change in the allocation of agricultural land toward the production of high-value crops like fruits and vegetables, especially among small farmers (De and Chattopadhyay, 2010). In Uttar Pradesh, high-value crops like potatoes, sugarcane, and minor oilseeds have also received significant attention among small farmers (Fatima and Nain, 2022). The need for crop diversification seems to have been realized, particularly since the 1990s.

The main objectives of this study are (i) to investigate the regional trends of crop diversification in Uttar Pradesh; (ii) to assess the degree of crop diversification in various districts of Uttar Pradesh; and (iii) to investigate the various technological, infrastructural, climatic, and demand factors affecting crop diversification in Uttar Pradesh.

2. Data and Methodology

2.1 Data Sources

The study is conducted at the district level of Uttar Pradesh from 1990-91 to 2020-21. The required data are sourced from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). ICRISAT contains a comprehensive data set on many components of the agriculture sector at the district level. The data on the area of 21 major crops, used for calculating Simpson index have been taken from this source. Over 80 percent of the total cropped area in Uttar Pradesh is occupied by the crops chosen for the study. The data on other variables like gross cropped area, cropping intensity, net and gross irrigated area, fertilizer consumption, road length, and the number of markets has also been taken from this website. The data on the district-level rainfall has been taken from the India Metrological Department, and the district-wise population data from 1990-91 to 2020-21 has been taken from the various publications of the Population Census.

2.2 Research Methodology

Since, Uttar Pradesh occupies a vast area, analysing it on an aggregate level will not be so efficient. So, this study has been conducted by dividing the seventy-five districts of the state into four agro-economic regions; the Western Region, the Central Region, the Eastern Region, and the Bundelkhand Region. In terms of geographical area, the Western Region is the largest comprising thirty districts. The Central Region comprises ten districts. The Eastern Region comprises twenty-eight districts. The Bundelkhand Region is the smallest and comprises seven districts of the state (Kumar *et al.*, 2020).

To measure crop diversification at the district level, the study has used the Simpson Index of Diversification (SID). The mathematical formula for calculating the index is as follows:

$$SID = 1 - \sum_{i=1}^N p_i^2 \quad (1)$$

Where P_i is the proportionate area to the gross cropped area of the i^{th} crop/crop sector.

The Simpson index of diversification (SID) is a measure of diversification that varies from 0 to 1, with a number closer to 1 indicating significant diversification and a value closer to 0 indicating no diversification. In recent years, Simpson's index has become the most used approach for measuring diversity. It is simple to calculate and understand (Joshi *et al.*, 2004). Thus, Simpson's index has been utilized to determine the study's objectives.

2.2.1 Panel Data Regression Model

To determine the factors for crop diversification at the district level in Uttar Pradesh, a panel regression model has been employed. The two critical techniques for panel data analysis are the Fixed Effects Model (FEM) and the Random Effects Model (REM). The Hausman specification test is utilized to determine which model, out of FEM and REM, is the best choice for the panel data analysis.

The fixed effect model has been used to quantify the association between the Simpson index of diversification (SID) and its determinants. It is a balanced data collection since there are an equal number of observations for each district in the panel. There are 1426 observations in the sample size. The potential factors considered in the study are Gross Irrigated Area (GIA), Cropping Intensity (CIN), Fertilizer consumption (FCN), Road density (RD), Market density (MD), Rainfall (RN), and POP (Population). We have also included region-specific dummy variables to examine the regional effect on crop diversification.

2.2.2 Fixed Effect Model

The following equation may be used to represent the fixed effect model for panel data:

$$SID_{it} = \beta_{1i} + \beta_2 GIA_{it} + \beta_3 CIN_{it} + \beta_4 FCN_{it} + \beta_5 RD_{it} + \beta_6 MD_{it} + \beta_7 RF_{it} + \beta_8 POP_{it} + u_{it} \quad (2)$$

Where, $i=1,2,3,\dots,46$ (cross section (districts)), $t=1,2,3,\dots,31$ (time period (years)), SID= Simpson Index of Diversification, GIA= Gross Irrigated Area, CIN= Cropping Intensity, FCN= Fertilizer Consumption, RD= Road Density, MD= Market Density, RF= Rainfall, POP= Population, u = stochastic error term.

To capture the technological effect, the gross irrigated area per hectare of gross cropped area (percent) and fertilizer use per hectare of gross cropped area (kg per ha) are used. To explain the infrastructural effect, proxy variables are market density (number of markets per 1000 ha of gross cropped area) and road density (square km per 1000 ha of gross cropped area). Annual rainfall (mm) is used to determine the climatic effect, and population (lakhs) is taken to capture the demand effect on crop diversification (Basavaraj *et al.*, 2016; Abro, 2017; Mithiya *et al.*, 2018; Kundu and Chattopadhyay, 2018).

3. Results and Discussion

3.1 Regional Trends of Crop Diversification

The state of Uttar Pradesh can be subdivided into the Western, Central, Eastern, and Bundelkhand regions (Kumar *et al.*, 2018; Gulati *et al.*, 2021). The trends of crop diversification among these regions and Uttar Pradesh during 1990-91 to 2020-21 are shown in Table 1. The western region had the highest diversification with an index score of 0.805 up till 2010-11. Next comes the Bundelkhand region, with a score of 0.797, followed by the central region, with a score of 0.779. However, during 2020-21 crop diversification is highest in the Bundelkhand region, showing an index value of 0.829. After that comes the western (0.812) and the central (0.788) regions. However, the eastern region had the least crop diversification, with an index value of 0.697 in 2010-2011 and 0.709 in 2020-21. The crop diversification index value in Uttar Pradesh as a whole decreased from 0.821 in 1990-91 to 0.797 in 2020-21.

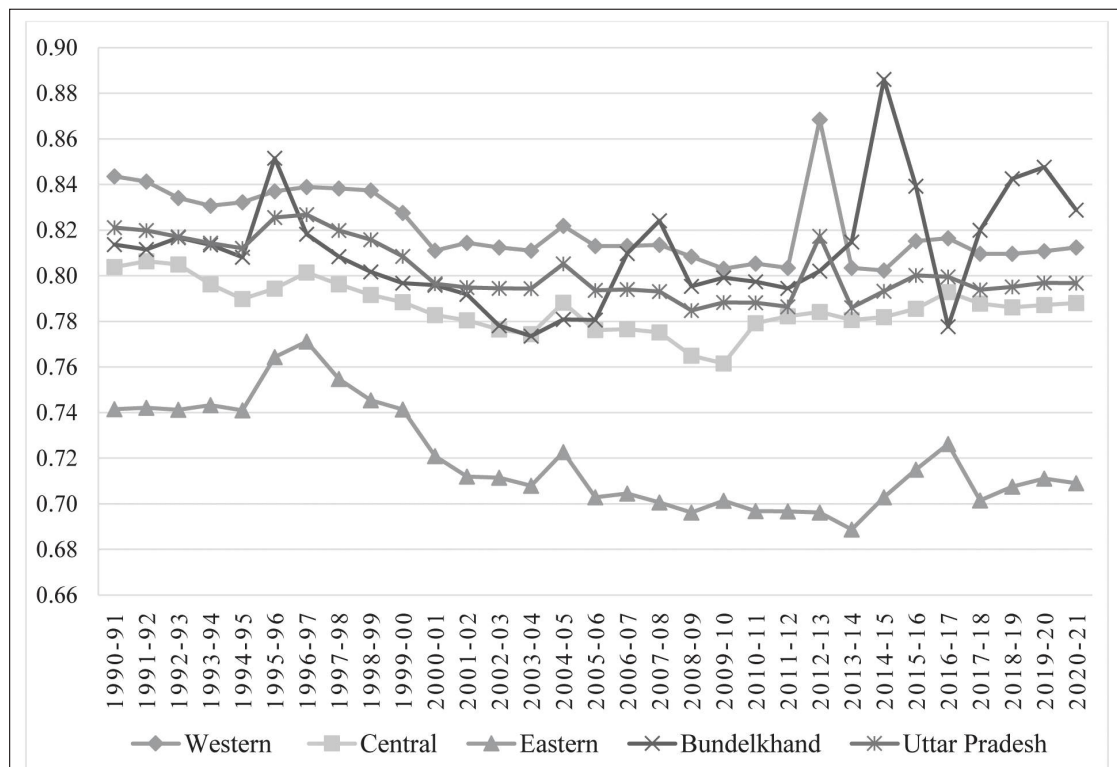
This aspect in regional trends of crop diversification is also shown in Figure 1. It can be observed that crop diversification declined slightly between 1990-91 to 1994-95 across all the regions and Uttar Pradesh. But between 1996-97 to 2011-12, crop diversification decreased rapidly across the regions and the state. However, after 2013-14 crop diversification grew significantly in the Bundelkhand region due to substantial expansion in the area of pulses and oilseeds. This topography naturally favours pulses and oilseeds since this region is trailing in adopting better fertilizer and irrigation types, as well as because of the regions low precipitation and absence of surface groundwater. Contrarily, the eastern region exhibited a significant decline in crop diversification over time due to sluggish growth in the area of food crops and a decrease in the number of non-food crops.

The findings show that all regions of Uttar Pradesh experienced declining crop diversification, particularly between 1996-97 to 2011-12. In agriculturally undeveloped Bundelkhand, agriculture is more diversified toward pulses and oilseeds, whereas in agriculturally developed western Uttar Pradesh, agriculture is more diversified toward sugarcane and potatoes.

Table 1: Regional Trends of Crop Diversification in Uttar Pradesh

Year	Western Region	Central Region	Eastern Region	Bundelkhand Region	Uttar Pradesh
1990-91	0.844	0.804	0.742	0.814	0.821
2000-01	0.811	0.783	0.721	0.796	0.797
2010-11	0.805	0.779	0.697	0.797	0.788
2020-21	0.812	0.788	0.709	0.829	0.797

Source: Author's calculations

Figure 1. Regional trends of crop diversification in Uttar Pradesh

3.2 District-Wise Extent of Crop Diversification

The various districts of Uttar Pradesh have been divided into four categories based on the Simpsons index magnitude from 1990-91 to 2020-21 as very low (0 to 0.59), low (0.60 to 0.69), moderate (0.70 to 0.80), and high (0.81 to 1.0) (Debasis *et al.*, 2018; Kumar *et al.*, 2018). These categories are shown in Table 2.

Crop diversification among districts in western Uttar Pradesh has had a highly inconsistent pattern throughout the years (Kumari, 2013). The western region saw moderate to high levels of crop diversification in 1990-91 while experiencing high to moderate levels of crop diversification in 2000-01, 2010-11, and 2020-21. The Bulandshahr and Farrukhabad districts have consistently maintained high levels of crop diversification, while districts like Firozabad, Saharanpur, Ghaziabad, and Kannauj exhibit a shifting tendency between high to moderate categories of crop diversification. While other districts, viz. Aligarh, Etah, Etawah, and Moradabad moved from the high to the moderate category during 2000-01. The Pilibhit,

Shahjahanpur, Bijnor, Rampur, and Muzaffarnagar districts fluctuated between moderate to low levels of crop diversification. However, crop diversification remained moderate in Agra, Badaun, Bareilly, Mainpuri, Mathura, and Meerut and the newly constituted districts of Amroha, Auraiya, Bagpath, and G.B Nagar.

Crop diversification in the central region of Uttar Pradesh has declined over time. In 1990-91, three districts- Fatehpur, Kanpur Dehat, and Sitapur fell in the high category of crop diversification, while till 2020-21, only Kanpur Dehat was left under a high category, and Fatehpur and Sitapur fell to the moderate category of crop diversification. However, it should be noted that no district in the central region falls under the low or very low crop diversification category, indicating that crop diversification in the region has decreased but has stayed between high and moderate levels.

Crop diversification in the Bundelkhand region has increased over the years. During the earlier decades under study, most of the districts of the Bundelkhand region fall into the moderate category of crop diversification; however, during the fourth decade, five districts- Banda, Hamirpur, Jalaun, Chitrakoot, and Mahoba fall into the high category, while only two districts- Jhansi and Lalitpur fall into the moderate category and low category, respectively.

Table 2 : District-wise Extent of Crop Diversification in Uttar Pradesh

	Very Low (0 to 0.59)	Low (0.60 to 0.69)	Moderate (0.70 to 0.80)	High (0.81 to 1.0)
Western Region				
1990-91			Agra, Badaun, Bareilly, Bijnor, Mainpuri, Mathura, Meerut, Muzaffarnagar, Pilibhit, Rampur, Shahjahanpur	Aligarh, Bulandshahar, Etah, Etawah, Farrukhabad, Firozabad, Ghaziabad, Moradabad, Saharanpur
2000-01		Pilibhit, Shahjahanpur	Agra, Aligarh, Badaun, Bareilly, Bijnor, Etawah, Firozabad, Mainpuri, Mathura, Meerut, Moradabad, Muzaffarnagar, Rampur, Amroha*, Auraiya*, Bagpat*, G.B. Nagar*, Hathras*	Bulandshahar, Etah, Farrukhabad, Ghaziabad, Saharanpur, Kannauj*
2010-11		Bijnor, Pilibhit, Rampur	Agra, Aligarh, Badaun, Bareilly, Etah, Etawah, Firozabad, Mainpuri, Mathura, Meerut, Moradabad, Muzaffarnagar, Saharanpur, Shahjahanpur, Amroha*, Auraiya*, Bagpat*, G.B.Nagar*, Hathras*, Kannauj*, Kasganj**	Bulandshahar, Farrukhabad, Ghaziabad

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	Very Low (0 to 0.59)	Low (0.60 to 0.69)	Moderate (0.70 to 0.80)	High (0.81 to 1.0)
2020-21		Bijnor, Muzaffarnagar, Rampur	Agra, Aligarh, Badaun, Bareilly, Etah, Etawah, Ghaziabad, Mainpu- ri, Mathura, Meerut, Moradabad, Pilibhit, Shahjahanpur, Amroha*, Auraiya*, Bagpat*, G.B.Nagar*, Shamli***	Bulandshahar, Far- rukhabad, Firozabad, Saharanpur, Hathras*, Kannauj*, Kasganj**, Sambhal***, Ha- pur***
Central Region				
1990-91			Barabanki, Hardoi, Kanpur Nagar, Kheri, Lucknow, Rae- Bareilly, Unnao	Fatehpur, Kanpur Dehat, Sitapur
2000-01			Barabanki, Fatehpur, Hardoi, Kheri, Lucknow, Rae- Bareilly, Sitapur, Unnao	Kanpur Dehat, Kanpur Nagar
2010-11			Barabanki, Fatehpur, Hardoi, Kanpur Dehat, Kheri, Lucknow, Rae- Bareil- ly, Sitapur, Unnao	Kanpur Nagar
2020-21			Barabanki, Fatehpur, Hardoi, Kanpur Nagar, Kheri, Lucknow, Rae- Bareil- ly, Sitapur, Unnao	Kanpur Dehat
Eastern Region				
1990-91		Azamgarh, Basti, Gorakhpur, Ma- harajganj, Mau, Sidharthnagar	Allahabad, Bahraich, Ballia, Deoria, Faizabad, Ghazipur, Gonda, Jaunpur, Mirzapur, Pratapgarh, Sultanpur, Varanasi	Sonbhadra
2000-01		Azamgarh, Deoria, Gorakhpur, Ma- harajganj, Mau, Sidharthnagar, Ambedkar Nagar*, Chandauli*, Sant Kabir Nagar*	Allahabad, Bahraich, Ballia, Basti, Faizabad, Ghazipur, Gonda, Jaunpur, Mirzapur, Pratapgarh, Sultanpur, Varanasi, Balrampur*, Kushinagar*, Sant Ravidas Nagar*, Shrivasti*	Sonbhadra, Kushambi*
2010-11	Sidharthnagar, Gorakhpur	Azamgarh, Basti, Deoria, Ghazipur, Maharajganj, Mau, Pratapgarh, Ambedkar Nagar*, Chandauli*, Sant Kabir Nagar*, Sant Ravidas Nagar*, Amethi**	Allahabad, Bahraich, Ballia, Faiz- abad, Gonda, Jaunpur, Mirzapur, Sultanpur, Varanasi, Balrampur*, Kushambi*, Kushinagar*, Shrivasti*	Sonbhadra

	Very Low (0 to 0.59)	Low (0.60 to 0.69)	Moderate (0.70 to 0.80)	High (0.81 to 1.0)
2020-21	Mau, Chandauli*, Sant Kabir Nagar*, Amethi**	Azamgarh, Deoria, Ghazipur, Gorakh- pur, Maharajganj, Sidharthnagar, Ambedkar Nagar*, Sant Ravidas Nagar*	Allahabad, Bahraich, Ballia, Basti, Faizabad, Gonda, Jaunpur, Pratap- garh, Sultanpur, Varanasi, Kusham- bi*, Kushinagar*, Shravasti*	Mirzapur, Sonbhadra, Balrampur*
Bundelkhand Region				
1990-91			Banda, Hamirpur, Jalaun, Jhansi	Lalitpur
2000-01			Banda, Hamirpur, Jalaun, Jhansi, Lalitpur, Mahoba*	Chitrakoot*
2010-11		Lalitpur	Banda, Jalaun, Jhansi, Mahoba*	Hamirpur, Chitrakoot*
2020-21		Lalitpur	Jhansi	Banda, Hamirpur, Jalaun, Chitrakoot*, Mahoba*

Source: Author's calculations

Note: Districts bifurcated after 1994*, 2008, 2011*****

In the eastern region of Uttar Pradesh, the pattern of crop diversification differs from that of other regions. While no district in other regions of Uttar Pradesh falls into the very low category of crop diversification, this is not the case in eastern Uttar Pradesh. The majority of districts of eastern region have a moderate and low level of diversification. Only the Sonbhadra district consistently maintained high levels of diversification during the study period. The districts Mirzapur and Balrampur joined it during 2020-21. The Allahabad, Bahraich, Ballia, Faizabad, Gonda, Jaunpur, Sultanpur, and Varanasi remained in the moderate category of diversification, together with newly constituted districts Kushinagar and Shravasti. In contrast, Azamgarh, Maharajganj, and Ambedkar Nagar remained at a low level of diversification. Other districts, such as Deoria, Ghazipur, Pratapgarh, Basti, and Sant Ravidas Nagar, varied between moderate and low categories, whereas Gorakhpur, Mau, Sidharthnagar, Chandauli, Sant Kabir Nagar, and Amethi fluctuated between low and very low categories. Overall, we can infer that crop diversification is lowest and declining in eastern Uttar Pradesh during the study period.

3.3 Determinants of Crop Diversification

To determine the district-level factors influencing crop diversification from 1990-91 to 2020-21, we employed the fixed effect model. The findings of the fixed effect model are shown

in Table 3. We have measured the diversification by the Simpson's Index. Using the four alternative models, factors that are statistically insignificant have been omitted one by one.

The results of Model 1 show that GIA, RD, RF, and POP have a negative and significant impact on crop diversification which means if farmers have better access to irrigation and road facilities along with high rainfall and rising population, crop diversification will decline in Uttar Pradesh. The CI and FC are negative; however, they are insignificant in the model. While MD is strongly positive and significant, which means better market networks induce diversification in the state. In Model 2, we have included the regional dummies WR, CR, and ER representing the western, central, and eastern regions, respectively, to capture the regional effect on crop diversification. The results of Model 2 show that the coefficient of the district dummy, WR and CR have positive and significant impacts on diversification. Whereas, ER has shown significant negative results exhibiting diversification against high-value crops. These results substantiate the argument of regional effect in diversification. In Model 3, we have dropped the variable CI since it is insignificant in both Models 1 and 2. Similarly, in Model 4, the variables MD and CI are dropped because both are insignificant in the previous models.

Table 3 : Panel Data Regression Results by Fixed Effect Model

Variable	Model1	Model2	Model3	Model4
GIA	-0.00051***	-0.00154***	-0.00157***	-0.00157***
CIN	-0.00004	-0.0001		
FCN	-0.00003	-0.00006*	-0.00006	-0.00006*
RD	-0.00233***	0.00225***	0.00223***	0.00218***
MD	1.05410***	-0.12861	-0.07258	
RF	-0.00004***	-0.00003***	-0.00003***	-0.00003***
POP	-0.00000***	-0.00000*	-0.00000*	-0.00000*
WR		0.05537***	0.05306***	0.05290***
CR		0.03414***	0.03246***	0.03244***
ER		-0.03420***	-0.03616***	-0.03571***
CONS	0.84407***	0.89177***	0.87916***	0.87745***
N	1426	1426	1426	1426
R ²	0.17698	0.41725	0.41687	0.41676
χ^2	350.00	1600.00	1600.00	1600.00
P-Value	0.00000	0.00000	0.00000	0.00000

Source: Author's calculations

4. Conclusion and Policy Implications

The study shows that conventional foodgrain crops are being replaced by high-value crops in the state. However, this change is not relatively dispersed among the districts and regions of Uttar Pradesh. The western region displayed the highest level of crop diversification till 2012-13, followed by the Bundelkhand and central regions. From 2013-14, however, the western region was replaced by the Bundelkhand region and recorded the highest levels of diversification in the state. Meanwhile, the eastern region consistently showed the lowest degree of crop diversification over the study period. Overall, agricultural diversification has decreased in all regions of Uttar Pradesh except for the Bundelkhand region from 1990-91 to 2020-21. The extent of crop diversification across districts shows that the majority of districts of western and central regions fall under the moderate (0.70 to 0.80) category, while the eastern region under the low (0.60 to 0.69) category and Bundelkhand's region under high (0.81 to 1.0) category of crop diversification. The results of the fixed effect model reveal that gross irrigated area, fertilizer consumption, rainfall, and population have a negative impact on diversification, thus, leading to less diversification. On the other hand, road density is strongly positive, which means better road networks induce diversification in the state.

Some of the important policy suggestions can be given are as follows:

1. Contrary to cereals, high-value non-food crops need a particular set of infrastructures because they are perishable. In order to minimize losses, high-value crops should be delivered to consumers in a short time. This is impossible without well-maintained roadways. Road connectivity becomes crucial for crop diversification in order to focus on high-value crops since it enables greater market penetration. The government should therefore prioritize improving road networks in order to speed up agricultural diversification.
2. In addition to roads, to increase the life of perishable high value crops is cold storage. Thus, establishing cold storage may reduce post-harvest losses of perishable non-food commodities like vegetables, fruits, and flowers. Therefore, the government needs to put effort into this direction also.
3. The Bundelkhand region's sparse rainfall hampers irrigation development. Therefore, in order to effectively manage water resources, we must focus on increasing water usage efficiency in the drier areas by using water-saving micro irrigation devices and techniques.

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Appendix

Table A1 : Crop Diversification in Districts of Western Region

Districts	Simpson Diversity Index			
	1990-91	2000-01	2010-11	2020-21
Agra	0.793	0.785	0.783	0.791
Aligarh	0.835	0.782	0.775	0.792
Badaun	0.794	0.744	0.729	0.708
Bareilly	0.790	0.734	0.733	0.737
Bijnor	0.762	0.696	0.665	0.640
Bulandshahar	0.812	0.821	0.813	0.812
Etah	0.832	0.812	0.763	0.790
Etawah	0.836	0.790	0.773	0.801
Farrukhabad	0.838	0.831	0.821	0.831
Firozabad	0.826	0.782	0.794	0.811
Ghaziabad	0.845	0.822	0.809	0.793
Mainpuri	0.793	0.746	0.731	0.730
Mathura	0.792	0.726	0.722	0.738
Meerut	0.798	0.775	0.748	0.753
Moradabad	0.809	0.782	0.790	0.738
Muzaffarnagar	0.769	0.731	0.703	0.652
Pilibhit	0.704	0.668	0.660	0.717
Rampur	0.765	0.701	0.687	0.678
Saharanpur	0.821	0.811	0.798	0.816
Shahjahanpur	0.757	0.689	0.702	0.701
Amroha J.B.Fulenagar*	NA	0.799	0.779	0.800
Auraiya*	NA	0.773	0.750	0.764
Bagpat*	NA	0.757	0.724	0.721
G.B.Nagar*	NA	0.758	0.703	0.774
Hathras*	NA	0.777	0.798	0.828
Kannauj*	NA	0.809	0.796	0.823
Kasganj Khansi Ram Nagar**	NA	NA	0.797	0.821
Hapur***	NA	NA	NA	0.824
Sambhal***	NA	NA	NA	0.806
Shamli***	NA	NA	NA	0.752

Source: Author's calculations

Table A2 : Crop Diversification in Districts of Eastern Region

Districts	Simpson Diversity Index			
	1990-91	2000-01	2010-11	2020-21
Allahabad	0.775	0.726	0.698	0.721
Azamgarh	0.691	0.641	0.615	0.610
Bahraich	0.774	0.793	0.758	0.777
Ballia	0.77	0.728	0.718	0.722
Basti	0.673	0.698	0.683	0.734
Deoria	0.711	0.648	0.596	0.615
Faizabad	0.701	0.716	0.706	0.730
Ghazipur	0.743	0.722	0.686	0.689
Gonda	0.751	0.768	0.768	0.756
Gorakhpur	0.662	0.620	0.587	0.616
Jaunpur	0.748	0.73	0.695	0.697
Maharajganj	0.660	0.633	0.610	0.625
Mau	0.659	0.625	0.598	0.579
Mirzapur	0.786	0.745	0.739	0.816
Pratapgarh	0.734	0.709	0.655	0.701
Sidharthnagar	0.632	0.605	0.563	0.606
Sonbhadra	0.870	0.830	0.851	0.913
Sultanpur	0.730	0.727	0.733	0.723
Varanasi	0.740	0.751	0.711	0.722
Kushi Nagar Padrauna*	NA	0.720	0.718	0.713
Santh Ravi Das Nagar Bhadoi*	NA	0.709	0.675	0.672
Ambedkar Nagar*	NA	0.655	0.651	0.667
Balrampur*	NA	0.760	0.769	0.808
Chandauli*	NA	0.637	0.619	0.581
Kushambi*	NA	0.810	0.760	0.794
Santh Kabir Nagar*	NA	0.624	0.615	0.588
Shravasti*	NA	0.753	0.707	0.715
Amethi C.S.M.Nagar**	NA	NA	0.661	0.570

Source: Author's calculations

Table A3 : Crop Diversification in Districts of Central Region

Districts	Simpson Diversity Index			
	1990-91	2000-01	2010-11	2020-21
Barabanki	0.758	0.77	0.753	0.779
Fatehpur	0.815	0.801	0.782	0.775
Hardoi	0.794	0.746	0.697	0.72
Kanpur Dehat	0.856	0.815	0.790	0.812
Kanpur Nagar	0.795	0.842	0.810	0.805
Kheri	0.797	0.768	0.753	0.734
Lucknow	0.771	0.761	0.776	0.77
Rae - Bareilly	0.721	0.711	0.695	0.761
Sitapur	0.821	0.792	0.787	0.789
Unnao	0.774	0.722	0.709	0.720

Source: Author's calculations

Table A4 : Crop Diversification in Districts of Bundelkhand Region

Districts	Simpson Diversity Index			
	1990-91	2000-01	2010-11	2020-21
Banda	0.799	0.799	0.794	0.873
Hamirpur	0.794	0.781	0.810	0.822
Jalaun	0.781	0.775	0.785	0.818
Jhansi	0.797	0.748	0.768	0.788
Lalitpur	0.823	0.758	0.681	0.692
Mahoba*	NA	0.762	0.765	0.812
Chitrakoot*	NA	0.831	0.828	0.847

Source: Author's calculations

Drivers of Capability Expansion among Left-behind Women: A Study on Malappuram District, Kerala

Shibinu. S¹, Sabira.A² and Abdul Rasheed. M³

Abstract

Migration has been a significant driving force behind the progress and achievements of humanity throughout history. When male family members migrate, the women left behind, particularly wives are compelled to assume new responsibilities and roles, enabling them to expand their capabilities. After detailing the methodology for measuring the capabilities of left-behind women in the context of male migration by identifying relevant capabilities, this study assesses the factors contributing to the capability expansion of left-behind Muslim women. The analysis is based on primary data collected from the Malappuram district of Kerala. Eight factors with 36 sub-dimensions were identified through a review of previous studies and survey experiences of the pilot study. To analyse the principal factors contributing to the capability expansion of the left-behind Muslim women in the study area, Exploratory Factor Analysis with Principal Component Analysis was used. The findings reveal that migration, foreign remittances, and the availability of banking and transport facilities have the highest factor loadings (>0.8), indicating they are the most influential factors in expanding the capabilities of left-behind Muslim women in the study area.

Keywords: *Emigration, Capability, Malappuram, Left-behind, Muslim, Women*

1. Introduction

The propensity for global connections provides people with opportunities to improve their quality of life. People often migrate in pursuit of employment, housing and business opportunities. Remittances sent by migrants to support their families are a significant source of income for many migrant households in developing nations. These remittances have an immediate and substantial impact on the standard of living of the recipient households, as they are often used to meet necessities like healthcare and education or to invest in enhancing

¹ Associate Professor, Department of Economics, PSMO College, Tirurangadi, Kerala 676306, India. Mail: shibinusbs@gmail.com. Mob +91 9495678449

² Assistant Professor, Department of Economics, Govt. College, Malappuram. Mail: sabiraarakkal@yahoo.com

³ Research Scholar, Department of Economics, EMEA College of Arts and Science, Kondotty, Kerala 673638, India. Mail: abdulrasheedibnu@gmail.com

human capital (Shibinu, 2017). Malappuram district in Kerala is distinguished for sending the largest number of emigrants and receiving the largest amount of foreign remittances in the state (Rajan & Zachariah, 2018). Male migration has brought both unique opportunities and challenges for the left-behind Muslim women in Malappuram, whose socio-cultural background is frequently shaped by patriarchal norms. In addition to increasing household incomes, remittances influence women's access to healthcare, education, decision-making roles and employment opportunities. Applying the Capability Approach to migration research offers great potential for understanding the challenges and opportunities faced by migrant families and the left-behind spouses of male migrants. (Sabrina, 2016). This approach focuses on enhancing the capabilities of people and their real opportunities to achieve desired states of being and doing. For left-behind women, empowerment in such contexts extends beyond financial gains to include social, psychological and political dimensions that are reshaped by their evolving roles and responsibilities. By examining these factors, this study aims to identify the key factors contributing to the capability expansion of left-behind women in the study area.

2. Review of Literature

Research on migration in Kerala shows that Malappuram district plays a central role among the state's districts due to its high emigration rates and significant impact on both the local economy and the social fabric. According to the Kerala Migration Survey 2018, Malappuram has the highest number of emigrants with approximately one-fifth of the population of the district living abroad. Likewise, among the fourteen districts, Malappuram receives the highest remittances, which significantly impacts the socio-economic dynamics of the region. (Zachariah & Rajan, 2018).

Research applying the Capability Approach to migration scenarios emphasises the challenge of selecting relevant capabilities of left-behind women in context-specific situations. Amartya Sen argues that the selection of fundamental capabilities should emerge through a process of public deliberation and he was cautious about proposing a universal list of capabilities (Sen, 1999a; 1999b; 2009). However, he also mentioned that different lists are used for different purposes, based on social values and concerns (Sen, 1990; 2004). Complementing this, Nussbaum (2011) proposed a broad and globally applicable set of ten central human capabilities that an ideal political system should ensure for all citizens.

Studies investigating the effects of migration on left-behind women reveal several positive outcomes, including enhanced decision-making power, better resource management, increased mobility and improved access to education and healthcare (Chapagain, 2015; Hena

&Jahan, 2021). The migration of husbands leads to significant shifts in the lives of left-behind wives, while it increases their responsibilities in managing finances and family affairs (Gulati, 1993). At the same time, it fosters greater autonomy and enhances their decision-making abilities. (Desai & Banerji, 2008; Hadi, 2001; Zachariah & Rajan, 2018a). Using the three-dimensional analytical framework of resources, agency and achievements, Stephanie (2011) assessed the impact of male migration on the strategic decision-making capabilities of women and found that migration and remittances significantly influence various aspects of the lives of left-behind women.

Hassan & Jebin (2019) explored the situation of left-behind women across four dimensions: decision-making involvement, mobility autonomy, reproductive choices and experiences of domestic violence. They found that these women often have greater control over financial decisions, increased mobility, and less domestic abuse compared to their peers. Similarly, studies have shown that male migration positively correlates with the socioeconomic status of left-behind women. Hadi (2001) identified a strong link between male migration and the decision-making abilities of women, influenced by their socio-economic and personal characteristics. Chapagain (2015) highlighted how male migration enhances the identity, agency and capabilities of left-behind women by granting them greater access to financial and non-financial resources, social networks and opportunities for personal and social growth. Robeyns (2003) examined how gender disparities in Western nations could be understood and evaluated using Sen's capability framework. She developed a list of capabilities, outlined five criteria and advocated for a procedural approach to selecting capabilities. The resource disparities that lead to gender differences in functioning and competence must be identified and mapped to comprehensively analyse gender inequality.

Despite these insights, few studies interlink migration and the capability approach in Kerala. Kathryn (2021) investigated how male migration to gulf countries created opportunities for women in Kerala to enhance their capabilities, enabling them to take on new roles and address migration-related challenges. However, there remains a dearth of empirical studies specifically analysing the effect of male migration on the capabilities and opportunities of left-behind women using Sen's capability approach.

Male migration for work has been a common phenomenon in Kerala. Among the districts of Kerala, Malappuram district has the distinction of sending out the largest number of emigrants. When low-educated or low-skilled male migrants from the district migrate, they leave their families behind in their place of origin. The absence of male family members often compels left-behind women, especially wives, to take on new responsibilities, such as decision-making, managing finances and engaging with public life tasks that were previously

unfamiliar to them. As a result, the traditional gender roles and obligations of left-behind women within families are rearranged and this change is especially noteworthy among Muslim households in Malappuram district.

However, this transformation is not uniform or guaranteed. It is shaped by a range of factors, including socio-economic and political conditions, family structures, access to education and healthcare and the role of technology. Notably, no studies have explored the direct impact of male migration on the capability expansion of left-behind Muslim women in the Malappuram district, nor have they identified the factors contributing to their capabilities. This study fills this gap in the existing literature by analyzing the key factors that contribute to the capability expansion of left-behind Muslim women in the unique socio-cultural context of Malappuram district.

3. Methodology

This study relies on both primary and secondary data. Primary data were collected through a field survey using a structured questionnaire from a sample of 423 left-behind Muslim women in the Malappuram district. The sample size was determined based on the Kerala Migration Survey 2018. Primary data were collected from selected panchayaths and municipalities in six taluks of the Malappuram district. A stratified multi-stage sampling technique based on the 2011 census was used to select the sample.

The taluks in the Malappuram district were categorised into two strata- urban and rural. This resulted in a total of 12 strata with 6 urban strata and 6 rural strata in 6 taluks. From each taluk 1 or 2 rural strata of grama panchayaths and one urban strata of municipality were selected at random. From the selected panchayaths and municipalities, one ward or division was selected at random. From the selected ward of the panchayaths and the divisions of municipalities, the researcher identified the Muslim migrant households with the help of elected ward members based on the electoral roll. Accordingly, from each taluk, the required number of samples were collected. Secondary data for the study were obtained from Indian Migration Reports, Kerala Migration Surveys, Census Reports, Centre for Development Studies Working Papers and other relevant publications.

The study offers a broad and multidimensional framework for estimating the capability of women by selecting the relevant capabilities of left-behind Muslim women based on reviews of previous studies and pilot study experiences. Accordingly, six indices with their respective indicators are measured. The first is the Quality of Living Capability (QoLC), which includes indicators such as access to adequate nutritious food, suitable accommodation, the ability to manage money, allocate time freely and engage in recreational activities. The second

is the Education and Information Capability (EIC), which focuses on the ability to make informed decisions, use the internet and social media, pursue desired education and secure a good job. The third index is the Decision-making Capability (DMC), which involves the ability to make decisions regarding personal and family health, education of children, visiting friends and family and choices related to food habits and dress style. The fourth index is the Control over Household Resources Capability (CoHRC), which consists of the ability to manage the husband's income, purchase daily necessities, buy major household goods and manage the family property. The fifth is the Mobility Freedom Capability (MC), which includes indicators such as the ability to visit hospitals or clinics, access banking services, participate in social events and festivals and visit public offices. Finally, the sixth index is the Participation Capability (PC), which assesses the ability to engage in social and religious organisations, local politics, business activities and household management (See Table 1).

Table 1 : Reliability of Women's Capability Dimensions

Capability Dimensions	Cronbach's alpha (α)
QoLC	0.891
EIC	0.703
DMC	0.847
CoHRC	0.706
MC	0.633
PC	0.812

Source: Primary survey

Table 1 indicates Cronbach's alpha (α) tested for indicators of all the dimensions of women's capabilities to measure internal consistency and reliability. The results indicate that the Quality of Living Capability (QoLC), Decision-Making Capability (DMC) and Participation Capability (PC) have Cronbach's alpha values of 0.891, 0.847, and 0.812, respectively, signifying excellent internal consistency ($\alpha > 0.8$). The Education and Information Capability (EIC) and Control over Household Resources Capability (CoHRC) also have high Cronbach's alpha (α) with 0.706 and 0.703 respectively ($\alpha > 0.7$). The sub-dimensions of Mobility Freedom Capability (MC) have a moderate Cronbach's alpha (α) with 0.633 having acceptable internal consistency. Hence the data for measuring women's capabilities is reliable.

The theoretical background of this study is Amartya Sen's Capability Approach. The extent to which people are free to pursue valuable activities or functions is referred to as capability

(Sen, 1992). According to Sen (1988), capabilities are the set of opportunities that a person can utilise to transform their abilities into real functioning. Functioning is the desirable actions and settings that make up the well-being of people, like having a rewarding job, being safe, being able to interact with family and friends and being well. Sen (1992) observed that the capability approach is related to various aspects of lives, such as people's health, the education they can enjoy and the support they can enjoy from their social networks. It is also associated with what people can do, such as being able to do work, raising a family, traveling, or being politically active. Hence, Sen's Capability Approach is applied to analyse how left-behind Muslim women in the Malappuram district utilise the opportunities arising from the absence of their husbands and manage the resulting situation.

The fundamental aim of this study is to assess the factors contributing to the capability expansion of left-behind Muslim women in the Malappuram district. Accordingly, nine factors with 40 sub-dimensions were identified and the reliability of these factors was tested using Cronbach's Alpha method. Exploratory factor analysis with principal component analysis was employed to analyse and reduce the number of variables, highlighting the principal components.

4. Results and Discussion

The factors contributing to the capability expansion of left-behind Muslim women were identified based on the research context, research reviews and pilot survey experiences. Accordingly, nine factors were identified which include health conditions, education conditions, availability of social infrastructure, political and religious conditions, possession of consumer durables, conversion factors, financial stability, living arrangements and migration of husbands and supports. Considering the reviews of previous literature and research environment, the sub-dimensions of each factor were identified and the number of sub-dimensions ranges from 2 to 8. The responses on health, education, availability of social infrastructure, technological factors, political and religious conditions and the migration of husbands and supports are recorded on a Likert scale with ordinal responses. The responses on conversion factors include three responses such as good, moderate and poor. The responses on property ownership include four categories such as own, jointly with husband, jointly with other members of the household and no property.

Cronbach's alpha was tested to ensure the reliability of the data. The factors of husbands' migration and support have the highest Cronbach's alpha with 0.870 and the availability of social infrastructure and possession of consumer durables also have high Cronbach's alpha ($\alpha > 0.8$). The variables of health conditions, education conditions, conversion factors and

political and religious factors also have high Cronbach's alpha ($\alpha > 0.7$). However, the sub-dimensions of financial stability have a very low Cronbach's alpha of $\alpha = 0.03$. Hence, the factor is less reliable and it was not considered for further analysis. With a Cronbach's alpha of 0.583, the living arrangement factor showed moderate internal consistency and was retained for further analysis. Therefore, eight factors with 36 sub-dimensions were selected for Exploratory Factor Analysis.

4.1 Principal Factors Contributing to the Capability Expansion of Left-behind Muslim Women: Exploratory Factor Analysis

An Exploratory Factor Analysis was performed using a Principal Component Analysis and Varimax rotation to determine the strength of the correlation between factors contributing to the capability of left-behind women. The minimum factor loading criteria was set to 0.50. The commonality of the scale, which indicates the extent of variance in each dimension was also assessed. Table 2 represents component loadings from a factor analysis. Component loadings represent the correlation between the variables and the components extracted from the data. The data shows that all commonalities were over 0.50. Though Principal Component Analysis does not consider the outcome variable, it considers the variance of the independent variables. Out of the eight factors and 36 sub-dimensions Exploratory Factor Analysis identified seven components with 25 factors (See Table 2).

Table 2 : Component Loadings

S No.	Factors	Components						
		1	2	3	4	5	6	7
1	Increased Responsibility	0.897						
2	Self-reliance and Autonomy	0.865						
3	Household Management	0.837						
4	Financial Status and Freedom	0.821						
5	Mobility Decisions	0.779						
6	Banking		0.832					
7	Transport and Communication System		0.816					
8	Public Education		0.745					
9	Recreation facilities		0.739					
10	Public Health		0.681					

S No.	Factors	Components						
		1	2	3	4	5	6	7
11	Education Level			0.748				
12	Pursuance of Higher Education after Marriage			0.689				
13	Financial Level				0.741			
14	Health Condition				0.694			
15	Occupation				0.677			
16	Living Situation				0.616			
17	Mobile Phone					0.735		
18	AC					0.636		
19	Washing Machine					0.688		
20	LPG/Electric Stove					0.671		
21	Administrative Post						0.726	
22	Contest Election						0.656	
23	Practice Religion without restraints						0.613	
24	Health Check-up							0.721
25	Proper treatment when sick							0.717

Source: Primary Survey

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalisation

Table 2 presents the component loadings from the factor analysis. In the factor analysis, component loadings represent the correlations between the variables and the factors extracted from the data. Higher loadings indicate a stronger relationship between the variables and the factors. Factor 1 denotes migration of husbands and foreign remittances, including increased responsibility, self-reliance and autonomy, household management and financial status and freedom and mobility decisions. Factor 2 includes the availability of social infrastructure such as banking, transport and public education, recreation facilities and public health. Factor 3 includes education conditions such as education level and pursuance of higher education after marriage.

Factor 4 includes conversion factors such as financial level, health condition, occupation and living situation. Possession of consumer durables such as mobile phones, ACs, washing

machines and LPG/electric stoves are included in the fifth factor. The sixth factor includes political and religious conditions such as holding administrative posts, contesting elections and practicing religion without restraints. The seventh factor is health conditions which includes proper treatment when sick and frequent health check-ups. The factors such as increased responsibility with a factor loading of 0.897, self-reliance and autonomy with a factor loading of 0.865, household management with a factor loading of 0.837 and financial status and freedom with a factor loading of 0.821, banking with a factor loading of 0.832, transport and communication system with a factor loading of 0.816 have strong factor loadings. These results indicate that these factors are the major factors (factor loading >0.800) determining the dependent variable in the study area.

Table 2 also indicates that the mobility decisions with a factor loading of 0.779, public education with a factor loading of 0.745, recreation facilities with a factor loading of 0.739, education level with a factor loading of 0.748, financial level with a factor loading of 0.741, mobile phone with a factor loading of 0.735, holding administrative post with a factor loading of 0.726, proper treatment when sick with a factor loading of 0.721 and frequent health check-up with a factor loading of 0.717. These results also show strong factor loadings (factor loading > 0.700), indicating that these factors are also important elements determining the outcome factor. Table 2 further demonstrates that public health, health condition, pursuance of higher education after marriage, living situation, AC, washing machine and LPG / electric stove also have notable factor loadings, suggesting that they are also the chief determinants of the outcome variable.

The analysis revealed that several factors including the political condition for free and fair elections, possession of consumer durables such as the possession of scooters, motor cars, computers and refrigerators, as well as the conversion factors of education level and health conditions did not load in the factor pattern matrix. Consequently, eleven items were removed from further analysis, indicating that these factors lack a significant correlation with the extracted factors. Additionally, factors related to living arrangements, such as family type and relationships with in-law parents also demonstrated no significant correlation.

4.2. KMO and Bartlett's Test for Sample Adequacy

The KMO and Bartlett's are instrumented to find evidence of the relationship among all variables supposed to be investigated. These two tests have provided the standards that must be accepted before carrying out a factor or principal component analysis. Bartlett's Test of Sphericity is used to weigh the overall significance of the correlation matrix, which provides a measure of the statistical probability that the correlation matrix has significant correlations

among some of its components. The results of the KMO (Kaiser-Meyer-Olkin) measure of sampling adequacy and Bartlett's test of sphericity indicate that the data set is suitable for Principal Component Analysis (See Table 3).

Table 3 : KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.832	
Bartlett's Test of Sphericity	Approx. Chi-Square	6140.070
	d.f.	378
	Sig.	<0.001

Source: Primary Survey

The KMO with higher values (0.832) indicates better suitability for factor analysis. A value of 0.832 suggests that the variables have a high degree of correlation, which is favourable for factor analysis. Bartlett's test of sphericity assesses whether the correlation matrix is an identity matrix. The chi-square value of 6140.070 with 378 degrees of freedom and a significance value of $p < 0.001$ indicate that the correlation matrix is significantly different from an identity matrix, supporting the presence of correlations among variables and justifying the use of factor analysis.

Table 4 displays the results of the factor analysis. The initial Eigenvalues represent the total variance explained by each factor before extraction. The factors having Eigenvalues over 1 are major components. The percentage of variance explained by each component is calculated based on the extraction sums of squared loadings. Higher Eigenvalues indicate that the factor explains more variance in the data. Accordingly, 7 components are retained having an Eigenvalue greater than 1. These components account for 67.1 percent of the total variance in the data. The cumulative percentage of variance shows the total variance explained by the components up to a certain point.

Table 4 : Results of Factor Analysis

S No.	Factors	Eigenvalue	Difference	Percent of Variance	Cumulative Percentage
1	Increased Responsibility	6.892	3.801	23.797	23.8
2	Self-reliance and Autonomy	3.091	0.928	10.853	34.6
3	Household Management	2.163	0.264	9.881	44.5
4	Financial Status and Freedom	1.899	0.527	7.245	51.8
5	Mobility Decisions	1.372	0.183	6.083	57.9
6	Banking	1.189	0.066	5.006	62.9
7	Transport and Communication System	1.123	0.128	4.246	67.1
8	Public Education	0.965	0.158	3.86	71.0
9	Recreation Facilities	0.948	0.017	3.791	74.8
10	Public Health	0.767	0.181	3.068	77.8
11	Education Level	0.765	0.102	2.66	80.5
12	Pursuance of Higher education after Marriage	0.638	0.027	2.551	83
13	Financial Level	0.622	0.016	2.488	85.5
14	Health Condition	0.531	0.091	2.126	87.7
15	Occupation	0.481	0.05	1.925	89.6
16	Living Situation	0.429	0.052	1.716	91.3
17	Mobile Phone	0.356	0.073	1.426	92.7
18	AC	0.334	0.022	1.337	94.1
19	Washing Machine	0.304	0.03	1.218	95.3
20	LPG/Electric Stove	0.282	0.022	1.128	96.4
21	Administrative Post	0.268	0.014	1.07	97.5
22	Contest Election	0.231	0.037	0.923	98.4
23	Practice Religion without restraints	0.202	0.004	0.807	99.2
24	Health Check-up	0.198	0.07	0.793	99.5
25	Proper treatment when sick	0.128		0.429	100

Source: Primary Survey

Table 4 shows that increased responsibility of women (Eigenvalue = 6.892), self-reliance and autonomy (3.091), household management (2.163), financial status and freedom (1.899) and mobility decision (1.372) are key factors. These factors account for 51.8 percent of the variance, indicating that the migration of husbands and the utilisation of the opportunities it creates are significant and influential in determining the outcome of women's capability.

Table 4 further shows that the husbands' migration and remittances and the availability of social infrastructure together account for 77.8 percent of the total variance. With the decrease in the Eigen values for other factors the relative value of variance explained by the factor is also decreasing. The difference reflects the gap in Eigenvalues between successive factors, indicating the amount of variation each new factor contributes to the overall model. The biggest difference is between the first and second factors signifying the first factor of increased responsibility accounts for 3.801, a large amount of variation, the second factor of self-reliance and autonomy accounts for 0.928 and the fourth-factor accounts for 0.527 variations in eigenvalue.

The percent of variance shows the percentage of the total variance explained by each factor. The increased responsibility accounts for 23.8 percent of the variance showing that the largest proportion of total variance is explained by this factor, while self-reliance and autonomy account for 10.85 percent and the variance explained by the succeeding factors is decreasing. The lowest proportion of the variance is explained by the proper treatment when sick (0.43 percent).

Cumulative Percentage is the running total of the variance explained by the factors. The first five factors together explain 57.9 percent of the variance, indicating that they contribute significantly to the overall data structure. The first eleven factors together explain 80.5 percent of the variance and 16 factors together explain 91.3 percent out of 25 factors. To conclude, the most significant factors contributing to the capability of left-behind women are increased responsibility, self-reliance, autonomy and household management. Other factors, like mobility decisions and public education, also play a role, but with decreasing significance as reflected in their lower Eigenvalues and percentages.

4.3. Component Score Coefficient Matrix

Component Score Coefficient Matrix showing the coefficients or loadings of each factor on the principal components extracted during Principal Component Analysis is given in Table 5. The table lists the principal components numbered 1 to 7, which correspond to the factors with Eigenvalues greater than 1. Each value in the matrix represents the strength and direction of the relationship between a factor and the principal component. The factor

increased responsibility has a high loading (0.424) on component 1 and component 6 with a factor loading of 0.433, suggesting that it contributes significantly to the variance explained by components 1 and 6. Similarly, self-reliance and autonomy have a relatively strong loading on Component 1 with a factor loading of 0.128, Component 2 with a factor loading of 0.133, Component 4 with a factor loading of 0.133, Component 5 with a factor loading of 0.112 and Component 6 with a factor loading of 0.207. It indicates a strong relationship with these components and an inverse relation with component 7 with a factor loading of -0.22. Monthly Remittances with a factor loading of 0.279, banking with a factor loading of 0.273, transport with a factor loading of 0.249, public education with a factor loading of 0.245 and recreation facilities with a factor loading of 0.219 have a relatively high loading on component 1, indicating a strong positive relationship. All the indicators of possession of consumer durables have notable negative loading on component 1, suggesting a strong inverse relationship with the component.

Table 5 : Component Score Coefficient Matrix

S No.	Factors	Components						
		1	2	3	4	5	6	7
1	Increased Responsibility	0.424	0.053	0.011	0.017	0.028	0.433	0.097
2	Self-reliance and Autonomy	0.128	0.133	0.009	0.133	0.112	0.207	-0.22
3	Household Management	0.037	0.065	0.045	-0.036	0.474	0.013	0.039
4	Financial status and Freedom	0.019	0.007	0.087	0.034	0.493	0.015	-0.072
5	Mobility Decisions	0.279	0.026	0.052	0.006	-0.11	-0.148	-0.167
6	Banking	0.273	0.092	-0.005	-0.033	0.034	0.08	-0.028
7	Transport and Communication System	0.249	-0.081	-0.036	0.044	0.022	0.003	-0.159
8	Public Education	0.245	-0.029	0.011	-0.079	-0.161	-0.043	0.052
9	Recreation facilities	0.219	0.114	-0.019	0.012	0.112	0.075	0.128
10	Public Health	0.012	0.335	0.068	0.038	-0.055	0.043	0.035
11	Education Level	-0.061	0.381	0.02	0.181	0.192	0.114	-0.112
12	Pursuance of Higher education after Marriage	0.098	0.292	-0.034	-0.042	-0.029	-0.096	0.009
13	Financial Level	0.042	0.221	0.058	0.016	-0.052	0.011	-0.01
14	Health Condition	-0.004	0.351	0.441	-0.002	-0.043	-0.077	0.02
15	Occupation	0.021	-0.001	0.497	-0.012	-0.16	-0.132	-0.026

S No.	Factors	Components						
		1	2	3	4	5	6	7
16	Living Situation	-0.018	0.036	0.144	-0.04	0.027	0.071	-0.038
17	Mobile Phone	-0.014	0.082	0.145	-0.131	0.054	0.078	0.114
18	AC	-0.03	0.02	0.01	0.473	-0.048	-0.098	-0.074
19	Washing Machine	0.005	0.057	-0.024	0.409	-0.012	-0.047	-0.015
20	LPG/Electric Stove	0.033	0.116	-0.049	0.244	0.178	0.119	0.007
21	Administrative Post	0.015	-0.053	-0.019	-0.106	-0.138	-0.045	0.414
22	Contest Election	-0.083	0.111	-0.045	0.05	0.008	0.105	0.389
23	Practice Religion without restraints	-0.048	-0.097	0.064	-0.039	0.068	-0.054	0.422
24	Health Check-up	0.044	0.11	-0.114	-0.153	0.085	0.504	0.230
25	Proper treatment when sick	0.052	-0.021	0.123	0.135	0.086	0.116	0.341

Source: Primary Survey

All the factors of male migration and remittances have a positive relationship with components 2,5 and 6. Likewise, the factors of public health with a factor loading of 0.335, education level with a factor loading of 0.381, pursuance of higher education after marriage with a factor loading of 0.292, financial level with a factor loading of 0.221 and health condition with a factor loading of 0.351 have a strong positive relationship with component 2. The factors of possession of washing machine with a factor loading of -0.024, LPG or electric stove with a factor loading of -0.019 and administration post with a factor loading of -0.053 also have negative loading on component 3, suggesting an inverse relationship with the component. The factors of health check-up with a factor loading of 0.230 and proper treatment when sick with a factor loading of 0.341 have high loading with component 7 suggesting that they contribute significantly to the variance explained by component 7. These findings suggest that factors like increased responsibility, self-reliance and remittances play a key role in the economic empowerment of left-behind women.

4.4. Correlation Matrix

This correlation matrix shows the pair wise correlations between different variables or factors in the Principal Component Analysis (F1 to F25). The results of the correlation matrix are given in Table 6.

Table 6 : Correlation Matrix
Correlation Matrix

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23	F24	F25	
F1	1																									
F2	0.21	1																								
F3	0.21	0.77	1																							
F4	0.20	0.73	0.81	1																						
F5	0.29	0.73	0.71	0.66	1																					
F6	0.05	0.10	0.13	0.08	0.14	1																				
F7	0.12	0.22	0.18	0.15	0.24	0.49	1																			
F8	0.19	0.25	0.23	0.25	0.28	0.34	0.30	1																		
F9	-0.02	-0.01	0.00	-0.06	0.06	0.19	0.24	0.40	1																	
F10	-0.10	-0.07	-0.07	-0.10	0.00	0.08	0.14	0.12	0.71	1																
F11	0.18	0.18	0.22	0.17	0.22	0.27	0.44	0.67	0.54	0.36	1															
F12	0.13	0.18	0.22	0.12	0.24	0.51	0.42	0.19	0.11	0.09	0.16	1														
F13	0.26	0.22	0.22	0.14	0.28	0.18	0.16	0.35	0.21	0.08	0.33	0.18	1													
F14	0.17	0.13	0.21	0.17	0.13	0.23	0.14	0.47	0.18	-0.06	0.38	0.17	0.48	1												
F15	0.35	0.25	0.23	0.14	0.31	0.20	0.24	0.37	0.18	0.10	0.37	0.16	0.59	0.43	1											
F16	0.32	0.14	0.24	0.16	0.22	0.21	0.21	0.38	0.10	-0.06	0.35	0.21	0.45	0.58	0.57	1										
F17	0.25	0.22	0.33	0.28	0.26	0.18	0.21	0.38	0.12	0.01	0.42	0.20	0.39	0.62	0.55	0.69	1									
F18	-0.04	-0.06	-0.12	-0.01	-0.10	-0.24	-0.13	-0.27	-0.15	-0.03	-0.15	-0.12	-0.27	-0.24	-0.16	-0.09	-0.11	1								
F19	0.11	0.15	0.03	0.04	0.10	-0.04	-0.02	-0.23	-0.18	-0.10	-0.25	-0.05	-0.20	-0.37	-0.09	-0.06	-0.07	0.37	1							
F20	-0.13	-0.02	-0.05	-0.05	-0.06	-0.03	0.03	-0.21	-0.16	-0.22	-0.20	0.03	-0.31	-0.26	-0.33	-0.18	-0.21	0.25	0.48	1						
F21	-0.24	-0.19	-0.20	-0.18	-0.30	-0.15	-0.17	-0.32	-0.20	-0.09	-0.31	-0.16	-0.47	-0.34	-0.53	-0.23	-0.34	0.48	0.35	0.50	1					
F22	-0.26	-0.26	-0.28	-0.25	-0.31	-0.17	-0.27	-0.31	-0.22	-0.14	-0.37	-0.16	-0.40	-0.30	-0.46	-0.36	-0.40	0.39	0.24	0.41	0.60	1				
F23	-0.19	-0.21	-0.17	-0.20	-0.25	-0.07	-0.05	0.05	0.02	0.03	0.11	-0.06	0.06	0.26	0.01	0.08	0.18	-0.02	-0.44	-0.36	-0.07	-0.09	1			
F24	-0.01	-0.01	0.02	0.01	0.02	0.17	0.02	0.37	0.20	0.26	0.30	0.11	0.25	0.37	0.32	0.27	0.36	-0.14	-0.40	-0.49	-0.32	-0.33	0.55	1		
F25	0.01	0.09	0.06	0.05	0.14	0.10	0.21	0.23	0.30	0.28	0.30	0.00	0.16	0.02	0.14	0.17	0.12	-0.04	0.06	-0.12	-0.03	-0.18	0.04	0.15	1	

Source: Primary Survey

Note: Bold indicates significance at the 5 percent level

The correlation matrix in the Table 6 indicates the relationships between variables in a dataset, helping to identify patterns, dependencies, and potential multicollinearity issues in statistical analysis. Each cell in the correlation matrix in Table 6 contains the correlation coefficient between two variables. The correlation coefficient ranges from -1 to 1. A correlation coefficient of 1 indicates a perfect positive correlation, meaning when one variable increases, the other variable also increases linearly. A correlation of -1 indicates a perfect negative correlation, meaning when one variable increases, the other variable decreases linearly. A correlation of 0 indicates no linear relationship between the variables.

The correlation between F1 with F2 and F3 is 0.21, indicating a low positive statistically significant correlation between these two variables. The correlation between F3 with F4 and F5 is 0.81 and 0.71 respectively, indicating a high positive statistically significant correlation between these two variables. The correlation between F11 with F8 is 0.67 and F9 is 0.54, indicating a moderate positive correlation. The correlation between F23 and F24 is 0.55, indicating a moderate positive correlation. Hence the correlation between most of the variables is positive and statistically significant indicating that the factors considered contributing to the capability expansion of left-behind Muslim women in the study have a positive statistically significant association. These findings suggest that enhancing these

factors can lead to improved socio-economic outcomes for left-behind women, promoting their empowerment and financial independence.

5. Conclusion and Policy Suggestions

The Capability Approach has special advantages when it is used in migration scenarios especially to analyse the impact of male migration and remittances on the empowerment of left-behind women. Male migration and the subsequent context enable left-behind women to improve their decision-making, control over financial and non-financial resources, social networks, access to information, mobility freedom and participation. These factors collectively enhance their capabilities. Policies could focus on supporting left-behind women by providing targeted initiatives such as financial literacy programs, better access to education, and strengthening social and healthcare infrastructure. These measures would enhance their capabilities, fostering economic independence and social inclusion. The capability approach, developed by Amartya Sen and further advanced by Martha Nussbaum provides a valuable framework for analysing migration and its effects on the women left behind.

The result of Exploratory Factor Analysis applied to assess the factors contributing to the capability expansion of left-behind women in the study area indicates that from eight factors and 36 sub-dimensions, the analysis identified 7 components with Eigen values over 1 and 25 factors with strong factor loadings. The results of the KMO (Kaiser-Meyer-Olkin) measure of sampling adequacy and Bartlett's test of sphericity indicate that the data set is suitable for Principal Component Analysis and the KMO with higher values (0.832) indicates better suitability for factor analysis. Among the factors contributing to the capability of left-behind Muslim women in the study area, the consequent factors of husbands' migration and remittances- increased responsibility (0.897), self-reliance autonomy (0.865), household Management (0.837), financial status and freedom (0.821) and social factors like banking (0.832), transport and communication system (0.816) have strong factor loadings. It suggests that these factors are the major factors (factor loading >0.800) determining the capability of women in the study area. The study shows that migration and foreign remittances, availability of social infrastructure and possession of consumer durables are the major factors contributing to the outcome variable. In light of these findings, policymakers could focus on developing support systems for left-behind women, including financial empowerment programs, improved access to social services and infrastructure enhancements in areas such as transport and communication. These measures would help strengthen their autonomy and capabilities, promoting greater social and economic inclusion.

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Accessibility to Social Security Measures of Kerala (India) Informal Sector Migrant Workers in Gulf Countries

Rekha V.¹ and V. Nirmala²

Abstract

The paper examined the accessibility of social security measures to Kerala informal sector migrant workers in Gulf countries. It also analysed the determinants of their accessibility to social security measures, besides the problems of non-accessibility to it. Primary data were collected from a random sample of 569 migrant households in Malappuram District of Kerala, India, during February to June 2017 for the study. The findings showed that majority of the migrants possessed poor human capital resources, due to which they were exploited and discriminated against in the Gulf countries. Most of them were employed by the Gulf nationals in urban areas. Less than a quarter of them had signed work contract after arriving in the host country, that included the availability of minimum wage rate, job categories, minimum eight hours work, return air tickets to home country, and other social protection measures. However, only about two-thirds of them received the signed benefits. Majority of the migrant workers were employed as salesman and helpers, cook and cleaners, and drivers. An analysis of the factors determining the migrant workers' accessibility to social security benefits indicated that being a Muslim, having permanent job and entry through contract or social network significantly increased their chances of receiving the benefits in the Gulf countries. The main problems of non-accessibility to the social security benefits were long work hours, risk and hazard at work place, and discrimination due to nationals doing the same work. Violations of minimum working hours and wages were reported, besides over-time payment issues, delayed salary or arrears and forced to quit without payment. The paper recommended inclusive social security measures through bilateral agreements between the host and home countries, besides implementation of ILO recommendations of decent work and human rights.

Keywords: migrant workers; informal sector; accessibility to social security measures; minimum wage rate; Gulf Countries

1. Introduction

The estimated international migrants in 2024 were 304 million, accounting for 3.7 percent of the world population (IOM, 2024). According to the Ministry of External Affairs report (MEA, 2025), 34.3 million Indians reside outside the country. The United States (US 5.69 million), United Arab Emirates (UAE 3.89 million), Canada (3.61 million), Malaysia (2.93

¹ Researcher, Department of Economics, Pondicherry University, Puducherry-605014. India.

² Professor & Director, School of Humanities & Social Sciences, GITAM University, Bengaluru, India. Email: nirmalavelan@gmail.com

million) and Saudi Arabia (2.75 million) are the top countries with the largest Indian migrants. Of the 17.18 million Non-Resident Indians (NRIs), the US, UAE and Saudi Arabia host the highest number. International migrants often face several risks like exclusion from different institutional or social security measures, under-employment, poverty and inequality (Jasso, 2011; Faist & Bilecen, 2015; Amelina, 2017; Faist, 2019; Faist, et al., 2019; Ewers, et al., 2023; and Sharma & Tripathi, 2025). Social protection measures generally comprise formal (i.e., opportunities expressed in national regulations and rules) and informal components (i.e., resources in the form of personal networks) (Bilecen & Barglowski, 2015). These forms of formal and informal social protection measures run across different levels, functioning along class, ethnicity, age and gender (Anthias, 2016; and Amelina, 2017) within the employment and bilateral agreements frameworks existing between the home and host countries (Holzmann & Wels, 2020; Ewers, et al., 2023; Berhané, 2024; and Sharma & Tripathi, 2025).

Despite the existence of international labour law principles and frameworks, social protection coverage for migrant workers in the host countries remains low. It is one of the major challenges confronted by them, which include administrative regulations and restrictive legislative laws, most often due to the lack of agreement and coordination between the home and host countries to transfer rights and benefits of the migrant, coupled with the problem of their ineffectiveness due to language and other practical issues. These challenges are more complex and complicated for the informal sector workers than the formal sector workers, especially in the Cooperation Council for the Arab States of the Gulf (GCC) (Robbins, 2023). They are less likely to be protected in the host country, because in their own home country they are neither included nor protected under law. Therefore, they are often compelled to work in poor working conditions, lack representation, and are discriminated, exploited and excluded from social security cover, resulting in poverty, inequality and under-employment (Hamza, 2015; Diop, Le & Ewers, 2017; Moyce & Schenker, 2018; Bilecen, et al., 2019; Ewers, et al., 2023; Berhané, 2024; and Sharma & Tripathi, 2025).

Although the worker sponsorship Kafala system in GCC States has attracted labour migrants, especially from Asia, to cater to the region's labour deficiency and development agendas, it has been exploiting and discriminating against them through tax regulations and exclusion from social protection labour laws. The system has resulted in inequalities between the nationals and migrants, resulting in lack of access to legal systems, besides human rights abuse and violations (Hamza, 2015). Several studies have examined the working conditions and accessibility of social security measures to international migrants in the GCC region. Hamza (2015) reported that the Kafala system had affected the quality of life of the migrant

workers, with no social protection measures, being subject to harassment at various stages of the immigration process, not only by the recruiting agencies in home countries, but also by the GCC Governments and their employers. They are compelled to work under harsh and risky conditions, devoid of any justice or basic human rights access in the GCC.

Naufal, Malit Jr & Genc (2017) examined contemporary Indian labour migration and the emerging challenges and opportunities in the Gulf region. They found that the major challenges experienced by the migrants were localization, oil price fluctuations, taxing remittance outflows, illegal recruitment and lack of minimum wage legislation. The latest labour laws of migrant rights protection, and certification and up-gradation of skill, were expected to generate economic opportunities, especially for the Indians in future. Diop, Le & Ewers (2017) arrived at a mixed view of varying conditions of the living and working conditions of migrant workers in the Gulf region. They reported that the migrants worked very hard at low pay with few benefits, without enjoying the prospects and protection of citizenship. According to them, the Kafala system was the major cause of poor working and living conditions of the migrant workers.

A review of 1999-2014 literature on occupational health and safety of migrant workers by Moyce & Schenker (2018) revealed about half the migrants to be often engaged in hazardous jobs, that were fatal and injurious to their health. They worked at low wages, for longer working hours, under conditions worse than the non-migrants. They were also subject to abuse, violence, human trafficking and human rights violations that affected their health outcomes, resulting in disparities due to environmental, occupational and political conditions, language and cultural barriers, health care accessibility issues and documentation status. According to Bilecen, et al. (2019), migrants were especially affected by challenges of access to social protection provisions in Europe, owing to unfamiliar welfare regulations in the host country, besides their family and friends located in different locations.

Saraswathi (2020) reported that although the legislative changes introduced in the Gulf regions improved the working and living conditions of the migrant workers, their actual impacts were mixed. Aboueldahab (2021) found the recent developments in labour reforms across the Gulf countries to be encouraging in providing social protection to migrant labourers in Qatar. The COVID-19 pandemic had further drawn attention on the social protection issues of the migrant workers in Qatar and the Gulf in general. Ewers, et al. (2023) studied the rights and welfare of migrant workers in the Gulf and reported that their opinions on satisfaction and awareness of rights, contracts execution and quality of life called for policy implementation from concerned international UN stakeholders, and the Gulf Governments.

To enhance inclusiveness of especially the low-skilled migrant workers who face greater challenges and lack transfer of social security benefits, Berhané (2024) suggested the implementation of social protection laws, Legislation and administrative procedures, and ILO Conventions and Recommendations, within the legal frameworks of the host country's policies. Agyeiwaah, Dayour & Adam (2025) studied the struggle of migrants for workplace inclusion that had substantial impact on their psychological well-being, job performance and identity. They recommended policy interventions to address the issue, so as to achieve the decent work and inclusivity goals (SDG 8.8). Sharma and Tripathi (2025) reviewed international studies and highlighted the importance of planning, and complications of executing social security and protection policies for migrant workers.

In sum, several studies on migrant workers reveal that most of the migrants the world-over, especially those engaged in the informal sector and women are insufficiently protected by social security measures. Although under the pressure of Human Right Organizations the Gulf countries have introduced policies for the protection of migrant workers' rights and benefits that have resulted in updated sponsorship laws in some countries, wage protection system, starting bank account for salary, and mobile based remittance e-payment system, studies report these measures to be inadequate for better working and living conditions of the migrant workers. The existing human rights and labour standards for migrants and their families hardly have the required effects on their conditions (Van Ginneken, 2013; Ewers, et al., 2023; Berhané, 2024; and Sharma & Tripathi, 2025). This warrants an assessment of the accessibility of social security benefits to informal sector workers and its consequences on their working conditions and wellbeing. Against this backdrop, the proposed paper attempts to examine the social security measures and work challenges of Kerala informal sector migrant workers in the Gulf region. The objectives of the study are as follows:

1. to examine the contract, work and wage related issues of informal sector Kerala migrantworkers in the Gulf countries;
2. to analyse the determinants of accessibility to social security measures by the migrantworkers; and
3. to over-view the problems of non-accessibility to social security benefits by the migrantworkers.

The remaining paper is organized in the following manner. Section II describes the database and methodology used by the study. The results are discussed in section III, while the concluding remarks are given in the final section.

2. Data and Methodology

The study is conducted in Kerala State of India, which has the largest immigration to the GCC countries. Kerala Migration Survey (Government of Kerala, 2018) records Malappuram District of the State to be having the highest concentration of migrants engaged in the unorganized sector. Hence, the paper focuses on the migrant workers of Malappuram District employed in the unorganized sector in the GCC countries. Primary data for the present research study have been collected from a sample of 569 migrant households from highly migrants concentrated four panchayats/Municipality, viz., Parappanagadi, Valavannur, Vengara and Kalpakamcherry of the District. The objectives of the study are analysed using percentages, ratios, averages and multiple regression model. The determinants of migrants' accessibility to social security measures are estimated using Ordinary Least Square (OLS) multiple regression. The estimated regression equation is of the form:-

$$SSIN = b_0 + b_1AGEM + b_2EDCN + b_3SKIL + b_4RLGN + b_5NEMT + b_6REGN + b_7ALBS + b_8AINC + b_9CSIN + U$$

where,

SSIN = accessibility to social security measures interaction variable;

AGEM = age of the migrant in years;

EDCN = education of the migrant in years;

SKIL = skill dummy, taking value one for semi-skilled and zero for unskilled;

RLGN = religion dummy, taking value one if the migrant is a Muslim and zero for non-Muslim;

NEMT = nature of employment dummy, taking value one for permanent and zero for temporary;

REGN = region dummy, taking value one for urban and zero for rural;

ALBS = annual labour supply of the migrant in hours worked during the years;

AINC = log value of annual income in Rupees;

CSIN = work contract and social network interaction variable; and

U = error term.

The theoretically expected association between the dependent and independent variables is as given.

Social security benefits accessibility interaction variable (SPIN): It is the dependent variable, computed as social security measures accessibility (SSAD) binary variable

multiplied by its number (SSNO) available to the migrant. Social security measures include minimum work hours, minimum wages, over-time payment, public holidays, leave salary, accommodation, food, water, beverages, medical care, health insurance, life insurance, transport to work place and free return air ticket to home. All these benefits influence the working and living conditions of the migrants positively.

Age of the migrant (AGEM): The expected effect of age of the migrants (AGEM) is positive, because as age increases, experience also increases. Hence, as the migrants age, their chances of receiving social security benefits are higher.

Education of the migrant (EDCN): A more educated migrant is likely to get better job opportunities with social security benefits. Therefore, its expected relationship is positive with SSIN.

Skill of migrant (SKIL): Generally a more skilled worker is likely to be absorbed in better jobs than those with low or no skill. Therefore, its expected association with social security benefits accessibility is positive.

Religion (RLGN): Religion (RLGN) dummy is hypothesised to be positively associated with social security accessibility, as a Muslim migrant would be more preferred in the Gulf country.

Nature of employment (NEMT): Migrants engaged in permanent jobs are more likely to have accessibility to social security measures. Hence, the nature of employment is expected to have a positive association with the dependent variable.

Region dummy (REGN): The expected association of region of employment with social security accessibility is positive, as migrants in urban locality tend to have better job opportunities.

Annual labour supply (ALBS): Higher annual labour supply implying more work is hypothesised to be covered with social security benefits. Therefore, the variable is expected to be positively associated with the dependent variable.

Annual income (AINC): Log of annual income has been considered for the analysis. Higher annual income implies better job, therefore greater the likelihood of having social security accessibility. Hence, it is expected to be positively related with the dependent variable.

Work contract and social network support (CSIN): Migrants who enter jobs through work contract (CONT) or social network (SCLN) are likely to be employed in more secure jobs with social security benefits. Therefore, its hypothesised relationship with the dependent variable is positive.

3. Results and Discussion

The empirical results of the study have been discussed in this section. Table - 1 shows the descriptive statistics of the selected variables relating to the respondent migrant workers. The average age of migrant (AGEM) was 43.42 years during the survey. The respondent's mean education (EDUM) was 7.97 years, implying an average education of middle school. Skill acquisition dummy (SKIL) revealed 52 per cent of the migrants to be semi-skilled. Malappuram District in Kerala being a Muslim dominated region, the religion dummy variable (RLGN) shows 95 percent of the respondents to be Muslims. The health dummy (HLTH) shows that 80 percent of the migrants perceived their health status to be good.

Table 1 : Descriptive Statistics

Sl. No.	Variables	Mean	Standard Deviation
1	AGEM	43.42	9.97
2	EDCN	7.97	3.26
3	SKIL	0.52	0.67
4	RLGN	0.95	0.21
5	HLTH (health dummy, taking value one for good and zero for bad)	0.80	0.40
6	NEMT	91.39	0.50
7	REGN	0.63	0.48
8	DSTY (duration of stay)	17.25	10.05
9	WHRD (number of hours worked per day)	12.02	3.16
10	ALBS	3823.10	1248.90
11	AINC	286485.64	0.00
12	REMP (percentage of remittances to family in home country)	38.93	32.38
13	SSAD (social security dummy, taking value one for yes and zero otherwise)	41.77	26.83
14	SSNO (social security number)	3.53	25.14
15	DISC (discrimination dummy, taking value one for yes and zero otherwise)	0.97	0.16
16	SCLN (social network dummy, taking value one for yes and zero otherwise)	0.66	0.47
17	CONT (work contract dummy, taking value one for yes and zero otherwise)	0.26	0.44

The nature of employment dummy (NEMT) shows that 91.39 per cent of the migrants were employed in permanent jobs. About 63 per cent of them were employed in urban locations (REGN). Their average duration of stay (DSTY) in the Gulf countries was 17.25 years. The mean number of hours worked (WHRD) was 12.02 hours per day, which is four hours more than the international standard of eight hours of work per day. The average annual labour supply (ALBS) was 3823.10 hours. They earned an average annual income (AINC) of Rs. 2,86,485.64, of which they remitted (REMP) 38.93 per cent to their families in home country. About 41.77 per cent of them claimed the availability of some social protection measures (SSAD), receiving nearly four (3.53) benefits (SSNO). Overall, a vast majority (97%) claimed being discriminated against the national workers.

About 66 per cent of the migrant workers had been assisted in migration through social network (SCLN), including family, relatives and friend. About 26 per cent had signed work contracts (CONT) on arrival in the host country.

Table – 2 presents the employment details of the migrants. The type of employment shows 91.39 per cent of the workers to be engaged in permanent jobs. As regards their category of employer, only 6.15 per cent were employed in Government and Municipality services. Nearly two-thirds of them (63.80%) were employed by Gulf nationals. More than a quarter migrants (27.59%) were employed in Keralite’s owned establishments, while the rest worked in foreign establishments. Of them, a vast majority (88.93%) were regular long-term employees, receiving monthly incomes. With respect to the location of workplace, 36.73 per cent worked in the main city, 33.06 per cent near city or in industrial city, and the rest (30.23%) in rural or remote areas, or at sea or in offshore areas.

Table 2 : Employment Related Issues

Sl. No.	Details	No. of Migrants	Percent
A. Type of Employment			
1	Permanent	520	91.39
2	Temporary	49	8.61
	Total	569	100
B. Category of Employer			
1	Foreign national	363	63.80
2	Establishment of Keralite	157	27.59
3	Government	32	5.62
4	Foreign establishment	14	2.46
5	Municipality	3	0.53
	Total	569	100

Sl. No.	Details	No. of Migrants	Percent
C. Nature of Job			
1	Regular long-term employee with monthly salary	506	88.93
2	Self-employment	36	6.33
3	Daily wage casual worker	13	2.28
4	Regular employee with a daily wage/piece wage	14	2.46
	Total	569	100
D. Location of Work Place			
1	City	209	36.73
2	Near City/Industrial City	188	33.04
3	Rural area/Remote area/Sea/Offshore	172	30.23
	Total	569	100

Table - 3 gives the contract details of the migrants. Less than a quarter (22.32%) had signed work contract, of whom majority (85.04%) had signed it on arrival in the host country and the rest had done it before in the home country. Benefits in contract indicated wage rate and category of job for all. It also included by minimum eight hours work per day and free return tickets to native country (92.13% each). Around half of them were promised medical care (50.39%) and over-time payments (45.67%). A few were promised family accommodation (7.87%) and leave salary (2.36%). However, of the promised benefits, only nearly two-thirds of the migrants (65.35%) claimed receiving all benefits mentioned in the contract. The rest had to work for longer hours (81.82%). Around a quarter each reported receiving lower wages and no return tickets to home (27.27% each). Lower social security benefits, no over-time payment and no holidays (25% each) were reported by a quarter each. The rest had to work at different locations than indicated in the contract (20.45%) and assigned more difficult jobs (18.18%), while some had to change the job (15.91%).

Table 3 : Contract Related Issues

Sl. No.	Details	No. of Migrants	Percent
A. Signed Work Contract			
1	Yes	127	22.32
B. Stage of Signing Contract			
1	Before arrival	19	14.96
2	After arrival	108	85.04
	Total	127	100.00

Sl. No.	Details	No. of Migrants	Percent
C. Benefits mentioned in the Contract			
1	Category of job	127	100
2	Minimum work of eight hours per day	117	92.13
3	Wage rate	127	100
4	Over-time payment	58	45.67
5	Paid holidays	107	84.25
6	Medical Care	64	50.39
7	Working Accommodation	115	90.55
8	Food	107	84.25
9	Free return air ticket to home	117	92.13
10	Leave salary	3	2.36
11	Family accommodation	10	7.87
D. Received Benefits as per the Contract?			
a	Yes	83	65.35
b	If No, Problems Faced		
1	Changed the job	7	15.91
2	Assigned more difficult job	8	18.18
3	Difficult work location	9	20.45
4	Increased working hours	36	81.82
5	Lower wage rate	12	27.27
6	No over-time payment	11	25.00
7	Lower in social security benefits	11	25.00
8	No holidays	11	25.00
9	No return air tickets to home	12	27.27
E. Passport Related Issues			
1	Employer collected passport when joined forwork	397	69.77
2	Faced problem due to refusal to return passport	16	2.81

Note: E. Multiple responses.

Passport related issues revealed that the passports of 69.77 per cent migrants had been collected by the employer when they joined for work. About 2.81 per cent were refused its return by their employer when they needed it.

The occupational status of the migrants is shown in table - 4. About 35.33 per cent of them worked as salesman or helper, while 18.80 per cent was engaged in hotels, house, bakery, palace, cool bar, defence, and in mess as cooks and cleaners. Another 14.24 per cent worked as drivers. The rest around one-third were engaged in other occupations, like shopkeepers, technicians, businessmen, cleaners and fisherman.

Table 4 : Occupational Status of the Migrants in Gulf

Sl. No.	Occupation	No. of Migrants	Percent
1	Salesman/Helper	201	35.33
2	Assistants	19	3.34
3	Hotel/House/Bakery/Palace/Cool bar/Defense/Mess (Cook and Cleaning)	107	18.80
4	Driver (House/Company/Office/Municipality/Shop/Own Taxi/Construction site/School/Defense/Airport)	81	14.24
5	Running Shop (Barber/Workshop/Fish/Mobile/Spare parts)	14	2.46
6	Plumber/Electrician/Welder/Tailor/Car Mechanic /A.C. Mechanic/ Computer Hardware Mechanic/Gold Designer/Spray Painting/ Watch Repair/Tiles work/Carpenter/Operators/Auto Mobile Mechanic/Forman/Painter)	50	8.79
7	Video Recording/Fish or meatCutting/Watchman/Laundry/Potter/ Loading/Farmer/Construction worker/Gardner Agriculture labour/ Horse Feedman /Maintainer/Store Keeper)	42	7.38
8	Fisherman	9	1.58
9	Sheaf	3	0.53
10	Business	28	4.92
11	Cleaning (School/Municipality/Hospital/Bank/Company/Palace/ Office)	15	2.64
	Total	569	100.00

Table – 5 contains information on monthly income promised and actually received by the migrant workers in the Gulf country. Although the minimum and maximum monthly income promised before emigration and after migration to the Gulf countries were almost the same, there was a disparity of Rs. 405.41 in the mean income received by them in the host country.

Table 5 : Monthly Income Promised / Received

Sl. No.	Details	Income in Rs.
A. Income Promised before Emigration		
1	Minimum	1000
2	Maximum	50000
3	Mean	11142.04
B. Income Received after Migration in ForeignCountry		
1	Minimum	1000
2	Maximum	50000
3	Mean	10736.63

Table – 6 gives details on implementation of work legislations at workplace. About 17.05 per cent migrant workers reported that minimum work hour and 19.16 per cent minimum wages legislations were being implemented. Only 6.15 per cent workers claimed being paid over-time payment for the extra hours of work performed.

Table 6 : Work Legislations

Sl. No.	Details	No. of Migrants	Percent
A. Labour Legislations Implemented			
1	Minimum Work Hours	97	17.05
2	Minimum Wages	109	19.16
3	Over-time payment	35	6.15
B. Wage Issues			
1	Discriminated	566	99.47
2	Delay in payment of salaries/wages	21	3.69
3	Salary arrears from the present or previous employer	12	2.11
4	Forced to quit job without getting all salary dues	12	2.11

As regards other issues, 99.47 per cent of the migrant workers reported being discriminated at work place. A few reported delays in salary/wage payments (3.69%), besides salary arrears still to be received and forced to quit job without salary payments (2.11% each).

Table - 7 furnishes information on the accessibility to social security benefits by the informal sector migrant workers. Majority quoted being provided with paid accommodation (70.65%), transport facility to work place (64.15%), free return air tickets to home country (57.47%), and food, water and beverages (54.48%) at work. Only 34.97 per cent received medical care and 21.79 per cent free accommodation.

Table 7 : Access to Social Security Measures

Sl. No.	Details	No. of Migrants	Percent
A. Social Security Benefits Enjoyed			
1	Accommodation (paid)	402	70.65
2	Rent free accommodation	124	21.79
3	Food, water, beverages	310	54.48
4	Transport to work place	365	64.15
5	Free return air ticket provided to home	327	57.47
6	Medical care	199	34.97
B. Leave			
a.	Weekend (Friday)	177	31.11
b.	Public holidays	177	31.11
C. Leave to Visit Home in Years			
1	Less than 1	1	0.18
2	1	128	22.50
3	2	397	69.77
4	3	25	4.92
5	More than 3	28	3.16
	Total	569	100
D. Social Security Covers			
a.	Health insurance	199	34.97
b.	Life insurance	26	4.57

Less than one-third migrants (31.11%) each reported having leave on Fridays and other public holidays. More than two-thirds (69.77%) received leave to visit home country only once in two years, whereas less than a quarter (22.50%) visited home country once in three or more years. As regards insurance, around one-third had Health Insurance (34.97%) and only 4.59 per cent had Life Insurance.

Table – 8 presents the OLS regression result of the social security accessibility function. The effects of migrant worker being a Muslim, employed in permanent job and entry into job through contractors and own social network are found to significantly increase their accessibility to social security measures.

Table 8 : OLS Regression Results – Social Protection Accessibility Function

Sl. No.	Variables	Coefficient	t-value
1	CNST	-49.725	1.11
2	AGEM	-0.066	0.46
3	EDCN	0.208	0.45
4	SKIL	0.900	0.50
5	RLGN	10.993	1.90***
6	NEMT	17.769	4.16*
8	REGN	3.868	1.54
9	ALBS	1.229	0.16
10	AINC	7.764	1.23
11	INCS	9.783	3.01*

Note: CNST– constant; and * and *** indicate statistical significance at one and 10 percent levels respectively.

The influence of the remaining factors like education of the migrant worker, place of work, annual income and labour supply had positive but insignificant effects on the accessibility to social security measures. On the other hand, the migrant’s age had a negative and insignificant effect. In sum, the influence of only few variables emerged significant due to the informal nature of employment of the migrant workers.

Table - 9 illustrates the problems of non-accessibility of social security benefits by the migrant workers. Among them, 44.99 per cent reported long hours of work, followed by existence of risk and hazard at workplace (43.76%). About 39.37 per cent of the migrants quoted not covered by social security schemes as the main problem. Further, discrimination due to nationals doing the same work was quoted as a problem by a quarter of the migrants (25.66%), followed by exploitative work conditions (18.45%). Less than 10 per cent quoted problems of wage (8.08%) and transport facility to workplace (4.92%). A few also reported accident at workplace, sponsor problem and work-related illness suffered due to the non-accessibility to social security protections.

Table 9 : Problems of Non-Accessibility of Social Security Benefits

Sl. No.	Problems	No. of Migrants	Percent	Rank
1	Long work hours	256	44.99	1
2	Wage problem	46	8.08	5
3	Existence of risk and hazard at work	249	43.76	2
4	Exploitative work conditions	105	18.45	4
5	Work-related illness	6	1.05	8
6	Accident at workplace	7	1.23	7
7	Sponsor problem	7	1.23	7
8	Transport problem	28	4.92	6
9	Discrimination due to nationals doing the same work	146	25.66	3
	Not covered by any social security scheme	224	39.37	

4. Concluding Remarks

The study examined the accessibility and determinants of social security measures to the informal sector migrant workers of Malappuram District of Kerala, India, in Gulf countries. It also examined the problems of non-accessibility to it. Primary data collected from February to June 2017 were used for the study. The study revealed that the migrants possessed poor human capital resources, due to which they were exploited and discriminated in the Gulf countries, despite a vast majority of them being employed in permanent jobs. Majority of them worked as salesman and helpers, cooks and cleaners, and drivers. Less than a quarter of the migrants had signed work contract after arrival in the host country, covering minimum wage rate, job categories, minimum eight hours work, return air tickets to home country, and other social protection measures, but only about two-third of them received the mentioned benefits. Violations of minimum working hours and wages were reported, besides over-time payment issues, delayed salary or arrears and forced to quit without payment. Passports of more than two-thirds of the migrants had been collected by their employers, due to which a few faced problems of refusal when needed.

As regards the social security benefits, more than half the migrants received paid accommodation, transport facilities to workplace, free return air tickets to home country, and food, water and beverages at work, respectively. Less than one-third enjoyed paid leave on Fridays and public holidays. Majority visited home only once in two years or more. About one-third had Health Insurance and a few Life Insurance. An analysis of the factors determining

the accessibility to social security benefits revealed that being a Muslim, having permanent job and entry through contract or social network significantly enhanced the migrant workers' chances of being covered by social security measures in the Gulf countries.

The findings of the study indicate that labour legislations need to be transformed into enforceable and practical social security measures to be effective to the benefit of the migrant workers in the Gulf countries. Social security being a basic human right, these measures should be formulated through bilateral labour agreements and employment contracts by the host and home countries, and the employers should be made accountable for violations of these laws (Migrant Forum in Asia – Kafala, 2013; ILO, 2019; Holzmann & Wels, 2020; Ewers, et al., 2023). In addition to the social security measures available, the migrant workers should also be made aware of the labour laws and their rights for their benefits. These social security measures would strengthen their social protection, rights and accessibility to safety in the host country (ILO, 2019; Berhané, 2024; and Sharma & Tripathi, 2025).

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A Critical Review of Global Net Zero Targets set – A Case Study of Indian Enterprises and Cities Sai Sailaja Bharatam,¹ Kimaya Joshi² and Ashwin Nair³

Abstract

World over mitigating the risk of further deterioration of the climatic conditions are turning as the primary concern. As of 2023, about 688 large companies and 381 cities pledged on the emission targets to be achieved by 2050 (Race to Zero Campaign (2023)). In the present work, the endeavour is to segregate the entities that pledged NG targets based on the nature of the pledge and analyse the results based on the patterns emerged. The work analysed existing data of the companies and cities of India and World using a classification tree. With the data sourced from zerotracker.net, the work builds empirical evidence for potential future carbon financing investments. With just 51 enterprises taking up the pledge, India has to go a long way. However even these enterprises need in depth evidence on the pattern of pledges. The work will aid the policy on carbon credits and tax exemption of India.

Keywords: *Climate Change, Net Zero Targets, Governance, Public Holdings, Private Ownership, Climate Policy of India*

JEL Q50, Q51, Q52, Q56,Q58, L32, L38

1. Background

Out of the 17 sustainable developments goals nearly, 7 goals (UN SDGs (n.d.)) either directly or indirectly are aiming to reduce the carbon footprint of the earth and make the globe 1.5 degrees cooler. Existing body of literature discussed the perspectives on key strategies (Chaturvedi (2021)), sector specific pathways (Das et al. (2023)), modeling scenarios (Lin (2022)), indicators for measuring changes(Anderson et al. (2023)), feasibility of Net Zero(Lin (2022)). Role of alternative energy sources(Bhattacharya et al. (2024)) and upgrading the existing coal technologies(Li & Haneklaus (2022)), techno economic feasibility of alternatives(Boruah & Chandel (2024)) as well received substantial address in the current literature. However literature is thin on assessing the patterns that are adopted to achieve

¹ Sai Sailaja Bharatam, Assistant Professor, Economics, School of Law, NMIMS, Hyderabad # 9949507969

² Kimaya Joshi, BBA LLB, School of Law, NMIMS, Hyderabad,#7709290932

³ Ashwin Nair, BBA LLB School of Law, NMIMS, Hyderabad #8130992190

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final Net Zero (NZ) action pledges. One unique feature of the NZ targets set is the bandwidth. It is interesting to note that both governments and businesses are racing to set targets for their governed and owned territories not really being committal. Though a company level analysis (Gözlügöl & Ringe (2022)) furthering empirical study on the public, private owned companies and cities of India need further deepening of the literature.

Approximately 2000 largest publicly held companies have declared Net Zero Targets (Walsh & Toffel (2023)) in the year 2024. Viewing the definition that simplifies the concept of Net Zero is, “Put simply, Net Zero refers to the balance between the amount of Green House Gas (GHG) that’s produced and the amount that’s removed from the atmosphere. It can be achieved through a combination of emission reduction and emission removal”(National Grid (n.d.)) In the emission reduction a firm can adopt to process modification, product reformulation, fuel switching, shifting to renewable power etc. While in the removal projects, firms can pledge to zero emissions by purchasing carbon offsets also popularly known as carbon credits. One predominant allegation on the carbon credit purchase by firms is (offsetting carbon) it leads to greenwashing and making in tall claims on environmental consciousness by entities that are pledging. As explained carbon credits can be broadly bought in two channels one either avoid generation of GHG, second remove GHG from atmosphere. It is a pertinent fact that firms opt to offset their carbon emissions rather than fix their technology. In other words, firms opt for forward solutions rather than backward solutions to mend the ways in order to reduce carbon emissions rather remove carbon in its entirety.

2. Net Zero in Literature

About 3,441 research articles were published on the theme of Net Zero in the year 2024. Around 796 of these are in the domain of environmental science and about 1000 are from the domain of energy. About 1222 are open access research articles published across the domain of Energy Economics. Net zero strikes a delicate equilibrium between the aggregate greenhouse gas emissions produced and the commensurate amount removed from the atmosphere (Sun et al. (2021)).

Backward solutions to carbon removal from atmosphere can be further segmented as natural and technological. Afforestation, reforestation, are natural ways of retrograding the level of carbon from atmosphere. Whereas, forward solutions are carbon capture and storage are technological solutions to free the atmosphere from carbon emissions.

The concept of “net zero” originates from scientific research in 2009 on how to determine the potential extent of global warming.

Studies suggest that businesses view achieving zero emissions as a way to show commitment, to addressing climate change issues. Among the monitored Forbes 2000 companies the number aiming for net zero targets has more than doubled from 417 in 2021 to 929 in 2023. However, a more detailed analysis of their overall performance has led to scepticism about these efforts and raised questions about their effectiveness. Legal disputes have emerged highlighting perceived inconsistencies between companies claims of striving for zero and their day, to day operational practices. (InfluenceMap (2023)) The current knowledge regarding NETs is unclear and inadequate based on evaluations. (Minx et al. (2018))

Integrity matters (UN Expert Group (2023)) a report of UN High Level Expert Group suggested that non- state entities or say privately owned entities run the risk of Net Green Washing. A London based Non -Profit organisation named InfluenceMap (2023) identified that the 21.5 percent of organizations that have been surveyed may thus be at grave risk of what is known as net zero greenwash given their connection with strategy. These individuals included Chevron, Delta Discuss, Duke Vitality, ExxonMobil, Glencore Universal, Nippon Steel Enterprise, Repsol, Stellantis, Southern Company plus Woodside Vitality Bunch Ltd. Every one of them has ensured a net zero or something close to wrap up line, however, citing InfluenceMap under the recovery of their climate dealings involvement sweats in the critical programs intended to deliver the Paris Assention. The companies are featured in the Spotlight on case because of their high interaction with climate strategy and under normal operation of amount to zero assertions on their websites.

3. Net-zero Vs Green Washing

Greenwashing includes the deceptive practice of outsourcing the off-target sense of environmental friendliness. In the case of HSBC, some of their promotions were denied in the UK because they baffled the open about their climate activities. Given that the global net-zero commitments are growing by way of expressing contempt of never-ending carbon radiations released into the climate, fears about the authenticity of the commitments.

Data Analysis

The work segregates the committed and greenwashing firms based on the end targets set by them. Defining the end targets the present work adopts the methodology of InfluenceMap.

Committed Firms

Data is utilized to decide which companies checked by InfluenceMap for this ponder have pronounced a net zero or comparable “end-state” pledge.

Green Washing Firms

Targets found in Net Zero Tracker for companies in this report that are not considered “net zero or comparative ‘end-state’ commitments” for the purposes of this inquire about are those portrayed as “science-based,” “emissions reduction,” “emissions intensity,” “no target,” and “other” targets.

While a add up to of 51 Indian ventures took portion in the promise to their commitment to outflow diminishment almost 21 of them expressed their conclusion targets as Other, No Target, Outflow concentrated or emanation diminishment. Rest of the 30 have conclusion target with a clear commitment explanation of Net Zero or Carbon Unbiased.

Table 1 : Enterprises with End Target Commitment

Name	End Target	Ownership
Tech Mahindra	Net zero	Private
Bharti Airtel	Net zero	Private
Wipro	Net zero	Private
Infosys	Net zero	Private
Mahindra & Mahindra	Carbon neutral(ity)	Private
Reliance Industries	Net zero	Private
HDFC Bank	Carbon neutral(ity)	Private
State Bank of India	Carbon neutral(ity)	Public
ITC	Net zero	Private
Hindalco Industries	Carbon neutral(ity)	Public
Yes Bank	Net zero	Private
Oil & Natural Gas	Net zero	Public
HDFC	Carbon neutral(ity)	Private
Tata Consultancy Services	Net zero	Private
Indian Oil	Net zero	Public
Larsen & Toubro	Carbon neutral(ity)	Private
Bharat Petroleum	Net zero	Public
Coal India	Net zero	Public
HCL Technologies	Net zero	Private
Tata Steel	Net zero	Private
Power Grid of India	Net zero	Public
Vedanta Limited	Net zero	Private
Tata Motors	Net zero	Private

Name	End Target	Ownership
Grasim Industries	Net zero	Private
JSW Steel	Carbon neutral(ity)	Private
IndusInd Bank	Carbon neutral(ity)	Private
Union Bank of India	Net zero	Public
Adani Port and Special Economic Zone	Net zero	PPP
Steel Authority of India	Net zero	Public
TATA Group	Net zero	Private

Source: zerotracker.net

Table 2 : Enterprises without End Target Commitment

Enterprise Name	End Target	Ownership
Central Bank of India	Other	Public
ICICI Bank	No target	Private
NTPC	No target	Public
Kotak Mahindra Bank	No target	Private
Axis Bank	Other	Private
Power Finance	No target	Public
Bajaj Finserv	No target	Public
Bank of Baroda	No target	Public
Punjab National Bank	No target	Public
Canara Bank	No target	Public
GAIL	Emissions reduction target	Public
Bank of India	No target	Public
Sun Pharmaceutical Industries	Emissions reduction target	Private
Bajaj Auto	No target	Private
Asian Paints	Emissions intensity target	Private
Rajesh Exports	No target	Private
Vodafone Idea	No target	Private
Avenue Supermarts	No target	Private
General Insurance Corporation of India	No target	Public
Indian Bank	No target	Public
IDBI Bank	No target	Public

Source: zerotracker.net

Table 3 : Ownership Wise Pledge Summary

	Public	Private
Committed	10	20
Green Washing	12	9
Total	22	29

Table 4 : Cities with Pledge Summary

Cities	End Target
19	Net Zero
94	No Targets Set

Results Discussion - Global Scenario – Enterprises and Cities

Global Scenario of Enterprises

Summary Statistics of the World over Companies that Pledged Race to Zero

Variable	Categories	Counts	Frequencies	%
race_to_zero_member	No	1667	1667	80.299
	Yes	409	409	19.701
end_target	1.5°C target	2	2	0.096
	Absolute emissions target	2	2	0.096
	Carbon negative	3	3	0.145
	Carbon neutral(ity)	298	298	14.355
	Climate neutral	46	46	2.216
	Climate positive	5	5	0.241
	Emissions intensity target	37	37	1.782
	Emissions reduction target	255	255	12.283
	GHG neutral(ity)	1	1	0.048
	Net negative	1	1	0.048
	Net zero	833	833	40.125
	No target	519	519	25.000
	Other	45	45	2.168
	Science-based target	13	13	0.626
	Zero carbon	4	4	0.193
Zero emissions	12	12	0.578	

Source: Author Compiled

Classification Tree for the companies worldwide depicts that over 60 per cent of the pledged targets can be considered non-committal. This further questions the bandwidth of the pledges that are more inclined towards green washing rather achieving palpable results.

Global Scenario of Cities

Summary statistics (Qualitative data):

Variable	Categories	Counts	Frequencies	%
race_to_zero_member	No	984	984	82.968
	Yes	202	202	17.032
end_target	1.5°C target	3	3	0.253
	Absolute emissions target	2	2	0.169
	Carbon neutral(ity)	78	78	6.577
	Climate neutral	23	23	1.939
	Climate positive	1	1	0.084
	Emissions intensity target	2	2	0.169
	Emissions reduction target	58	58	4.890
	GHG neutral(ity)	4	4	0.337
	Net negative	1	1	0.084
	Net zero	156	156	13.153
	No target	766	766	64.587
	Other	77	77	6.492
	Reduction v. BAU	4	4	0.337
	Zero carbon	7	7	0.590
Zero emissions	4	4	0.337	

Above classification tree explains that just about 13 per cent of the global cities are committed towards Net Zero remaining cities world across pledged with not so serious commitments and the act can be considered as a green washing exercise.

Our preliminary results conclude that both public and private enterprises are indulging in Green washing. The analysis reveals promising progress in terms of taking pledges but highlights critical gaps in corporate alignment with global net-zero targets.

Standardization of the Reporting and Future of Carbon Financing

The Corporate Maintainability Detailing Mandate (Mandate (EU) 2022), was introduced to boost the straightforwardness and similarity of ESG execution information. It is to curtail

greenwashing by establishing transparent benchmarks and guidelines of maintainability detailing. This entails elaborating not so much on the data necessary to obtain it as the company impact in terms of maintainability as well as even more critically the data vital to understand the impacts of the supportability problems in the statement of the company in terms of execution. Under the backdrop of monetary detailing, materiality is classified into the two strongly connected perspectives of materiality: (i) financial materiality, in which incline to an outside in procedure, where a supportability issue or action is considered fabric in the event that it produces or can produce observable budgetary effects on the overall organization (ii) impact materiality, in which follows an inside out procedure, where an issue related to supportability is considered fabric in the event that it causes adverse or positive effects, genuine or potential, on people and/or the climate. (Mure et al. (2025))

Understanding the Carbon Credit Accreditation

The carbon credits may be certified either on the scenery of avoidance or as removal (negative surges). Avoid or build based courses of action in its own right, these courses of action are also referred to as nature-based courses of action towards avoiding or building. What was tended in the show work was pursuit towards switch courses of action or propelling courses towards the accreditation of carbon credit. A course of action rooted in nature-based event could be a. Woodland conservation expects to diminish their change to provincial arrive. The regenerative growing plans entrap on the carbon and bind it to soils and the plants. Built Courses of action may be one on the other hand. The catch of carbon and potential of nursery gasses in the outpourings at control plants energized by coal and natural-gas at unique types of mechanical offices. Wind and sun set in advanced and controlled workstations which substitutes the necessity of fossils. Burning up of backup of ozone depleting chemicals that would otherwise Something in the talk about escape. Landfills emit burnt methane to the surroundings. Nursery gasses could be evidently captured in the environment by tangent deep-well capacity techniques. (Walsh & Toffel (2023))

Regulatory Considerations in Assessing Transition Plans

Controllers and directors under whose stewardship depended surveying climate move plans, there exists a number of considerations. Basically, in decarbonisation strategies, the focus should be on financed or energized spreads or rather than on operational surges because these are more significant and deeper-rooted to adhere to a net zero pledge. The banks share in capital markets is probably by all means more pressing. Sierra Club has, nowadays, disclosed the extent to which the greater part of the funding of the fossil fuel development emerged through the underwriting of bonds and stocks. WWF disseminated an open letter that details

a variety of actions numbering a number of suggestions that overlap with the IIGCC banking standard. There are three key centres brought out in the report. First, it requires an accurate radiations reporting framework so that there would be a reliable estimation and comparison across businesses. Also, it biases a focus about actual radiation reductions or even real offsetting methods, and central banks and controllers allot desirable weather targets. Thirdly, it discourages relying and exaggerating on wily propels in preferences of modern-day tactics. Besides, the report suggests stringent controls to those covered with the actual damages worked out, accounting to increased capital and liquidity requirements, concentration risk capital add-ons, and buffers on extended systemic risk chances.

4. Summary and Argument in Place

It was Edgar Morin and Anne Brigitte Kern, complexity theorists who coined the term polycrisis more than twenty years ago. (Helleiner (2024)). But in the current discourse of the work we introduce the crisis that is propelling the scholars in analogies in their decision-making process in the frontward and backward solutions of engaging in the climate change activity. Net Zero pledges and targets also do not indicate that they will achieve the objective. Specifically, where there is presence of firms, which are engaging in green washing instead they are not serious with commitments made. Moreover, it can also be seen that much of the government support has been directed at reduction of emissions as well as switch to an alternative energy path and not zero or pulling out of the carbon. The plan on negative emission is as herculean to embrace, enact and scale up. In short, the argument in the work is that without blatant advancement in the analogy of the Net Zero at the governmental level as well as the entities that decide on the targets, the process of reduction of greenhouse gases is turning out to be slowing down. The aspects of Fiscal Policy such as tax revenue and government expenditure can be used to temper the issue of the Green Washing. EU (2024), Theo Aphecette addressed the fiscal implication of the shift to the climate neutrality in the entire world, focussing on expenditures of governmental bodies, the income of the governments, and the necessity of building the comprehensive fiscal strategy and transitions plans at the country level. The paper examined the effects of climate change and public policies regarding its finances and how the effect of the two elements may decrease the amount of the country revenues and may increase expenditures caused by climate induced damages as well as mitigation policies. The work explores the necessity of investment to support the economic transformation towards a Net Zero emissions future and discusses the varying degrees of fiscal impact across different regions and policy mixes of the EU region. However, such a study focusing Indian conditions needs execution sooner for analysing the nuances of the Net Zero transition.

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Structure, Conduct, and Performance of Weaning Food Markets in Benue State, Nigeria

O. Ojogho¹ and I. O. Olisakwe²

Abstract

It is difficult to assert, a priori, how the structure, conduct, and performance (SCP) of an ideal weaning foods market impact market competitiveness and affordability to the target market. For indigenous weaning food markets in Benue State, Nigeria, a study on the nature of competition and performance vis-à-vis profit margin of marketers and price paid by target market is proactive. The study used data from a cross-section of 216 indigenous weaning-food marketers in Benue State, Nigeria, to examine the structure, conduct, and performance of these marketers using the corrected Herfindah– Hirschman Index (HHI) and Lerner index. The estimates of the market concentration index in the state showed that only the akamu, akamu-okiri, and akamu-joro markets had defined concentration indexes representing a difference and relative difference in market concentration of 64.316 and 9.28%, respectively. In the state where HHI was defined, zone B of the state had higher concentration for akamu-joro (739.317) than for akamu and akamu-okiri (729.171) in zone A, representing a difference and relative difference in market concentration of 10.146 and 1.39%, respectively. There was evidence that weaning-foods firms charge a price that ranges from about 4 to 8 times the marginal cost. Market performance in the state was determined mainly by HHI, market efficiency, and demand price elasticity, or a combination of any of these across the zones. Indigenous weaning food markets in the state are not only unconcentrated, with high market power, and with market performance impacted by HHI, production efficiency, and demand price elasticity, but the SCP affects the market price.

Keywords: *Weaning-foods; HHI; Lerner index; Demand elasticity; Market performance*

1. Introduction

Numerous imported brands of complementary foods abound in most wholesale and retail outlets in Nigeria. These include cerelac, nutrend, nutriben, frisogold, and SMA baby formulae. A few of them have been locally developed or sourced exclusively from readily available local staples, including a blend of dairy products with indigenous staples (Ugwuoke, 2001). In Nigeria, the usual first indigenous weaning food is gruel made from fermented maize (*zea mays*), millet (*pennisetum americanum*), or guinea corn (*sorghum spp*) products

¹ & ² Department of Agricultural Economics, Faculty of Agriculture, University of Benin, Benin City, Nigeria.
E-mail: o.ojogho@uniben.edu; ORCID: 0000-0002-9662-5528

of farmers called pap, akamu, ogi, or koko (Ugwu, 2009) as a complement to breast milk. Producers of these indigenous weaning foods, who most often double as retailers, process cereals and starchy staple foods such as sorghum, soybean, rice, and maize (Onweluzo and Nwabugwu, 2009; Awogbenja and Peter, 2021). Such weaning foods in Benue State are highly differentiated based on their protein and carbohydrate contents, though homogeneous from the perspective of buyers. However, it is necessary to aggregate the microprocessors into various industry classifications. For indigenous weaning food markets in Benue State, Nigeria, a study on the nature of competition and performance vis-à-vis profit margin of marketers and price paid by target market is proactive. The challenge is to make nutritionally adequate products available and affordable to poor consumers. The questions that pertain to the efficiency among processors, how competitive the dominant indigenous weaning-foods markets are, and the “right” price in Benue States remain unanswered. It is important to assert how the structure, conduct, and performance (SCP) of an ideal weaning foods market impact market competitiveness and affordability to the target market.

The performance of any production process greatly depends on the expansion of market opportunities (Diao and Hazel, 2004; Wanjohi and Karani, 2017). Despite progress in the timely introduction of complementary foods, only 55% of infants receive complementary foods, whereas only 30% of infants receive proper complementary feeding from 6 to 24 months in accordance with the World Health Organization (WHO) Infant and Young Child Feeding Practices. The use of proper infant feeding remains very low, with only approximately 13% of infants exclusively breastfed until the age of six months as of 2008, a decrease of approximately 17% from that in 2003. Processing, a secondary production process that has a crucial function in the marketing of agricultural products, is almost inevitable in the marketing of weaning foods. Therefore, to sustain the success of the process of production and distribution with a view to expanding the market opportunities for indigenous weaning foods, relevant stakeholders need information in the task of monitoring price margins of producers and marketers alike to avoid monopolistic practices and unfair business competition. One such source of information on the occurrence of unfair business competition is the structure, conduct, and performance.

Studies on the nature of marketing of weaning foods, especially locally processed ones, have been in the empirical box, not receiving much attention as most industrial products, unlike other agricultural market products (Imodu and Afolabi, 2002), on the assumption that locally processed weaning food markets are highly performing competitive markets with low market power. Available studies have focused on the nutritional value of indigenous weaning foods and their consumption. In this era of technological advancement and increasing competition,

buyer's needs, interests, and preferences keep changing, and there is a need for a thorough understanding of the marketing system of these foods (Wanjohi and Karani, 2017). Hence, researchers, manufacturers, marketers, and consumers of infant weaning foods need to be abreast of these changes and constantly modify and improve their offerings to meet with demand. Marketing of indigenous weaning foods that can be prepared easily from available raw materials using simple processing technology that is within the reach of the producer is also of great importance here.

This study examined the structure, conduct, and performance of indigenous weaning food markets in Benue State, Nigeria. It provides an up-to-date concentration measure that more accurately reflects the markets within which the price is determined for weaning foods in Benue States, Nigeria. It explores a situation where there are processors producing weaning foods that are produced using assets that could readily be reassigned to the production of the relevant product in the weaning food market.

2. Methods and Data

The data for the study were drawn from a sampling frame of indigenous weaning-food producers who double as marketers in Benue State, Nigeria. Benue State is one of the North-Central states in Nigeria with coordinates 7°20'N 8°45'E. It occupies a landmass of 34,059 km² and a population of approximately 4,253,641 in 2006 census spread across the 23 Local Government Areas of the State. The state borders Nasarawa State to the north, Taraba State to the east, Kogi State to the west, Enugu State to the southwest, Ebonyi and Cross-Rivers States to the south, and has an international border with Cameroon to the southeast. Agriculture is the mainstay of the economy, engaging more than 70% of the working population and over 75% of the farming population. Its rich agricultural produce is not limited to cattle, pork, poultry, goat, yam, rice, beans, cassava, sweet potato, maize, soybean, sorghum, millet, sesame, and cocoyam. A rough estimated employment percentage in the state suggests 75% farmers, 10% traders, 6% civil servants, and 9% private initiatives. Private initiatives in commerce and industry, particularly by indigenes, are also on a small scale and limited to carpentry, shoe repairs and manufacturing, small-scale rice mills, leather and plastic industries, weaving, printing, catering, block making, and food processing. The Zaki-Ibiam International yam market is the largest market for a single product in Nigeria. Benue State towns are categorized into three groups. The first group consists of towns with a population of 80,000–500,000 people. These include Makurdi, the State Capital, and Gboko and Otukpo the “headquarters” of the two dominant ethnic groups with 125,944 and 88,958 people, respectively. The second group comprises towns with a population of between 20,000

and 50,000 people and includes Katsina-Ala, Zaki-Biam, Ukum, and Adikpo, Kwande. The third category comprises towns with a population of 10,000–19,000 people and includes Vandeikya, Lessel, Ihugh, Naka, Adoka, Aliade, Okpoga, Igumale, Oju, Utonkon, Ugbokolo, Wannune, Ugbokpo, Otukpa, Ugba, and Korinya. Most of these towns are the headquarters of recently created Local Government Areas and/or district headquarters or major market areas. Some of the headquarters of the newly created LGAs have populations of less than 10,000 people. Such places include Tse-Agberaba, Gbajimba, Buruku, Idekpa, Obagaji, and Obarikeito. The study, hereafter, represents these categorized groups as zones A, B, and C.

A two-stage sampling procedure was used to select marketers in each zone. The first stage used purposive sampling of towns from the three zones. The towns were Makurdi in Zone A, Zaki-Bian, and Ukum in Zone B, and Vandeikya, Ihugh, Naka, Aliade, Oju, Ugbokpo, and Ugba in Zone C. The second state was the simple random sampling of weaning food marketers. The sample size for the study in each town was determined using the small sample-size estimator of Krejcie and Morgan (1970) at 95% confidence interval and 0.05 degree of accuracy as used by Ojogho and Imade (2022). The sample size estimator is given as

$$S_i = \frac{\chi^2 N_i P(1-P)}{d^2(N_i-1) + \chi^2 P(p-1)} \quad [1]$$

Where S_i is the sample size of the i th community, N_i is the maximum target population proportion of the i th community, $\chi^2_{(0.05,1)} = 3,841$, and $d = 0.05$. The sample size was 52 from Makurdi in Zone A, 53 from Zaki-Bian and 62 from Ukum in Zone B, 15 from Vandeikya, 16 from Ihugh, 18 from Naka, 12 from Aliade, 16 from Oju, 14 from Ugbokpo and 15 from Ugba in Zone C of the State. However, only 49 copies of the questionnaire from Makurdi in Zone A, 33 from Zaki-Bian, 42 from Ukum in Zone B, 13 from Vandeikya, 15 from Ihugh, 16 from Naka, 11 from Aliade, 15 from Oju, 12 from Ugbokpo, and 10 from Ugba in Zone C of the State were valid for analysis.

3. Model Specification

A number of different indices or measures of market (industry) concentration have been proposed over the years (Kvålseth, 2022). The study followed the method used by Ojogho and Olisakwe (2023). This age-long framework presumes a causal link between the structure of the market, the nature of competition, and market outcomes in terms of prices, output, and profits. However, a good measure of concentration should be inversely related to the number of firms and positively related to the magnitude of size inequalities. In Ojogho and Olisakwe (2023), the Herfindahl index was stated to consider both the number of firms and their relative size, theoretically justified using the static Cournot model, and satisfy the

necessary and desirable properties of continuity, symmetry, zero-indifference, and Schur-convexity (Kvålseth, 2015), except the value validity (Kvålseth, 2022). Schur convexity is also important as it preserves the transfer property and Lorenz order (Marshall et al., 2011). It follows, therefore, that the HHI is only appropriate for making order comparisons of concentration values, not difference or relative difference comparisons. If S_i is the static market share of the i th marketer in a weaning-foods market, the Herfindah– Hirschman index (HHI) for the structural analysis of weaning - foods markets was defined as $HHI = \sum s_i^2$. However, an approximation of any concentration index in relation to HHI for n -observations is given as $C = \left(1 - \frac{1}{n}\right) \sqrt{\frac{nHHI-1}{n-1}} + \frac{1}{n}$ (Kvålseth, 2020) but lacks the zero - indifference property. Consequently, the study used a corrected Herfindah– Hirschman concentration index HHI^c , that approximately meets the value-validity condition, defined by Kvålseth (2020) as follows:

$$HHI^c = \begin{cases} \sqrt{HHI} \text{ if } HHI \geq HHI_0 = \left[\frac{(n+20 - \sqrt{(n-1)(n+40)})}{20} \right]^2 \\ \text{undefined if } HHI < HHI_0 = \left[\frac{(n+20 - \sqrt{(n-1)(n+40)})}{20} \right]^2 \end{cases} \quad [2]$$

The values of HHI^c can reasonably be compared in terms of actual, absolute, or relative differences. However, only order comparisons are permissible if $HHI < HHI_0$. The classification of concentration levels based on HHI^c then are $HHI^c > 2500$ for highly concentrated, $1500 \leq HHI^c \leq 2500$ for moderately concentrated, and $HHI^c < 1500$ for un-concentrated, *ceteris paribus*.

Structural measures such as the HHI have difficulty reflecting the relationships between firms operating at different stages of the production process and how well a market performs from an efficiency perspective. The study included production establishment in the same market since weaning foods are closely substitutable in consumption using the cross-price elasticity of demand. Achieving this was by using the Lerner index (Elzinga and Mills 2011; Giocoli 2012), which relies on the assumption of profit-maximizing behaviour (Bikker, et. al., 2012) and compares a firm’s output price with its associated marginal costs. The Lerner index was stated as follows:

$$L(q) = \frac{P(q) - MC(q)}{P(q)}, q > 0 \quad [3]$$

The Lerner index directly assesses a firm’s ability to charge a supra-competitive price for a particular product. The value of the Lerner index is monotonically associated with market

power, and a zero value reflects competitive behaviour, whereas a positive value is associated with market power. Under profit maximization, $L(q^*) = \epsilon_d^{-1}(q^*)$. Here q^* is the profit-maximizing output quantity and $\epsilon_d^{-1}(q^*) = \frac{-P'(q^*)q^*}{P(q^*)}$ the firm's inverse price elasticity of demand evaluated at q^* (Lerner 1934) with $L(q^*) \geq 0$, while $L(q) < 1$ for any $q > 0$. Thus, competitive ($\epsilon_d = \infty$) was distinguished from uncompetitive ($\epsilon_d(q^*) < \infty$) behaviour on the basis of the Lerner index sign. The standard interpretation of the Lerner index is that a zero value reflects competitive behaviour, whereas a positive value is associated with market power.

In the indigenous weaning-foods industry, the output cannot generally be stored for too long and so may have to be supplied on demand. Producers try to supply weaning food at the lowest possible costs. Similarly, producers do not have the luxury of collective price bargaining, so input prices are fixed in the price-taking sense. If this is the case, producers will choose the mix of inputs that minimizes the cost of producing any given level of output. Similarly, industry behavior strongly correlates with industry structure; the larger a firm is within its industry, the more likely it is to engage in supra-competitive pricing or other anti-competitive conduct (Ojogho and Olisakwe, 2023). To determine the Lerner Index and market demand elasticities of the different indigenous weaning foods, given $P(q)$ as the inverse demand function satisfying $P'(q) \leq 0$ and $C(q)$ denoting a twice differentiable total costs as a function of output given as:

$$C(q) = \begin{cases} F + \int_0^q C'(x) dx & \text{for } q > 0 \\ 0 & \text{otherwise} \end{cases} \quad [4]$$

with the corresponding marginal cost function, $MC(q) > 0$ and a fixed cost, F , the Cobb–Douglas cost stochastic frontier parameterization that corresponds to the Cobb–Douglas production technology was adopted to estimate the marginal cost. The function is stated explicitly as

$$\ln c = \beta_0 + \beta_1 \ln Q + \beta_2 Q^2 + \beta_3 \ln P + \beta_4 \ln M + \beta_5 \ln T + \beta_6 \ln S + \varepsilon \quad [5]$$

Where P is the cost of processing raw material to 1 kg of weaning-foods M is the marketing charge on 1 kg of weaning-foods T is the transaction cost on 1 kg of weaning-foods S is the storage cost on 1 kg of weaning-foods ε is the composite error term of disturbance and cost inefficiency $\beta_3 = \frac{\alpha_1}{r}$, $\beta_4 = \frac{\alpha_2}{r}$, $\beta_5 = \frac{\alpha_3}{r}$, $\beta_6 = \frac{\alpha_4}{r}$, $\beta_5 = \frac{\alpha_5}{r}$, while α_i are the parameters of the generalized Cobb–Douglas production function to be estimated and r is degree of economies of scale that is a continuous function of output. A simple cross-market regression

was used to compare performance in different weaning-food markets and its determinants. The equation was stated as

$$l_i = \gamma_0 + \gamma_1 H_i + \delta' X_i + \varepsilon_i \quad [6]$$

where l_i was the Lerner index as a measure of performance of the i th weaning food marketer, H_i was the Herfindah–Hirschman index as a measure of market concentration in the study area, and X_i for $\forall i = 1, 2$ were efficiency of production and demand elasticity for a weaning food market that measure other factors considered to affect performance.

4. Results and Discussion

The estimates of the market concentration index of the indigenous weaning-foods market are presented Table 1. The results showed that for the weaning-foods market in the state, only the akamu and akamu-okiri markets (729.171) in zone A and the akamu-joro market (739.317) in zone B had a defined market concentration index. In zone C of the state, all weaning food market concentration indexes were undefined. In the entire Benue State, only the akamu and akamu-okiri markets and the akamu-joro market had a defined concentration index. The market concentration index for the akamu-joro market (757.014) was higher than that of the akamu and akamu-okiri markets (692.698), implying a difference and relative difference in market concentration of 64.316 and 9.28%, respectively, in the state.

These results suggest that processors of akamu-joro have higher technological progress and innovation, leading to decreased competition and efficiency than processors of other weaning foods. Thus, the markets for akamu-joro can be said to be largely exempt from anticompetitive effects. The markets of such weaning foods with relatively higher market concentrations are more likely to engage in supra-competitive pricing or other anti-competitive conduct.

Table 1: Estimates of the Market Concentration Index of Indigenous Weaning Foods Market in the State

Location	\sqrt{HHI} , HHI, HHI_0				
	<i>Akamu and Okiri</i>	<i>Akamu</i>	<i>Akamu Okiri</i>	<i>Akamu Joro</i>	<i>Akamu Okiri and Akamu Joro</i>
BENUE	692.708 (47.983) [189.109]	555.158 (30.820) [1771.072]	657.701 (43.257) [832.605]	757.014 (57.307) [692.407]	555.140 (30.818) [1314.471]
Zone A	729.171 (53.169) [565.477]	548.799 (30.118) [1375.231]	555.230 (30.828) [2116.465]	886.000 (78.499) [2934.524]	559.446 (31.298) [2604.645]
Zone B	683.462 (46.712) [1088.790]	545.573 (29.765) [587.596]	846.682 (71.687) [1156.225]	739.317 (54.659) [403.456]	555.806 (30.892) [1408.196]
Zone C	650.092 (42.262) [757.121]	642.970 (41.341) [972.228]	598.481 (35.818) [2119.288]	683.462 (46.712) [2116.465]	631.015 (39.818) [921.578]

Source: Authors' computation from 2021 Field Data Survey. Values in parentheses are HHI, values in brackets are HHI_0

In the state where HHI is defined, zone B of the state had higher concentration for akamu-joro (739.317) than for akamu and akamu-okiri (729.171) in zone A, representing a difference and relative difference in market concentration of 10.146 and 1.39%, respectively. These results suggest that the akamu-joro market in zone B is more concentrated than the akamu and akamu-okiri markets in zone A by approximately 10%. Thus, there are more marketers with the possibility of one marketer with a very large market share in the akamu-joro market in zone B with a tendency for asymmetry compared with the akamu and akamu-okiri markets in zone A. These results suggest that processors of akamu-joro in zone B have higher technological progress and innovation than processors of akamu and akamu-okiri in zone A and other weaning foods in the state. The results of the concentration index in the state suggest that weaning food markets can be classified as unconcentrated. The market structure for agricultural products in Nigeria has been adjudged not perfectly competitive (Imoudu and Afolabi, 2002).

Estimates of the Lerner index and marginal cost of indigenous weaning foods in the study area are presented in Table 2. The results showed that the Lerner index values for all weaning foods in the study area are greater than zero. Under long-run competitive equilibrium, this

would imply some degree of market power, implying some attendant welfare loss and likely motivating some policy response. The results also showed that in the State, akamu and akamu-okiri had the highest marginal cost of production (N108.13) and the lowest marginal cost of production (N80.42). The trend is the same in the zone A of the State. This explains the lowest level of market power for akamu and akamu-okiri in the state. This is also true for Akamu-Okiri in zone B and akamu and akamu-okiri in zone C of Benue state. This was also true in zone B and zone C of the state where akamu and aramu-okiri had the highest levels of marginal cost than other weaning foods in the state and the lowest Lerner index. The contrary can be said about Akamu-Okiri in Benue state, which has a higher marginal cost and Lerner index of 111.010 and 0.724, respectively, than other weaning foods in the state. This suggests that because akamu-okiri in Benue state has even higher price levels, the price level difference between akamu-okiri and other weaning foods in the state is larger than the difference in the level of marginal cost of the other categories of weaning foods markets. Imoudu and Afolabi (2002) attributed this to the collusive tendencies of sellers by forming associations for a particular product.

Overall, it is noticed that the weaning-foods industry in the study area has a high level of market power, with the Lerner index reaching 0.807 in the Akamu-Okiri market. This shows that the weaning food markets in the study area are far from perfect or near-perfect competition. In other words, the weaning food industry in the study area, *ceteris paribus*, yields a higher price level, which is a bad signal for the welfare of society. This is evident in the mark-up factor that ranges from 2.924 to 8.264, suggesting that the weaning food producers charge a price that is between 2.92 and 8.264 inclusive of the marginal cost. On the other hand, this is a signal for higher profits to firms. This will most likely improve the production technology and lower prices of weaning foods in the future for the study area.

Table 2: Estimates of Marginal Cost of Indigenous Weaning-Food Marketing in Benue State, Nigeria

Location	<i>Akamu and Akamu-Okiri</i>		<i>Akamu</i>		<i>Akamu-Okiri</i>		<i>Akamu-Joro</i>		<i>Akamu Okiri and Akamu Joro</i>	
	MC	Lener index	MC	Lener index	MC	Lener index	MC	Lener index	MC	Lener index
BENUE	108.131 [35.861]	0.696 [0.105]	80.428 [32.876]	0.804 [0.043]	111.010 [36.673]	0.724 [0.103]	99.327 [25.297]	0.779 [0.053]	83.761 [27.671]	0.792 [0.077]
Zone A	96.298 [32.902]	0.727 [0.100]	80.428 [31.801]	0.804 [0.120]	92.020 [30.477]	0.759 [0.100]	85.520 [21.542]	0.809 [0.045]	69.432 [22.996]	0.818 [0.075]
Zone B	126.348 [39.508]	0.658 [0.114]	113.209 (28.130)	0.732 (0.085)	128.698 [32.530]	0.697 [0.090]	113.039 [22.617]	0.751 [0.047]	97.107 [24.545]	0.771 [0.068]
Zone C	110.162 [31.957]	0.686 [0.097]	83.902 (23.154)	0.710 (0.054)	106.043 [37.147]	0.725 [0.112]	90.250 [23.846]	0.797 [0.052]	80.013 [28.028]	0.794 [0.084]

Source: Authors' computation from 2021 Field Data Survey. Values in brackets are standard deviations, MC is Marginal cost

The results of the market performance determinants in each state are presented in Table 3. The results show high R-square values for the least square estimation. This implies that HHI, market demand elasticity, and market efficiency are sufficient to explain the variation in market performance of weaning food firms in the state. The results also showed that HHI and market demand elasticity were statistically significant at $p < 0.1$ at least in explaining market performance of weaning foods marketing among akamu and akamu-okiri, akamu-okiri and akamu-okiri, and akamu-moro marketers in the state. The positive relationship of HHI with market performance of weaning foods marketing among akamu and akamu-okiri, akamu-okiri and akamu-okiri, and akamu-joro marketers in the state implies that market power is exploited by weaning foods marketers in more concentrated markets in the state. Among akamu and akamu-okiri, akamu-okiri and akamu-okiri, and akamu-joro marketers, a unit increase in HHI would increase the market power by approximately 0.56, 0.29, and 0.24, respectively. These also imply that if HHI is causal, concentration causes high margins for marketers in the state. Similarly, the negative relationship of market demand elasticity with market performance of weaning foods marketing among akamu and akamu-okiri, akamu-okiri and akamu-okiri, and akamu-joro marketers in the state implies a lack of market power being exploited by weaning foods marketers in markets with elastic price demand for weaning foods in the state. Among akamu and akamu-okiri, akamu-okiri and akamu-okiri, and akamu-joro marketers, a unit increase in market demand elasticity would decrease the

market power by approximately 0.42, 0.58, and 0.62, respectively. One potential implication of such a relationship, were it capturing a causal relationship indicating that weaning foods market structure causes high margins and profits, would be that if the weaning foods firms are split-up, reducing concentration, profits but also margins would fall and that would help consumer welfare.

The trend is the same with efficiency of production and market performance in the case of akamu and akamu-ogiri. The positive relationship between efficiency of production and market performance of weaning foods marketing among akamu and akamu-ogiri marketers in the state implies evidence of market power being exploited by weaning foods marketers with significant levels of efficiency of production in the state. Among akamu and akamu-ogiri marketers in the state, a unit increase in efficiency would increase the market power by approximately 0.09 and 0.07, respectively.

Table 3: Least Squares Estimates of Market Performance Determinants of Local Weaning Foods Marketing in Benue State

Variables	Coefficients				
	<i>Akamu and Akamu Ogiri</i>	<i>Akamu</i>	<i>Akamu Ogiri</i>	<i>Akamu Joro</i>	<i>Akamu Okiri and Akamu Joro</i>
HHI	0.561* (0.300) [0.027]	-0.016 (0.036) [0-.002]	0.292* (0.165) [0.030]	-0.145 (0.151) [-0.010]	0.241* (0.131) [0.015]
Efficiency	0.119 (0.110) [0.023]	0.089*** (0.014) [0.037]	0.066** (0.025) [0.034]	0.040 (0.064) [0.011]	0.077 (0.064) [0.014]
Market Demand Elasticity	-0.419*** (0.031) [-0.976]	-0.674*** (0.015) [-1.005]	-0.584*** (0.015) [-1.004]	-0.584*** (0.020) [-0.997]	-0.617*** (0.010) [-0.992]
constant	1.198*** (0.086)	1.555*** (0.027)	1.464*** (0.036)	1.493*** (0.051)	1.499*** (0.070)
R-square	0.9494	0.995	0.992	0.993	0.996

Source: Authors' computation from 2021 Field Data Survey, *significant @ $p < 0.1$, **significant @ $p < 0.05$, ***significant @ $p < 0.001$, values in parentheses are standard errors, values in brackets are standardized beta coefficients

5. Conclusion

The study used data from a cross-section of 216 indigenous weaning-food marketers in Benue State, Nigeria, to examine the structure, conduct, and performance of these marketers using the corrected Herfindah– Hirschman Index (HHI) and Lerner index. There was evidence that weaning-foods firms charge a price that ranges from about 4 to 8 times the marginal cost. Market performance in the state was determined mainly by HHI, market efficiency, and demand price elasticity, or a combination of any of these across the zones. Indigenous weaning food markets in the state are not only unconcentrated, with high market power, and with market performance impacted by HHI, production efficiency, and demand price elasticity, but the SCP affects the market price.

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Eco-Innovations, Sustainable Livelihoods and Resilience among Small-Scale Wheat Farmers in Jigawa State of Nigeria

Sadiq, M.S¹., Singh, I.P²., Ahmad, M.M³. Gama, E.N¹ and Sambo, A.A⁴.

Abstract

The adoption of eco-innovations for sustainable livelihoods among wheat farmers in Jigawa State, Nigeria, presents a pressing problem that necessitates attention and intervention. Despite the potential benefits associated with eco-friendly agricultural practices, the rate of adoption remains a significant challenge, hindering the attainment of sustainable livelihoods for wheat farmers in the region. Consequently, this research is timely as it investigates the spectral effects of eco-innovations on the sustainable livelihood resilience of small-scale wheat farmers in Jigawa State, Nigeria. Using cross-sectional data elicited through a well-structured questionnaire coupled with an interview schedule from a total of 284 farmers selected via a multi-stage sampling technique during the 2022–2023 cropping season, the research gap was analyzed using both descriptive and inferential statistics. In spite of the accumulative livelihood strategy and high adoption of eco-innovations among the majority of farmers, the extension gap challenge hampered the landslide adoption of eco-innovations and the intention to key into crop insurance among these farmers. Though marginally above the average sampled population, the majority of the farmers accepted the idea of crop insurance, and this owed to the skeletal reach of the risk sharing system of the NIRSAL programme in the study area. Nevertheless, the majority of the farmers had their farms to be sustainable, which underscores the importance of adopting eco-innovations as a climate change resilience measure, thus enabling them to achieve the accumulated livelihood strategy in the study area. Succinctly, adoption of eco-innovations has a strong endogenous effect on livelihood status en-route farm sustainability but a weak endogenous effect on livelihood status en-route willingness-to-pay (WTP). Consequently, onus lies on policymakers to address the extension gap by enhancing advisory services for effective feed-forward and feed-backward flows of information sources, risk orientation, and slight modification of the neo-conventional eco-innovations in order to suit the farms' ecological settings in the study area. This singular approach has the potential to be a single silver bullet that will enhance farmers' climate change resilience, farms' sustainability, and guarantee a prosperous sustainable farm family livelihood status in the study area.

Keywords: *Eco-innovations; Adoption; Sustainability; Livelihood; Resilience; Wheat farmers; Nigeria*

¹Department of Agricultural Economics and Extension, FUD, Dutse, Nigeria

²Department of Agricultural Economics, SKRAU, Bikaner, India

³Department of Agricultural Economics and Extension, BUK, Kano, Nigeria

⁴Graduate Student, Department of Agricultural Economics and Extension, FUD, Dutse, Nigeria

Author's correspondence address: Sadiq, Mohammed Sanusi, Department of Agricultural Economics and Agribusiness, FUD, P.M.B. 7156, Dutse, Nigeria

Email: sadiqsanusi30@gmail.com (+2347037690123)

0000-0003-4336-5723^a,  0000-0002-1886-5956^b,  0000-0003-4565-0683^c, 0000-0003-4532-7982^d and 0009-0006-2977-4968^e

1. Introduction

An important part of Nigeria's agricultural landscape is Jigawa State, which is situated in the north. One of the main economic activities in the area is agriculture, with wheat farming having a special significance. Small-scale farming, where many families make their living from growing wheat, is the main driver of the state's economy. Nigerian wheat is a staple crop that is very important both economically and nutritionally. In Jigawa State, wheat farming is the main source of income for many people and makes a significant contribution to both revenue generation and food security. However, a number of issues, such as soil erosion, climate variability, and conventional agricultural practices that could upset the ecological balance, pose a threat to the sustainability of wheat production.

Eco-innovations comprise a range of methods and tools intended to reduce environmental effects while fostering economic viability/feasibility (Dybikowska and Graczyk, 2019; Dudek and Wrzaszcz, 2020; Alizadeh et al., 2022). These advancements encompass sustainable resource management, organic farming, agro-ecological methods, and water-saving strategies (Aroonsrimorakot et al., 2021; Buchana, 2023). Farmers that embrace eco-innovations may be able to decrease their reliance on hazardous agrochemicals, increase the sustainability of the environment overall, and strengthen the resilience of their farming systems to climate change (Tretiak et al., 2021; Todorova, 2022). Like many other places in the world, Jigawa State struggles with issues related to the environment, such as irregular rainfall patterns, degraded soil, and limited water supplies. Unsustainable farming methods, including overusing chemical inputs, might make these problems worse and force a move toward eco-innovations. Although Jigawa State may have some broad studies on agriculture, there aren't many studies specifically looking at wheat farmers' adoption of eco-innovations. If any research has been done thus far, it might not fully cover the special opportunities and problems related to sustainable farming methods in the area. Therefore, a crucial field of research with significant consequences for environmentally conscious farming, sustainable farming methods, and small-scale farmers' livelihoods is the adoption of eco-innovations by wheat farmers in Jigawa State, Nigeria.

The policies and other support systems in place have an impact on the adoption of eco-innovations. Jigawa State's current agriculture laws don't have any explicit clauses or incentives to encourage wheat growers to widely implement eco-innovations. It is difficult to incorporate environmentally friendly techniques into regular agricultural operations when there are gaps in policy or poor execution. Nonetheless, Jigawa State's wheat farmers are not fully guided or encouraged to embrace sustainable practices by the policies that have been put in place. Furthermore, there is a dearth of research on wheat farmers' reasons for adopting eco-innovations, as well as their obstacles and viewpoints. Designing effective solutions

therefore requires an awareness of farmers' attitudes, knowledge gaps, and sociocultural issues.

Jigawa State's wheat producers are particularly susceptible to the negative effects of climate change, which is a danger to agricultural productivity. The need for sustainable and environmentally friendly farming methods is growing as worries about climate change and environmental sustainability spread around the world (Durán-Romero et al., 2020; Leszek and Grzegorz, 2021; Yordanova, 2023). Under these conditions, implementing eco-innovations becomes an essential means of reducing environmental deterioration, strengthening climatic resilience, and guaranteeing the sustainability of agricultural practices. Furthermore, investigating eco-innovations becomes essential for determining methods that can improve climate resilience, reduce environmental hazards, and support wheat farming's long-term sustainability. Furthermore, wheat cultivation in Jigawa State plays a vital role in the financial stability of many families. Understanding the uptake of eco-innovations is vital for assessing their potential to boost farmers' income, cut production costs, and contribute to overall livelihood sustainability.

Even with the potential advantages of eco-innovations, further research is needed to determine how widely adopted they are among Jigawa State's wheat growers. Comprehending the variables impacting the implementation of sustainable practices is imperative in order to formulate focused interventions, formulate efficacious policies, and endorse environmentally conscious farming techniques that conform to the distinct socio-economic and environmental milieu of Jigawa State.

Succinctly, the need to solve environmental issues, strengthen climate resilience, and promote small-scale farmers' social and economic well-being is what drives this research. This study is to close knowledge gaps and offer insightful information to the farming community, academic institutions, policymakers, and agricultural extension services in order to ensure the long-term sustainability of wheat growing in Jigawa State and to encourage sustainable practices. To put it another way, this study aims to provide important insights that can guide policies for improving sustainable livelihoods, safeguarding the environment, and ensuring the continued existence of wheat farming in the area by examining the current state and dynamics of adoption. Research on the particular nuances of these problems in the context of Jigawa State, however, will be crucial for developing strategies that encourage wheat farmers to adopt eco-innovations, which will ultimately help the region achieve sustainable livelihoods. Consequently, the following specific research objectives were carefully designed: to assess the current adoption status of eco-innovations among wheat farmers; to identify the key drivers and barriers influencing the adoption of eco-innovations practices; to determine sustainability of wheat farm in the study area; to assess the livelihood status of the wheat

farmers; to assess willingness-to-pay (WTP) for crop insurance in the study area; to evaluate the environmental and economic impacts of eco-innovations adoption on wheat farming sustainability and livelihoods' of the farmers; and to provide insights for policymakers, extension services, and farmers to enhance the adoption of eco-friendly practices.

2. Research Methodology

The State is one of the 36 States in the country that shares common borders with Kano State and Katsina State to the West, Bauchi State to the East and Yobe State to the Northeast. The State has a shared international border with the Zinder Region of the Republic of Niger to the north, which presents a special possibility for cross-border trade activity (Jigawa State Government (JSG), 2017; 2021). It is located in the country's Northwestern region between latitudes 11°N and 13°N and longitudes 8°E and 10.15°E Greenwich meridian time. It is the eighth most populous state in terms of ethnic composition, with a predominance of Hausa and Fulani residents (JSG, 2017). Rainfall volume normally varies between 600 and 1000 millimetres during the rainy season, which runs from May to September, according to Sadiq and Sani (2022). The province's southern region has heavier rainfall than its northern region does (Sadiq and Sani, 2022). The State's overall land area is about 22,410 square kilometres, and the estimated population is 4,361,002 (National population Commission (NPC), 2017), with a current projection of 4,884,322 million people at a 3% growth rate. Sand dunes of varied sizes that extend several kilometres in some areas of the state add to its undulating geography. The Hadejia, Kafin-Hausa, and Iggi Rivers are the primary rivers, and other tributaries in the state's northeast feed large marshlands. The Hadejia and Kafin-Hausa Rivers traverse the state from the west to the east through the Hadejia-Nguru wetlands before emptying into the Lake Chad Basin. The state's economy is still heavily dependent on agriculture, and because of its semi-arid climate, workers frequently migrate to nearby states like Kano State in search of seasonal work (JGS, 2021). One of the state's most valuable natural resources is its large tracts of lush arable land, to which nearly all tropical crops may adapt. A large portion of the Sudanese savannah vegetation zone consists of grazing areas that are ideal for raising livestock.

Using a multi-stage sampling technique, a total of 283 selected active wheat farmers were used to elicit farm survey data. Firstly, given that wheat production cuts across all the agricultural strata of the state, the saturated sampling frame of the stratified Jigawa State Agricultural and Rural Development Agency (JARDA) zones, namely, Zone I (Birnin-Kudu), Zone II (Hadejia), Zone III (Gumel) and Zone IV (Kazaure) was taken. Secondly, the major producing Local Government Areas (LGAs) in each zone were purposively selected. The selected LGAs

in Zones I, II, III and IV were Jahun; Ringim; Hadejia; and, Kazaure respectively. Thirdly, from each of the selected LGAs, three (3) villages were randomly selected, thus giving a total of 12 selected villages. Lastly, based on the sampling frame obtained from the JARDA and Reconnaissance survey (Table 1), a Krejcie and Morgan formula (Equation 1) was used to generate the representative sample size for the study. Thus, a total of 283 active wheat farmers were randomly selected. Using an easy cost-route approach, farm survey data for the 2022 wheat production season were elicited with the aid of a well-structured questionnaire coupled with an interview schedule. In descending order, the objectives were achieved using adoption index; confirmatory factor analysis (CFA) jointly with composite index, farm sustainability index; livelihood sustainability index; contingent valuation method; and CFA (formative and reflective models).

Table 1: Sampling Frame of Wheat Farmers in the Study Area

Zones	LGAs	Villages	Population	Sample size
Birnin Kudu Zone (Zone I)	Jahun	Harbo Tsohuwa	134	16
		Harbo Sabuwa	149	18
		Jama'a	137	17
Gumel Zone (Zone II)	Ringim	Ringim Town	130	16
		Gabarin	143	18
		Dabi	198	24
Hadejia Zone (Zone III)	Hadejia	Sunamu	178	22
		Mai Alkama	258	31
		Hago	184	23
Kazaure Zone (Zone IV)	Kazaure	Farin Daba	321	39
		Gada	230	28
		Tudun Wayo	250	31
Total 4	4	12	2312	283

Source: Reconnaissance survey, 2021; Jigawa State Agricultural and Rural Development (JARDA), 2021

$$n_p = \frac{N(X)}{X + (N - 1)}, \dots\dots\dots (1)$$

$$X = \frac{Z^2 * P(1 - P)}{e^2}, \dots\dots\dots (2)$$

n = Sample size; N = Population size; e = Acceptable sampling error; X= Finite sample size; and, P = Proportion of the population

3. Model Specification

3.1 Adoption Index:

Using a numerical strength, the adoption index is given as follows (Table 2a):

$$ADPI = \frac{\text{Adopted technology}(s)}{\text{Total available technologies}} \dots\dots\dots (3)$$

Where, ADPI is Adoption index

3.2 Eco-Innovation Attributes:

Following Alizadeh et al.(2022), the six attributes of eco-innovations statuses viz. awareness (AW), attitude (AT), knowledge (KN), information access (IN), willingness to creativity (WC), and risk orientation (RT) were assessed using composite index (Table 2a). Adapted from Sadiq et al.(2023), the following are the formulae used to achieve the composite index:

$$I_s = \frac{I_i - I_{min}}{I_{max} - I_{min}} \dots\dots\dots (4) \text{ (Minimization normalization index)}$$

$$I_s = \frac{I_{max} - I_i}{I_{max} - I_{min}} \dots\dots\dots (5) \text{ (Maximization normalization index)}$$

Where, I_s is the sub-indicator index, I_i is the value of the i^{th} sub-indicator; I_{min} is the minimum value of the i^{th} sub-indicator; and, I_{max} is the maximum value of the i^{th} sub-indicator.

$$I = \sum_{i=1}^{n=0} \left(\frac{W_{si} * I_{si} + \dots\dots\dots + W_{sn} I_{sn}}{W_{si} + \dots\dots\dots + W_{sn}} \right) \dots\dots\dots (6) \text{ (Composite index)}$$

Where, I is the indicator/dimension index of i^{th} farmers and w is the weight of i^{th} sub-indicator index.

Table 2a : Eco-Innovations and their Attributes

Eco-innovations	Mechanism	Effects
Bio-fertilizers	Process	Reduces costs; Easier to use; Marketability
Bio-control	Process	Protects soil microorganisms; Increases crop yield ; Increases the profit
Conservation tillage	Process	Increases fertility; Save water; Reduces costs
Crop rotation with legumes	Process	Increases fertility; Increases income; Increases the quality of the product
Soil mulching	Process	Increases fertility; Protects soil microorganisms; Increases crop yield
Water management	Process	Saves water usage; Reduces costs; Makes irrigation easier
Waste management	Marketing	Increases profits ; Product marketability
Organic production	Product	Improve the health of the community; Increases income in the long time
Product in ecological packing	Marketing	Desire to buy; Increases profit; Waste limiting
Social media for the production of organic products	Organizational	Increases knowledge and information; Development of organic products production
Personalities and cognitive characteristics		
Eco-innovation awareness		6 likert scale (Very highly aware to Very unaware)
Attitude towards eco-innovation		6 likert scale (Very high to Poor)
Eco-innovation knowledge		6 likert scale (Very high to Poor)
Access to sources of information		6 likert scale (Very high to Poor)
Creativity willingness		6 likert scale (Very high to Poor)
Risk oriented		6 likert scale (Very high to Poor)

Source: Adapted from Alizadeh *et al.*(2022)

3.3 Farm Sustainability Assessment Index:

In measuring farm sustainability index, three dimensions of farm sustainability vis-à-vis economic (ES), social (SS) and environmental (ENS) sustainability indicators were aggregated (Nazir *et al.*, 2017; Ranasinghe *et al.*, 2021) (Appendix). The economic, social and environmental sustainability were measured using economic efficiency index, social security index and environmental security index respectively. Given below is the model; succinctly,

the composite index of the sustainability indicators were first subjected to normalization (minimum and maximum) (see equations 4 and 5 for the normalization formula). Presented below are the sub-sustainability and sustainability composite indexes.

$$S_s = \sum_{i=1}^{n=0} \left(\frac{w_{si} * S_{si} + \dots + w_{sn} S_{sn}}{w_{si} + \dots + w_{sn}} \right) \dots \dots \dots (8) \text{ (Composite index)}$$

Where, S_s is the sub-dimension (ESI/SSI/ENSI) index of i^{th} farmer(s) and w is the weight of i^{th} sub-dimension index.

$$S_i = \frac{ES + SS + ENS}{w_{ES} + w_{SS} + w_{ENS}} \dots \dots \dots (9)$$

Where, S_s is the farm sustainability index of i^{th} farmer(s).

Note: S= sustainable (≥ 2.00); SS= somewhat sustainable (≥ 1.00); IN= intermediate (≥ 0.00); PU= possibly unsustainable (≥ -1.00); PQU= possibly quite unsustainable (≥ -2.00); PVU= possibly very unsustainable (< -2.00) (Adopted categorized names by Shamsudin et al., 1994; Sultana et al., 2021).

3.4 Livelihood Sustainability Index (LSI):

Before specifying the index, the various livelihood indicators were subjected to the normalization index (Equation 4). Nevertheless, the LSI index is given below:

$$LSI_i = \frac{H + N + S + F + P}{w_H + w_N + w_S + w_F + w_P} \dots \dots \dots (7)$$

Where, LSI_i is the Livelihood strategy index of i^{th} households; w is the weight of i^{th} dimension.

The livelihood capital assets' classification (Sadiq and Sani, 2022): $< 20\%$ = very poor; $\geq 20\%$ = poor; $\geq 40\%$ = moderate; $\geq 60\%$ = good; $\geq 80\%$ = very good.

The livelihood strategy classification is: < 1 = survival strategy, ≥ 1 = coping strategy, ≥ 2 = adaptation strategy, ≥ 3 = accumulation strategy (four-scale) (Morris et al., 2001); < 1 = survival strategy, ≥ 1 = coping strategy, ≥ 2 = adaptation strategy, ≥ 3 = consolidation and ≥ 4 = accumulation strategy (five-scale).

Livelihood assets:

The household's livelihood may be constructed on a foundation that is represented by the assets accessible for generating income. The five categories listed below serve as representations of these assets in the DFID framework (Table 2b).

Natural capital (N): refers to the stocks of natural resources that provide resource flows necessary for subsistence (such as land, water, animals, biodiversity, and environmental resources);

Human capital (H): refers to the abilities to work, learn, and maintain good health, all of which are necessary for pursuing a variety of livelihood options;

Physical capital (P): is the production machinery and tools that allow individuals to pursue their livelihoods, as well as the essential infrastructure (transportation, housing, water, energy, and communications);

Social capital (S): the social assets (networks, group membership, trust-based relationships, and access to larger institutions of society) that people rely on in order to support themselves; and,

Financial capital (F): the available financial resources that enable people to choose from a variety of sources of income, such as savings, credit, regular remittances, or pensions.

These assets include both the intangible resources more commonly studied by sociological and anthropological research (such as social capital, health, and educational status) and the tangible productive resources more commonly linked with economic studies (such as land, labor, capital, and stocks).

Table 2b : Livelihood Assets

Dimension	Indicator	Dimension	Indicator
Human capital	Farming knowledge	Financial capital	Income
	Farming skills		Savings
	Farming experience		Assistance / Subsidies
	Health		Individual Credit
	Household size		Credit from Credit Institutions
	Other business skills		Remittances
	Other business experiences		Physical capital
Natural capital	Land fertility	Production facilities	
	Irrigation water sources	Infrastructures	
	Climate suitability	Working equipment	
	Farm production	Accessibility to institutions	
Social capital	Community Organizations		
	Social Networking		
	Mutual cooperation		
	Trust		

Source: modified from Illu *et al.*(2021); Sadiq and Sani (2022)

Livelihood strategy

Among others, Devereaux (1993) and Davies (1996) have distinguished between survival, coping, adaptive, and accumulative strategies (Table 2c). In response to an opportunity, accumulative techniques boost asset stocks and consumption results. Adaptive strategies aim to disperse consumption failure risk in response to foreseen negative trends. This could be achieved by expanding into new activities or by intensifying current livelihood methods. Coping mechanisms involve lowering consumption and depleting assets in order to lessen the effects of a negative shock. In the absence of respite, coping may result in survival tactics. In an effort to avoid poverty and death, survival methods not only dramatically cut back on consumption but also significantly, and most frequently irreparably, deplete household assets.

Table 2c : Typology and Examples of Different Livelihood Strategies

Livelihood strategy	Internal livelihood system component		
	Change to assets	Strategies	Consumption outcomes
Accumulative	Increased asset stock. Increased flexibility across asset base.	As for adaptive	More income. Better nourishment. Increased security.
Adaptive	Altering the mix of assets. Prudently preserving money and other assets.	Extensification (cultivation of more land). On-farm & off-farm diversification (e.g. change in cropping mix, wage labour). Intensification of cash cropping. Investments in social capital. Migration.	Consumption and income smoothing Lowering of risk Spreading of risk. smoothing of labor
Coping	Increased livestock sales Calling down impromptu claims (for instance, via kin networks).	Farm labor, piecework Temporary migration Youngsters being taken out of school.	Reduced meal frequency, size, and quality. Use where available of relief food. Less social and ceremonial duties.
Survival	Selling of useful assets (like bicycles and land). Sale of furniture and other home items.	Illicit behavior. Begging.	Permanent out-migration Poverty and starvation.

Source: Morris *et al.*(2001); Davies (1996); Devereaux (1993)

3.5 Contingent Valuation Method (CVM)

In non-marketed commodities like insurance, CVM is frequently used to evaluate WTP modifications (Gidey *et al.*, 2019; Ogundeji *et al.*, 2019; Njie *et al.*, 2023). The contingent valuation method, which is based on a fictitious market scenario, is frequently used to gauge public willingness to pay. It is also frequently employed in cost-benefit analyses in the field of actuarial economics. The fact that welfare economics serves as the methodology's theoretical underpinning is a notable aspect of WTP's (willingness to pay) approach to

economic evaluation. One of the most popular participative approaches for determining the total economic value (TEV) of different categories of environmental goods and services that are difficult to exchange on the open market is the contingent valuation method (CVM).

Let W_i^0 represent welfare prior to policy intervention (or the status quo), and W_i^1 represent welfare following policy intervention. Additionally, let $W_i^0 \equiv (y_i^0, P^0)$ and $W_i^1 \equiv (y_i^1, P^1)$ reflect, respectively, the budgets that gauge the prices (p) and incomes (y) that consumer i will encounter under the new policy plan. Thus, the change from the status quo level to the level following the implementation of the policy is just the variation in the indirect utility denoted by:

$$v(y_i^1, P^1) - v(y_i^0, P^0) \dots\dots\dots (8)$$

If $v(y_i^1, P^1) - v(y_i^0, P^0) > 0$, the consumer i will consent to the modification brought

on by the new insurance plan. On the other hand, $v(y_i^1, P^1) - v(y_i^0, P^0) < 0$, the customer will reject the proposal. Nevertheless, $m(q; y, P)$ tells us how much money a particular person, i , would require at a vector of pricing, q , in order to be well off as they would be facing prices, P , while having income, y . As a result, equation (8) can be expressed as follows:

$$m(q; y_i^1, P^1) - m(q; y_i^0, P^0) \dots\dots\dots (9)$$

If the sole difference between the pre-policy intervention and post-policy intervention levels is a price shift, such as $q \equiv P^0$ or $q \equiv P^1$, this results in the CV and EV indicators of welfare changes, respectively. They are each defined as follows:

$$EV = m(P^0; y_i^1, P^1) - m(P^0; y_i^0, P^0) = m(P^0; y_i^1, P^1) - y_i^0 \dots\dots\dots (10)$$

$$CV = m(P^1; y_i^1, P^1) - m(P^1; y_i^0, P^0) = y_i^1 - m(P^1; P^0, y_i^0) \dots\dots\dots (11)$$

Equation (11), when expressed in absolute terms, reflects the consumer's WTP to be at W_i^1 . or the sum of money the customer is WTA (willingness to accept) from the policy planner to maintain the previous, declining level of welfare W_i^1 .

AG = Age (years); GEN = Gender (male =1, otherwise =0); ED = Education (year(s)); HHS = Household size (number of person(s)); FEXP = Farming experience (year(s)); AGH = Agricultural holding (hectare); OPH = Operational holding (hectare); LAIN = Logarithm

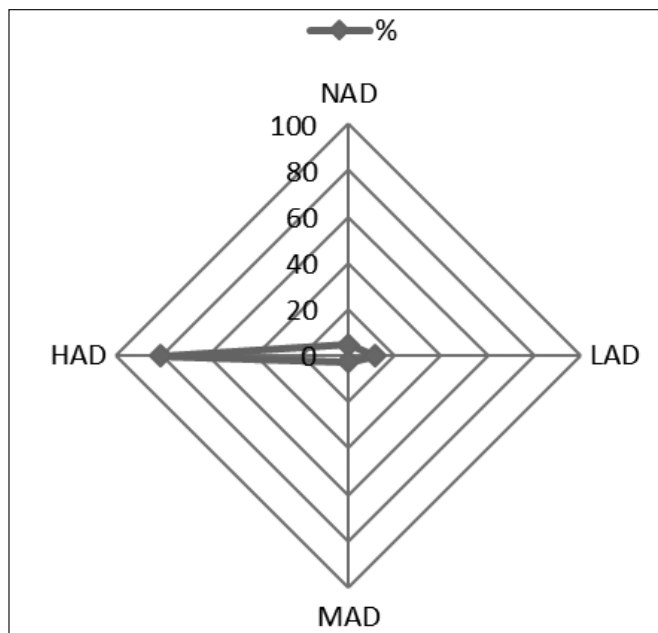
income (Naira); LS Livestock ownership (Tropical livestock unit (TLU)); EXT = Extension contact (yes =1, otherwise= 0); CR = Credit access (yes =1, otherwise= 0); COP = Co-operative membership (yes=1, otherwise= 0); IAW = Insurance awareness (yes =1, otherwise =0); IK = Insurance knowledge (yes =1, otherwise =0); and, CFI = Confidence in financial institutions designated as fund managers for crop insurance.

4. Results and Discussion

4.1 Eco-Innovations' Adoption Status

A perusal of the results showed that the majority (80.9%) of the farmers adopted the eco-innovations, possible as resilience and adaptation measures against weather-induced changes (Figure 1). However, only a handful of the farmers (4.6%) didn't adopt the eco-innovation, and this is likely to have happened among the laggard farmers owing to their reservations about the non-conventional or indigenous technologies. Nevertheless, few of the farmers moderately (11.7%) and less (2.8%) adopted the eco-innovation, and this might be largely attributed to capital paucity and poor knowledge on these technologies, especially the non-conventional eco-innovations.

Figure 1: Adoption status of the farmers

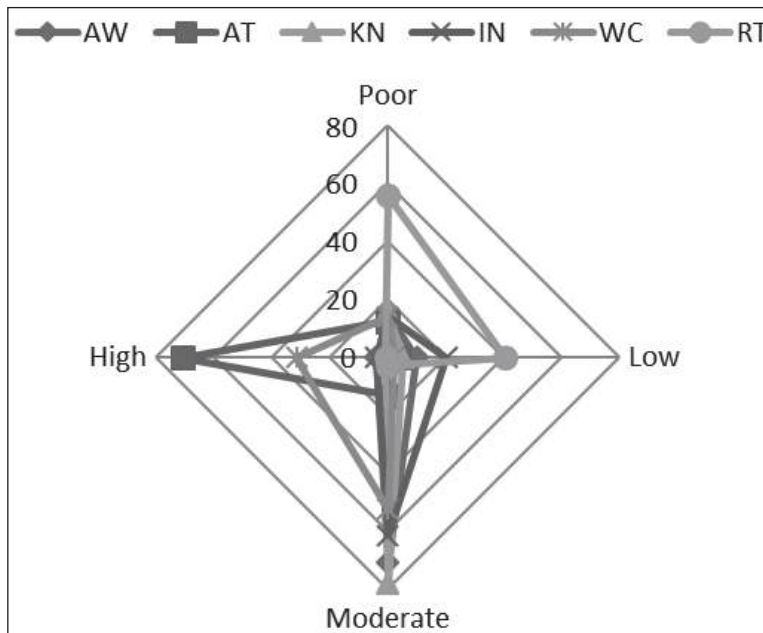


Source: Field survey, 2022

Note: NAD = Non-adoption; LAD = Less adoption; MAD = Moderate adoption; HAD = High adoption

Furthermore, the individual-wise results vis-à-vis the eco-innovation indicators showed that the majority of the farmers had moderate awareness (AW) about the eco-innovations; likewise, moderate knowledge (KN), access to information sources (IN) and creativity willingness (WC) on eco-innovations (Figure 2). Besides, the attitude (AT) towards eco-innovation was established to be high among the majority of the farmers in the study area. However, the majority of the farmers had poor risk orientation (RT) on eco-innovation for sustainable wheat production.

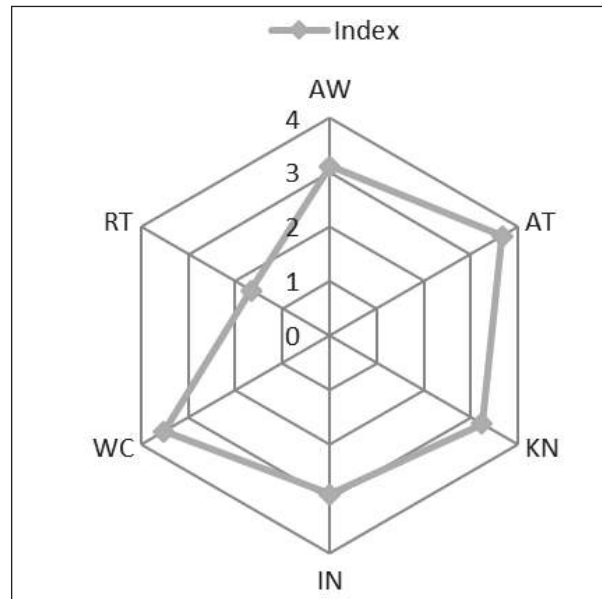
Figure 2: Individual-wise perceptions on eco-innovations' indicators



Source: Field survey, 2022

Nevertheless, average-wise, the farmers were moderately aware about eco-innovations; had moderate creativity willingness on the innovation; moderate knowledge on the innovation; and a moderate attitude towards adoption of the eco-innovation (Figure 3). However, the low access to information sources and risk orientation on eco-innovation might be attributed to the extension gap and poor cosmopolitan link of the farmers; likewise, risk aversion due to fear of capital loss, a limiting factor in a subsistence agrarian setting, is a portend/significant contributory factor. Consequently, it can be inferred that the duo of the foregoing indicators were the challenge to adequate adoption of eco-innovation for sustainable wheat farming in the study area.

Figure 3: Average-wise perceptions on eco-innovations' indicators



Source: Field survey, 2022

Furthermore, the CFA results after satisfying the diagnostic validity of model fit showed all the indicators, except creativity willingness (WC), to have significantly influenced adoption of eco-innovation, as evident by their respective coefficients, which were within the acceptable error margin of 1% probability level (Table 3a). Empirically, the inelastic of awareness (AW), knowledge (KN), and risk orientation (RT) coefficients implied they are necessities for eco-innovation adoption. The elastic of attitude (AT) coefficient means it is a superfluity for eco-innovation adoption; while, the perfect inelastic of access to information sources (IN) coefficient implied it has a secondary effect on eco-innovation adoption (Table 3b and Figure 4). Thus, the implication is that the farmers had a keen interest in awareness, knowledge and risk orientation in the adoption of eco-innovations. However, the less interest in the sources of information might be attributed to the fact that most of these farmers fall into the early majority adoption category, characterized by a non-cosmopolitan nature and relying heavily on information from contact farmers/lead farmers. Consequently, the perfect inelastic and non-significant of the willingness creativity (WC) coefficient implied that most of these farmers had little or no intent of being creative in their adoption of these eco-innovations, i.e., modification of the technologies that proved to be stereotyped to the farming ecology of the study area. Generally, the positive significant of AW, KN, RT and AT coefficients means that farmers with adequate awareness, knowledge, risk orientation and positive attitude toward

these eco-innovations are likely to adopt these technologies. However, farmers with little or no access to information sources on eco-innovations are less likely to adopt these technologies in the study area, as evident by the negative significant of 'IN' coefficient. Therefore, an increase in awareness, knowledge, risk orientation and favourable attitudes towards eco-innovations has the likelihood of increasing adoption of these innovations by 0.882, 0.619, 0.464 and 2.078% respectively (Table 3c). However, an increase in the information sources on these innovations has the likelihood of decreasing the adoption of eco-innovations by 2.326%.

Table 3a : Model fit summary

Category name	Index name	Obtained	Recommended
Absolute fit	CMIN	17833.23	-
	DF	1764	-
	P	0	$p \leq 0.05$
	RMSEA	0.18	< 0.08
	RMR	0.631	< 0.02
	GFI	0.289	> 0.90
Incremental fit	AGFI	0.238	> 0.90
	NFI	0.486	> 0.90
	RFI	0.467	> 0.90
	TLI	0.493	> 0.90
	CFI	0.511	> 0.90
	IFI	0.512	> 0.90
	PGFI	0.269	> 0.90
	FMIN	63.238	> 0.90
Parsimonious fit	CMIN/DF	10.11	< 5.0

Source: Field survey, 2022

Table 3b: Effects of Adoption's Attributes on Eco-Innovation's Adoption

Variable (←)		Estimate (US)	S.E.	C.R.	P	Estimate (S)	R ²
AW1	AW	1	-	-	-	0.973	0.947
AW2	AW	1.24	0.018	68.693	***	0.999	0.997
AW3	AW	1.257	0.025	50.634	***	0.974	0.949
AW4	AW	1.238	0.035	35.131	***	0.924	0.853
AW5	AW	0.504	0.08	6.315	***	0.354	0.125
AW6	AW	0.764	0.053	14.289	***	0.656	0.431
AW7	AW	0.735	0.033	22.017	***	0.81	0.656
AW8	AW	0.606	0.024	25.415	***	0.851	0.725
AW9	AW	0.011	0.06	0.184	0.854	0.011	0
AW10	AW	0.25	0.06	4.154	***	0.241	0.058
AT1	AT	1.992	0.077	26.028	***	0.983	0.967
AT2	AT	2.368	0.09	26.237	***	0.987	0.973
AT3	AT	1.838	0.077	23.838	***	0.948	0.898
AT4	AT	1.968	0.077	25.447	***	0.974	0.95
AT5	AT	1.891	0.111	17.048	***	0.795	0.632
AT6	AT	0.658	0.119	5.517	***	0.319	0.102
AT7	AT	0.872	0.097	8.997	***	0.496	0.246
AT8	AT	0.863	0.065	13.183	***	0.67	0.449
AT9	AT	0.788	0.05	15.87	***	0.76	0.578
AT10	AT	1	-	-	-	0.852	0.726
RT1	RT	1	-	-	-	0.95	0.903
RT2	RT	1.11	0.03	37.329	***	0.968	0.936
RT3	RT	0.723	0.054	13.466	***	0.647	0.418
RT4	RT	0.771	0.025	30.327	***	0.92	0.847
RT5	RT	0.408	0.071	5.718	***	0.329	0.108
RT6	RT	0.258	0.063	4.079	***	0.24	0.058
RT7	RT	-0.032	0.052	-0.621	0.535	-0.038	0.001
RT8	RT	0.025	0.049	0.512	0.609	0.031	0.001
RT9	RT	0.242	0.057	4.281	***	0.252	0.063
RT10	RT	0.079	0.048	1.65	0.099	0.099	0.01
KN1	KN	2.443	0.14	17.404	***	0.973	0.947
KN2	KN	2.849	0.16	17.83	***	0.994	0.989
KN3	KN	2.071	0.122	16.997	***	0.953	0.908
KN4	KN	2.155	0.128	16.811	***	0.944	0.891

Variable (←)		Estimate (US)	S.E.	C.R.	P	Estimate (S)	R ²
KN5	KN	1.702	0.138	12.364	***	0.714	0.509
KN6	KN	1.287	0.12	10.742	***	0.625	0.391
KN7	KN	1.052	0.115	9.122	***	0.535	0.286
KN8	KN	1.015	0.08	12.684	***	0.731	0.534
KN9	KN	1.011	0.08	12.657	***	0.729	0.532
KN10	KN	1	-	-	-	0.732	0.535
WC1	WC	1	-	-	-	0.951	0.904
WC2	WC	1.198	0.027	44.927	***	0.985	0.97
WC3	WC	1.222	0.029	41.553	***	0.974	0.948
WC4	WC	1.015	0.035	28.645	***	0.9	0.811
WC5	WC	0.885	0.023	37.77	***	0.958	0.918
WC6	WC	0.927	0.023	39.45	***	0.966	0.932
WC7	WC	0.209	0.035	5.985	***	0.339	0.115
WC8	WC	0.358	0.033	10.733	***	0.549	0.302
WC9	WC	0.518	0.036	14.524	***	0.672	0.451
WC10	WC	0.563	0.037	15.016	***	0.685	0.469
IN1	INF	2.095	0.344	6.081	***	0.915	0.838
IN2	INF	2.494	0.409	6.098	***	0.932	0.868
IN3	INF	2.46	0.402	6.118	***	0.951	0.905
IN4	INF	2.777	0.452	6.137	***	0.973	0.947
IN5	INF	2.402	0.402	5.971	***	0.824	0.679
IN6	INF	2.251	0.379	5.938	***	0.801	0.642
IN7	INF	1.457	0.297	4.914	***	0.44	0.194
IN8	INF	1.044	0.234	4.453	***	0.362	0.131
IN9	INF	0.901	0.22	4.093	***	0.313	0.098
IN10	INF	1	-	-		0.348	0.121
ADPI	AW	0.882	0.091	9.705	***	0.375	0.595
ADPI	INF	-2.362	0.471	-5.009	***	-0.332	
ADPI	KN	0.619	0.176	3.516	***	0.138	
ADPI	WC	-0.28	0.09	-3.115	0.002	-0.12	
ADPI	AT	2.078	0.178	11.677	***	0.496	
ADPI	RT	0.464	0.071	6.495	***	0.254	

Source: Field survey, 2022

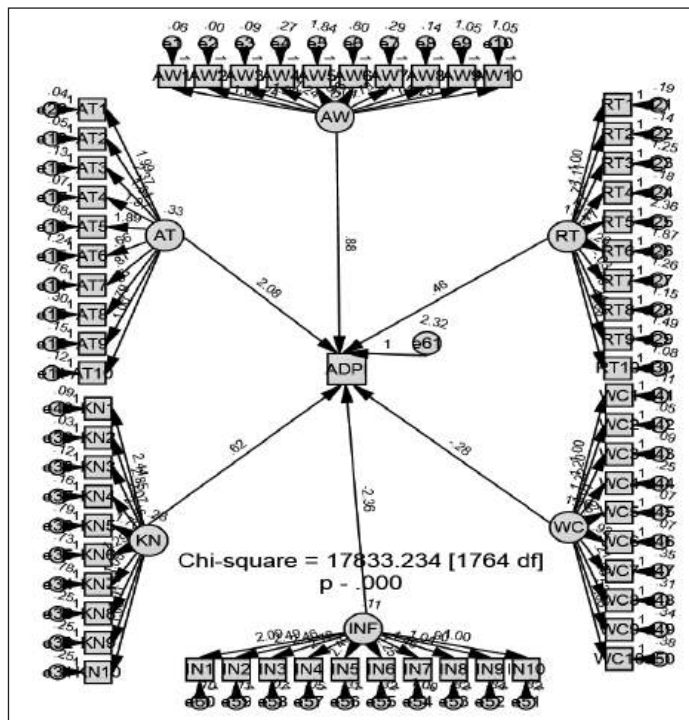
Note: ***, **, * & NS mean significant at 1, 5, 10% and non-significant respectively; US= Unstandardized; S= Standardized; SE= Standard error; CR= Critical ratio; P= Probability; R²= Squared multiple correlation; → = relationship; and, INF/IN.

Table 3c: Total, Direct and Indirect Effects of Adoption’s Attributes on Eco-Innovation’s Adoption

Item	INF	WC	KN	RT	AT	AW
ADPI	Total effect (unstandardized)					
	-2.362	-0.28	0.619	0.464	2.078	0.882
	Standardized					
	-0.332	-0.12	0.138	0.254	0.496	0.375
	Direct effect (unstandardized)					
	-2.362	-0.28	0.619	0.464	2.078	0.882
	Standardized					
	-0.332	-0.12	0.138	0.254	0.496	0.375
	Indirect effect (unstandardized)					
	0	0	0	0	0	0
Standardized						
0	0	0	0	0	0	

Source: Field survey, 2022

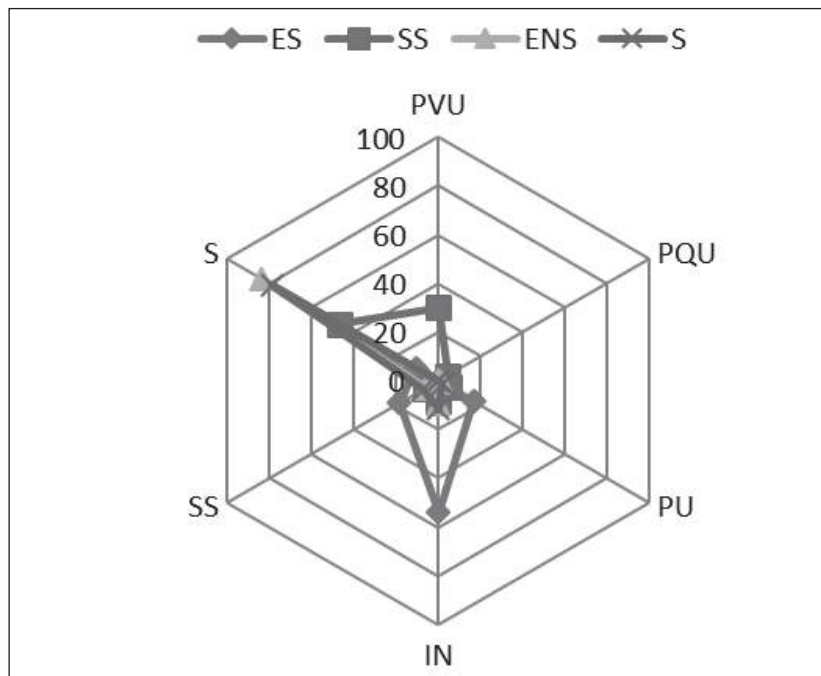
Figure 4: Structural Modeling of the Effect of Eco-Innovations Indicators on Eco-Innovation’s Adoption



4.2 Sustainability Assessment of Wheat Farming

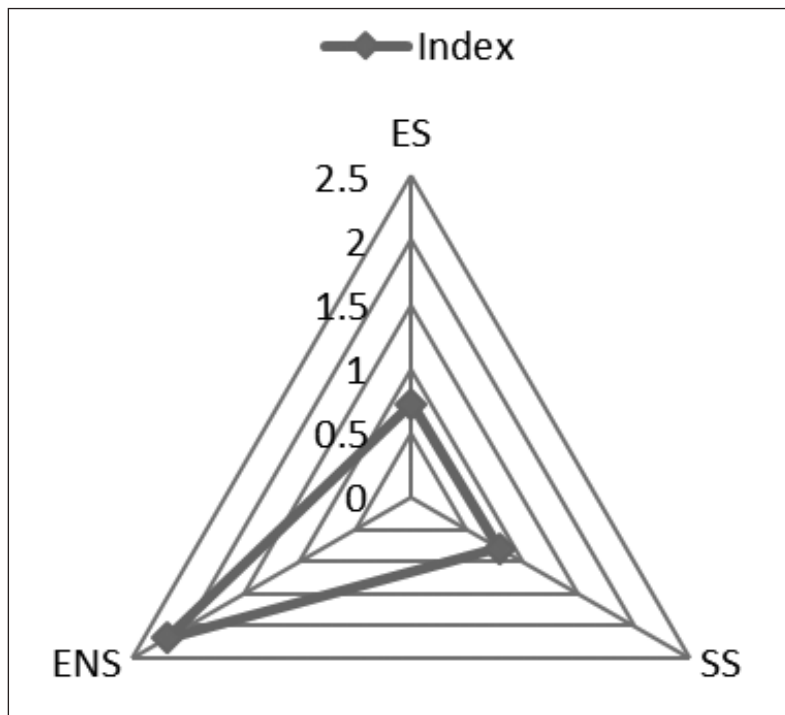
A perusal of sustainability index showed that majority (78.8%) of the farmers had their farms to be sustainable while an insignificant of the sampled population had their farms to be unsustainable (Figure 5). Nevertheless, indicator-wise results showed that only 10.6, 46.3 and 83.4% of the farmers, respectively, had their farms to be economically, socially and environmentally sustainable. Thus, the heightened index of environmental sustainability is a possible reason for the robust farm sustainability achieved by the majority of the farmers in the study area. Consequently, the study calls on the few farmers whose wheat farms are unsustainable to enhance their economic and social sustainable farm practices. Therefore, it can be inferred that the farmers were conscious of the effects climate change on their farms, thus used climate change adaptive strategies. Though in a different enterprise, this finding is contrary to the findings of Ranasinghe *et al.*(2021) and Sultana *et al.*(2021), who in their various study areas found the majority of paddy rice farmers not to have sustainable farms, thus recommending the need to enlighten and inculcate good agricultural practices (GAP) to these farmers.

Figure 5a: Farm sustainability assessments of wheat farmers



Source: Field survey, 2022

Figure 5b: Aggregate indicator level of farm sustainability



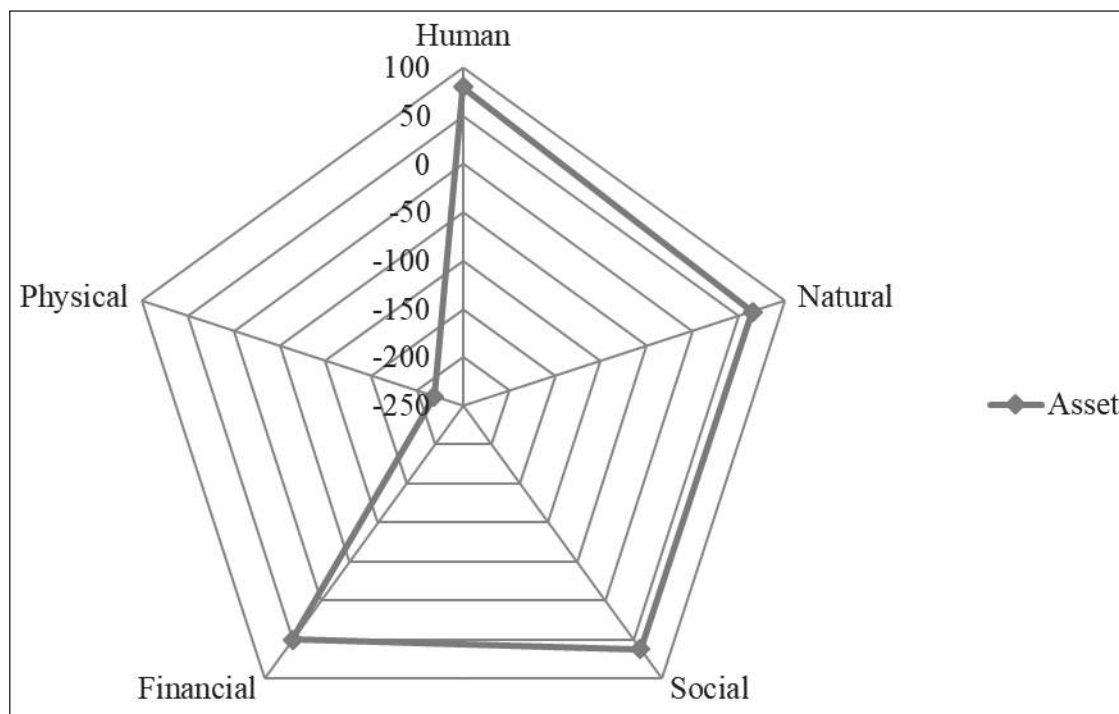
Source: Field survey, 2022

4.3 Livelihood Status of the Farmers

On the average, the empirical evidence showed the statuses of human (80.19%), natural (65.13%) and social (62.24%) livelihood’s capital assets in the study area to be good while that of financial and physical capital assets respectively were moderate (50.02%) and poor (-218.55%)(Figure 6a). By implication, it can be inferred that most of the farmers had good possession of human, natural and social livelihood’s capital assets against financial and physical assets possession that were poor. The moderate status of financial asset may be attributed to poor supply of credit facilities and low income base. However, the poor physical asset is attributed to poor access to institutions, inadequate working implements, poor production facilities, inadequate provision of infrastructural facilities, i.e., public commodities *viz.*, poor feeder road networks, social amenities etc., and poor access to transportation and information and communication technology. Therefore, the study advises policymakers to remedy the challenges that affected the livelihood’s financial and physical capital assets so as not to jeopardize the good statuses of the trio livelihood’s capital assets,

thus containing the near likelihood of livelihood vulnerability of most of the respondents to shocks and stresses, especially those caused by weather induced extremities in the study area.

Figure 6a: Livelihood's capital assets distribution of the respondents



Moreover, the results in Figure 6b (five-dimension, modified) showed that majority (51.9%) of the respondents adopted consolidation strategy for livelihood sustenance, 31.8% used accumulation strategy, and 2.5% adopted adaptive strategy while 9.2 and 4.6% respectively resorted to coping and survival strategies for livelihood sustenance. On four-dimension, majority (71%) of the farmers adopted accumulation strategy for livelihood sustenance, while handful of 14.1, 8.1 and 6.7% respectively used adaptive, coping and survival strategies for livelihood sustenance (Figure 6c). Generally, it can be inferred that in response to opportunities, majority of the respondents adopted strategies (accumulation and consolidation) that increased their stocks and consumption outcomes. Nevertheless, for those that adopted adaptive strategy, it can be concluded that in response to anticipated adverse trends, they tend to spread their risks of consumption failure. However, for those that adopted coping, it can be inferred that in order to absorb the impact of adverse shocks, they draw down their assets and

reduce consumption. For those that were caught in the survival strategy, it can be concluded that the respondents didn't only cut down consumption drastically, but household's assets were extensively, most often irreversibly eroded, in an attempt to ward-off destitution and mortality.

Figure 6b: Distribution of the respondents based on livelihood strategies

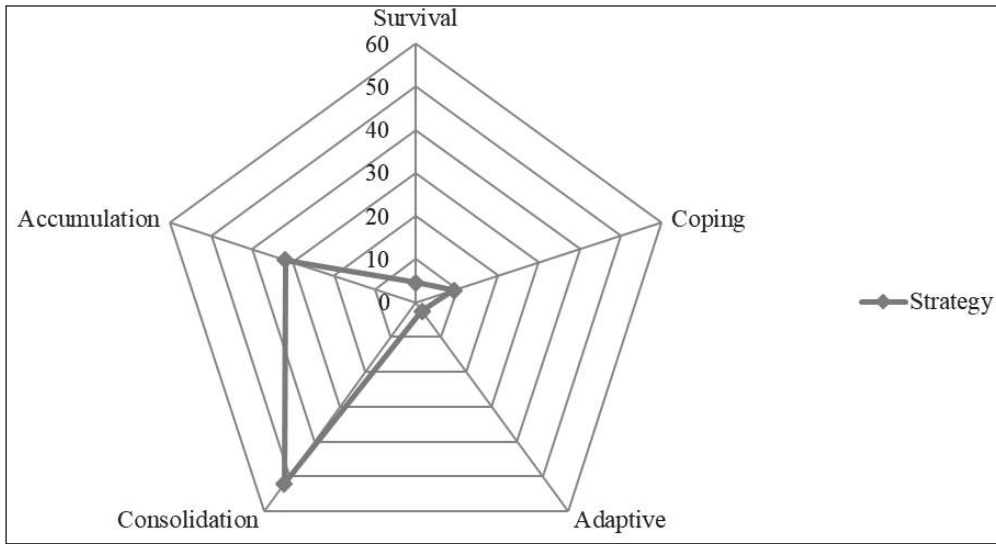
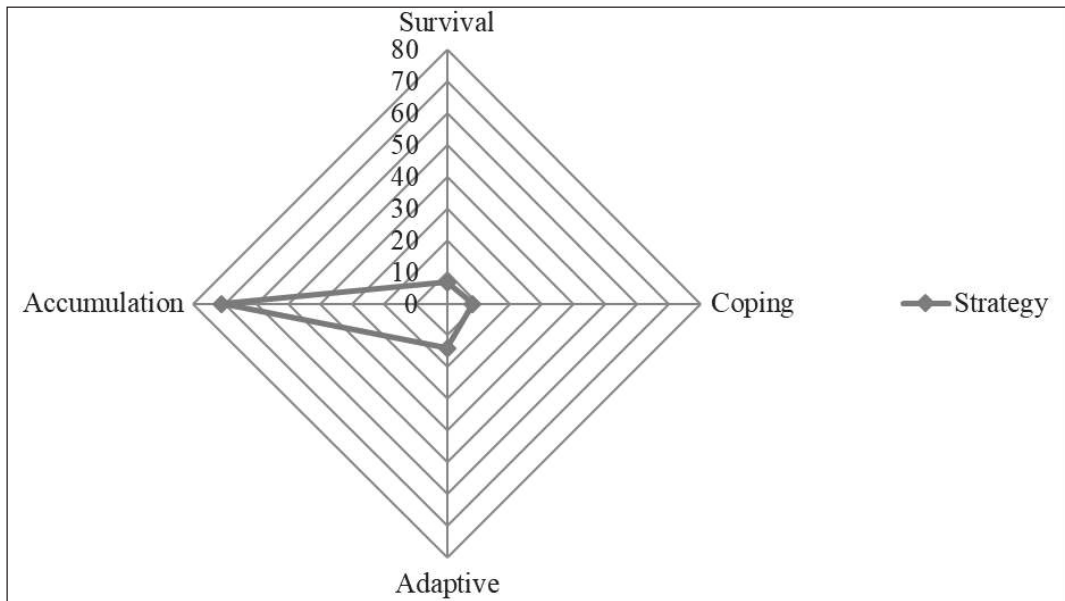


Figure 6c: Distribution of the respondents based on livelihood strategies



4.4 Willingness to Pay (WTP) for Crop Insurance

A cursory review of the WTP results showed that the majority (55.8%), though just marginally above the average of the sampled population, were willing to pay for crop insurance while barely close to the average (44.2%) of the sampled population were not willing to pay for crop insurance (Table 4). The possible reason for this slight marginal difference between the farmers willing to pay and not willing to pay may be attributed to adequate awareness and knowledge about crop insurance coupled with capital paucity, which is a common phenomenon in a typical agrarian setting. However, government incentives on risk de-escalation adopted by the Nigerian incentive-based risk sharing system for agricultural lending (NIRSAL) cannot be overruled in influencing most of the farmers who keyed into the idea of crop insurance in the study area. Consequently, at an initial bid (IBID) of 5% of the annual income, though still the majority, the percentage of farmers willing to insure their crop plummeted by 8.78%, thus justifying the challenge of economic capital paucity among most of these farmers in the study area (Table 4). As a rider, there was a slight increase in the percentage of farmers who were not willing to pay for crop insurance at an initial bidding. Nevertheless, at the initial IBID, the minimum and maximum cum average premiums the farmers were willing to pay are ₦ 13750 (\$39.29), ₦ 170000 (\$485.71) and ₦ 39129.17 (\$111.80) respectively.

Table 4 : Willingness to Pay and Ibid of the Farmers

Items	Frequency	Percent
WTP		
No	125	44.2
Yes	158	55.8
Total	283	100.0
IBID		
Total	283	100.0

Source: Field survey, 2022

Note: \$1= ₦350 at the time of the study: 2022

4.5 Nexus between Eco-innovation's Adoption and Livelihood Status via WTP and Sustainability

The nexus between eco-innovation's adoption and livelihood status via WTP and sustainability was verified using CFA, and the diagnostic test results proved the model to be fit for the specified equation as evident by its test statistics that are within the recommended thresholds (Table 5a). Thus, the SEM is reliable for future prediction with accuracy, efficiency, certainty

and consistency. Empirically, eco-innovation's adoption has significant twin influence on WTP and sustainability; likewise, it transcends a significant influence on livelihood status via sustainability as a mediating variable (Table 5b and Figure 7). However, the effect of eco-innovation becomes elusive on livelihood status through WTP and sustainability as mediating factors. Generally, sustainability has a significant effect on the livelihood status of farmers. The significant effect of eco-innovation's adoption on WTP and sustainability might be attributed to the need for climate change resilience among farmers, thus a catalyst for livelihood resilience. However, the negative sign and non-significant of the WTP coefficient might be attributed to risk aversion due to fear of capital loss, a limiting factor in a small operational holding, a common phenomenon among most of these farmers. Furthermore, the total effect of ADPI on WTP, SI and LV respectively, is 0.023, 0.077 and 0.267; the total effect of WTP on SI and LV is -0.017 and -0.060; whilst the total effect of SI on LV is 3.484 (Table 5c). Therefore, for a robust eco-innovation's adoption, a catalyst for livelihood's vulnerability resilience, the study calls for an effective utilization of the social capital pool, i.e., co-operative associations, as a complement in addressing capital paucity; likewise, a holistic implementation of the risk sharing system project of NIRSAL coupled with a wider scope of coverage in the study area.

Table 5a : Model Fit Summary

Category name	Index name	Obtained	Recommended
Absolute fit	CMIN	5012.68	-
	DF	299	-
	P	0.00	$p \leq 0.05$
	RMSEA	0.023	< 0.08
	RMR	0.020	< 0.02
	GFI	0.954	> 0.90
Incremental fit	AGFI	0.941	> 0.90
	NFI	0.911	> 0.90
	RFI	0.942	> 0.90
	IFI	0.921	> 0.90
	TLI	0.950	> 0.90
	CFI	0.918	> 0.90
	PGFI	0.301	> 0.90
	FMIN	17.775	> 0.90
Parsimonious fit	CMIN/DF	4.765	< 5.0

Source: Field survey, 2022

Table 5b : Nexus Between Eco-Innovation's Adoption and Livelihood Status via WTP and Farm Sustainability

Variable (←)		Estimate (US)	S.E.	C.R	P	Estimate (S)	R ²	
ADPI	AW	1.311	0.079	16.638	***	0.464	0.781	
ADPI	AT	1.673	0.079	21.128	***	0.589		
ADPI	KN	0.341	0.08	4.236	***	0.118		
ADPI	INFO	-1.399	0.096	-14.543	***	-0.406		
ADPI	WC	-0.293	0.078	-3.759	***	-0.105		
ADPI	RISK	-0.488	0.081	-6.002	***	-0.167		
WTP	AG	0.004	0.001	3.367	***	0.111	0.692	
WTP	GEN	0.021	0.035	0.587	0.557	0.019		
WTP	ED	0.001	0.003	0.306	0.76	0.01		
WTP	HHS	-0.003	0.003	-0.954	0.34	-0.032		
WTP	FEXP	-0.004	0.002	-1.694	0.09	-0.056		
WTP	AGH	-0.047	0.014	-3.419	***	-0.113		
WTP	OPH	0.084	0.019	4.322	***	0.143		
WTP	LAIN	0.02	0.037	0.556	0.578	0.018		
WTP	LS	-0.07	0.007	-10.429	***	-0.345		
WTP	EXT	0.17	0.035	4.823	***	0.159		
WTP	CR	-0.284	0.075	-3.761	***	-0.124		
WTP	COP	0.026	0.029	0.895	0.371	0.03		
WTP	IBID	0.536	0.026	20.221	***	0.668		
WTP	IAW	0.054	0.036	1.508	0.132	0.05		
WTP	IK	-0.018	0.037	-0.491	0.624	-0.016		
WTP	CFI	0.016	0.03	0.531	0.595	0.018		
WTP	ADPI	0.023	0.004	5.368	***	0.177		
SI	ADPI	0.077	0.003	22.972	***	0.814		0.657
SI	WTP	-0.017	0.026	-0.658	0.51	-0.023		
LV	SI	3.484	0.103	33.825	***	0.896		0.802

Source: Field survey, 2022

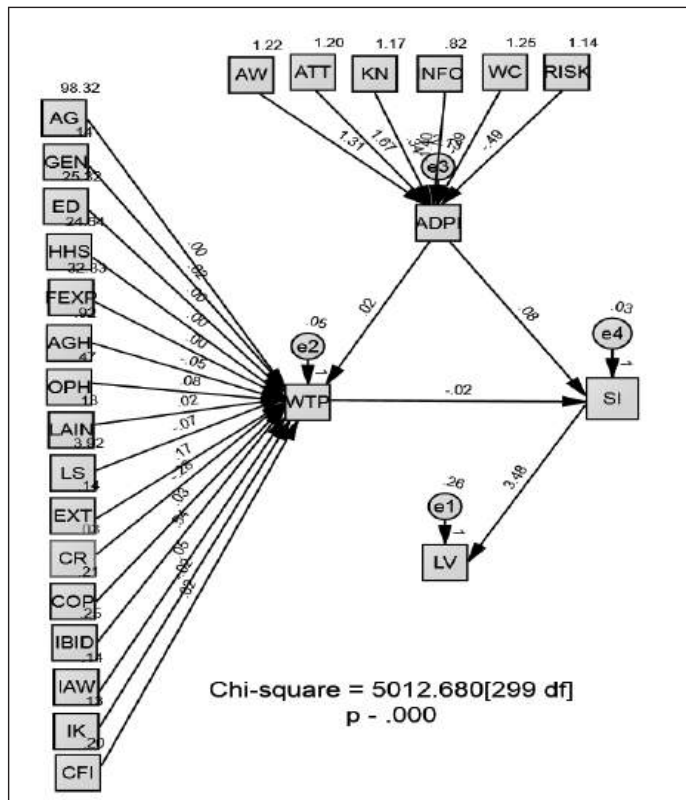
Note: INFO/IN, Risk/RT, LV = livelihood status, SI = farm sustainability index; for the other acronyms, check the appendix table

Table 5c : Total, Direct and Indirect Effects of Eco-Innovation's on Livelihood Status via WTP and SI

Variable	ADPI	WTP	SI
	Total effect (unstandardized)		
WTP	0.023	0	0
SI	0.077	-0.017	0
LV	0.267	-0.06	3.484
	Standardized		
	0	0	0
WTP	0.177	0	0
SI	0.81	-0.023	0
LV	0.726	-0.021	0.896
	Direct effect (unstandardized)		
	0	0	0
WTP	0.023	0	0
SI	0.077	-0.017	0
LV	0	0	3.484
	Standardized		
	0	0	0
WTP	0.177	0	0
SI	0.814	-0.023	0
LV	0	0	0.896
	Indirect effect (unstandardized)		
	0	0	0
WTP	0	0	0
SI	0	0	0
LV	0.267	-0.06	0
	Standardized		
	0	0	0
WTP	0	0	0
SI	-0.004	0	0
LV	0.726	-0.021	0

Source: Field survey, 2022

Figure 7: Structural modeling of nexus between eco-innovation's adoption and livelihood status via WTP and farm sustainability



5. Conclusion and Recommendations

Empirically, there is high adoption of eco-innovation in the study area which owed to livelihood accumulation status of majority of the farmers. However, adoption of eco-innovation is hindered by an extension gap owing to low access to information and poor risk orientation. Consequently, this extension gap marred the intention of almost all of the average sampled farmers, who were not willing to key into the idea of crop insurance, a precursor against risk and uncertainty that are largely driven by weather-induced vagaries, a threat to farm families' livelihood status. Nevertheless, it was just marginally above the average sampled population, though the majority accepted the idea of crop insurance, and this was due to skeletal reach of the risk sharing system of the NIRSAL programme in the study area. Furthermore, the majority of the farmers had their farms to be sustainable, which underscores the importance of adopting eco-innovation as a climate change resilience measure, thus enabling the majority

of the farmers to achieve the accumulated livelihood strategy in the study area. Generally, adoption of eco-innovation has a strong endogenous effect on livelihood status en-route sustainability but a weak endogenous effect on livelihood status en-route WTP. Therefore, the study recommends the need for enhancement of extension services as a measure to address the extension gap that marred effective feed forward-backward flows of information sources and risk orientation on the technologies. Besides, good advisory services will enable the farmers to adapt the eco-innovations, especially non-conventional ones, in a manner that suits their farms' ecological settings, thus enhancing the farmers' climate change resilience, farms' sustainability, and a guarantee of prosperous, sustainable livelihood status.

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Appendix A : Economic, Social and Environmental Dimensions

Dimensions	Sub-dimensions	Measurement
Economic stability	Seasonal yield	Wheat output divided by operational holding per season
	Seasonal farm income per hectare	Total wheat farm income divided by operational holding per season
	Ratio of season farm return per hectare	Wheat profit per hectare divided by the total cost per hectare per season
Social stability	Ratio of seasonal farm income from total income	Income earned from wheat farming divided by the total household's income per season
	Frequency of extension services per season	Number of contact(s) with extension agent per season
	Ratio of women's participation in wheat farm per season (woman hour/woman-day)	Working hours of women on wheat farm per season divided by the total work hours(s) on the wheat farm
	Educational level (year(s))	Number of education years spent by the farmers
	Household size (number)	Total household size of the farmer
Environmental stability	NPK fertilizer used per season per hectare	Quantity of NPK fertilizer (kg) used per hectare per season
	Urea fertilizer used per season per hectare	Quantity of urea fertilizer (kg) used per hectare per season
	Herbicides used per season per hectare	Quantity of pesticide (litre) used per hectare per season
	Fuel used per season per hectare	Quantity of fuel (litre) used per hectare per season
	Irrigation water per season per hectare	Volume of irrigation water per hectare per season
	Level of adoption of IPM	Number of IPM used by a farmer per season
	Level of adoption of GAP	Number of GAP used by a farmer per season
	Level of adoption of TAP	Number of TAP used by a farmer per season

Source: Modified from Ranasinghe *et al.*, 2021

IPM = Integrated pest management practices; GAP = Good agricultural practices; TAP = Traditional practices

Appendix B : Selected Practices

Strategies	Practices
IPM	Use of natural enemies, predators and biological agents in the season to prevent diseases and pest attacks
	Changes in frequency of irrigation
	Seasonal application of adequate nutrients for wheat cultivation
	Continuous maintenance of field sanitation throughout the season
	Use of mixed cropping practices in the season
	Usage of trap crops/ traps in the season
	Usage of pheromones seasonally
	Use of bio-pesticides seasonally (e.g., neem leaves or seeds, hot pepper, tobacco, wood ash, and soap)
	Usage of barriers to protect the crop in the season
	Selection of the most effective sowing date avoiding drought, pests and diseases occurrences
GAP	Performing minimum tillage
	Availability of biodegradables and non-biodegradables in the paddy fields
	Use of improved and resistant seeds to the most frequent diseases
	Use of correct crop protection chemicals, fertilizer and compost according to the directions in the labels
	Use of good quality water for irrigation
	Sowing at an adequate distance
	Using clean garden tools
	Practicing monthly weeding
	Consulting agricultural instructor when needed during the cropping season
	Use of proper amount of organic and inorganic fertilizers
TAP	Using traditional practices and rituals in the season
	Use of traditional manual land preparation methods in the season
	Performing season fetish festival before harvesting
	Use of traditional weed control methods
	Practicing traditional manure application techniques in the season
	Using traditional methods in the season to safeguard the field
	Use of traditional bio pesticides in the season
	Use of traditional water management techniques
	Use of traditional seed treatment methods
Selection of paddy varieties in the season based on the traditional weather forecasting	

Source: Modified from Ranasinghe *et al.*, 2021

Do Remittances Enhance the Effectiveness of Sustainable Development Goals (SDGs) by Reducing Poverty in Asian Countries? An Empirical Evidence

Diksha Kumari¹ and Arun Kumar Giri²

Abstract

Sustainable Development Goal 1 is to “End poverty in all its forms everywhere”. To end extreme poverty, migration plays a crucial role; hence, remittances serve a vital role in improving the standard of living and sustainable livelihoods. Therefore, this research aims to explore the contribution of remittances to poverty reduction in Asian nations over the period from 2000 to 2023. In this study, the analysis uses various econometric methods such as the CSD test, second-generation tests like CIPS and CADF unit root tests, and the Westerlund ECM panel cointegration test. Finally, to estimate the model, CS-ARDL is used, and a pairwise Granger panel causality test is employed to find the causal direction between the chosen variables. The findings revealed that remittances are crucial in eliminating poverty and helping to attain sustainable development goals (SDG Goal 1), i.e., no poverty. Likewise, workforce participation and formation of gross fixed capital positively relate to poverty reduction, while inflation is negatively related. Remittances increase household income, help people cope with economic hardships, and foster sustainable development in their economies. This paper conceptualises the significance of remittances in mitigating poverty in Asian countries. The research benefits policymakers and concerned public authorities and suggests relevant policies to encourage migration-friendly policies and attain the SDGs by 2030.

Keywords: Sustainable Development Goals, Poverty Reduction, Migration, Remittances, CS ARDL, Asian Countries

1. Introduction

The UN Sustainable Development Goal 1 is no poverty (UNDP, 2024). The Sustainable Development Goals (SDGs) represent the shared aspirations of both developed and developing countries to work together and take urgent action to achieve the desired targets and to reduce poverty while dealing with climate change and protecting the environment. Hence, the goal

¹Research Scholar, Department of Economics and Finance, BITS Pilani, Pilani Campus, Pilani City, Rajasthan (India), Email: p20220421@pilani.bits-pilani.ac.in

ORCID: <https://orcid.org/0009-0004-6198-7547>

²Professor, Department of Economics and Finance, BITS Pilani, Pilani Campus, Pilani City, Rajasthan (India), Email: akgiri.bits@gmail.com

ORCID: <https://orcid.org/0000-0002-7122-4517>

is to exterminate extreme poverty by 2030 in all forms, presently characterised as surviving on less than \$2.15 per day. It consists of seven associated targets or aims. According to the SDG Report 2024, if the current trend persists, 590 million people might still live in destitution by 2030. Hence, the speed of poverty reduction must pick up (UNDP, 2024). Poverty alleviation improves people's living standards. Further, it is crucial in achieving other goals. It improves living conditions and access to essential necessities like nutrition, clothing, education, shelter, and Medicare. It improves their overall quality of life.

The broader global challenge of poverty turns into hardships for millions of individuals. Impoverished populations are less likely to attend school and attain quality education (Buck & Deutsch, 2014). Hence, without proper education, their contribution to economic and sustainable development is insignificant. In addition, poor people living in slums or deplorable conditions face inadequate access to healthcare, sanitation, and safe water, and they face life-threatening diseases (Sheuya, 2008). Their high proportion of income goes to out-of-pocket expenditure, which drains their resources and makes them unable to save for the future. Additionally, people living in extreme poverty do not care much about environmental damage (Mellor, 1988). They often exploit natural resources to meet their needs, such as cutting down trees for firewood to use for cooking and engaging in fishing. All these activities degrade common resources and contribute to increased carbon emissions. Often, poverty leads to a vicious cycle of poverty (Zaman et al., 2021); a never-ending cycle. Due to poverty, the development of children is hindered by their lack of access to healthcare, education, and career options. This lack of skill leads to lower earning potential. The vicious cycle of poverty hinders their development.

In this process, migration plays a crucial role (Dingle & Drake, 2007). It benefits the migrants and their kin living back in their native lands. When labour migrates from their origin to host countries in search of work and better opportunities, the host countries require specific assistance and measures as migrants generally struggle with unusual poverty hurdles like high discrimination and lousy working conditions. Migrants mainly transfer a large, substantial share of their financial resources back to their families as remittances that might help poor people escape poverty (Rapoport & Docquier, 2006). Family members use remittances to improve their well-being. They can spend on children's education, buy assets like land, and expansion of necessary services, particularly medical expenses. All these measures lead to a high standard of living. When immigration increases in host economies, it supports domestic economies (Nicolai et al., 2017).

Considering the macroeconomic level, remittances help families in overcoming poverty. Indirect effects of remittances include providing more job opportunities and increasing

demand for domestic goods back home, leading to increased economic growth. When families receive remittances, they spend money on essential needs and improving their living standards. It serves as an additional source of income (Amuedo-Dorantes & Pozo, 2011), reducing their dependence on formal sources of credit or informal sources such as money lenders that charge them very high, exorbitant interest rates. This increases the economy's liquidity and helps keep equilibrium in the money market. Additionally, they can invest in small businesses to foster entrepreneurship and become a job creator (Kakhkharov, 2019). This reduces unemployment and enhances economic growth in the economy.

Considering the microeconomic level, remittances can increase human capital formation by upgrading education quality and healthcare facilities (Ngoma & Ismail, 2013; Salas, 2014). The migration takes place as migrants seek better job opportunities and send money back to their homes. This reduces inequality.

Therefore, the present research aims to study the role of remittances in poverty reduction. Studying the nexus of poverty and remittances is very much essential for many reasons, as it reflects the interconnectedness of migrants and remittances, and their role in eradicating poverty. Researchers, policymakers, and stakeholders focus on realising the importance of financial transfers for the implementation of the goals of sustainable development. It is crucial to make policy decisions that foster sustainable development while preserving the needs of future generations. Thus, to achieve economic progress and SDG Goal 1, i.e., no poverty, this analysis highlights the significance of remittances in poverty reduction within Asian countries. The present study considers 31 Asian countries. Countries namely, India, China, Indonesia, Bangladesh, Pakistan, Philippines, Japan, Viet Nam, Türkiye, Malaysia, Iran, Islamic Rep., Thailand, Yemen, Rep., Saudi Arabia, Nepal, Korea, Rep., Syrian Arab Republic, Sri Lanka, Tajikistan, Lao PDR, Israel, Brunei Darussalam, United Arab Emirates, Bhutan, Cyprus, Armenia, Mongolia, Kuwait, Oman, Lebanon, Singapore. We chose 31 Asian countries based on data availability and other economic conditions. We try to cover a wide range of economic varieties. We examine four Asian Tigers, large growing economies such as China, India, and Indonesia; small developing countries such as Bhutan and Nepal, and transition economies like Georgia, among others.

The different segments of the study include: Subsection 2 examines the literature review; Subsection 3 explains data and variable identification; Subsection 4 encompasses methodology; Subsection 5 discusses the outcome obtained, and the final Subsection draws the conclusion.

2. Literature Review

2.1 Theoretical Framework

As per the International Organisation for Migration (IOM), a migrant refers to an individual who relocates either over an international border or within a single country, leaving their usual place of residence (Geiger & Koch, 2018).

Drivers of migration

Migration occurs due to various reasons. Push factors such as economic hardships like low productivity, poverty, joblessness, inadequate pay, diminished consumption, poor living standards, and political issues like dictatorship, bad governance, shadow democracy, human rights violations, terrorism, and minority maltreatment can make people leave their homes (Urbański, 2022). Additionally, more factors, including disasters, depletion of natural endowments, insufficient water, erosion of soil, poor environmental policy, information flows, and limited educational institutions, social security, and health care services, make people leave their homes for better job prospects (Prieto Rosas & López Gay, 2015). While pull factors such as public welfare assistance, health benefits, social safety, high wages, demand of labour, improved living standard, high consumption, better implementation of law and order, stability, human rights protection, peace, minority protection, better environment to live in, better schooling persuade people to move to a different place (Parkins, 2010). Poverty is a major reason for migration back to their households. Poor people are unable to find a suitable job for their skill sets and remain unemployed (Thet, 2014). This forces them to remain in a vicious cycle of poverty.

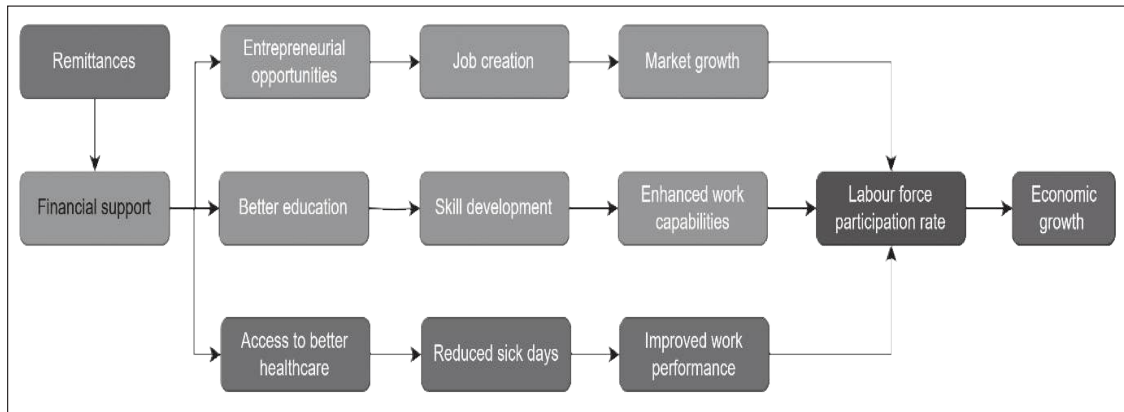
Remittances and SDGs

Remittances are the financial funds that migrants transfer to their kin in their origin country to provide economic support. Remittances make a significant contribution to maintaining foreign exchange for many developing countries (Glytsos, 2002). Remittances positively affect economic growth by driving consumption, increasing savings, and investment (Meyer & Shera, 2017). It also increases financial inclusion access via formal transfers (Anzoategui et al., 2014). Remittances provide additional income to the receiving families. It enhances their consumption pattern and basic need fulfilment. Hence, it reduces income volatility and increases economic interdependence. It helps in poverty alleviation and achieves UN SDG 1 of no poverty (Akanle et al., 2022). Increased financial autonomy allows for better healthcare expenditure, educational quality, and increased business opportunities. Remittances alleviate poverty via the poverty income channel. A surge in income tends to enhance the health of

families by providing access to a healthy diet. It helps in achieving SDG 2, which is zero hunger (Nurse, 2018). Furthermore, improved healthcare reduces the mortality rate in families who obtain access to remittances as the elderly persons in the family have access to satisfactory health care, in doing so, commence SDG 3 (Berloff & Giunti, 2019). Improved education facilitates higher school enrolment and regular attendance, notably girls (Zhunio et al., 2012). On top of that, it brings down the incidence of child labour and underage girl-child marriage. This raises women's participation in the labour force and they significantly contribute to the economic growth (Cox-Edwards & Rodríguez-Oreggia, 2009). Research has revealed that remittances contribute significantly to fulfilling sustainable development goals, notably when utilized for food, educational purposes, employment opportunities, and Medicare, human development becomes inexorable. With an uninterrupted passing of resources, this expansion can be assisted over time. This, nonetheless, leads to the accomplishment of SDG 4 and SDG 5 goals, focused on quality education and ensuring gender equality, respectively. Remittances have proven to be highly significant to developing economies and nations by encouraging market competition. The inflow of remittances has a considerable favourable effect on the increase in human capital formation and productivity (Ngoma & Ismail, 2013; Salas, 2014). Due to various job opportunities available overseas, remittances can influence labour force participation via skill development and reduce economic pressure on families. An increase in income for skilled workers further encourages people to pursue skill development for a more improved standard of living. Remittances can be used to invest in small businesses or enhance local infrastructure such as schools, colleges, roads, highways, and ports, which directly empower gross fixed capital formation (GFCF). GFCF implies investment in physical assets like machinery, buildings, and infrastructure. Further, Adenutsi (2011) suggests that investment in machinery and human capital advances the development of economic conditions. This might help to achieve SDG 9, which is Industry, Innovation, and Infrastructure.

Figure 1 illustrates how remittances drive economic growth. This flowchart shows that remittances provide financial support, leading to entrepreneurial opportunities, better education, and access to better healthcare. As a result, this boosts labour force participation rate and hence, economic growth.

Figure 1: Conceptualised framework



Source: Author’s work

2.2 Empirical Review

Numerous studies have shown the contribution of remittances on fighting poverty. The study by (Ali et al., 2021) reviewed the connection between remittances and poverty in Pakistan, in the short period and long-run across the dataset from 1980 to 2018. The model is estimated by applying the ARDL bound test technique. The study concluded that remittances are effective in lowering poverty. With an increase in remittances, the economy’s poverty level decreases. Similarly, a study by (Ojeyinka & Ibukun, 2024) examined the link between REM and poverty reduction by utilizing the top thirty-eight countries in terms of recipients of remittances from 1990 to 2021. The findings revealed that remittances are crucial for poverty alleviation. Another work by (Acosta et al., 2008) focused the impact of worker’s remittances in Latin American and Caribbean (LAC) countries on inequality and poverty analysing household surveys for ten LAC countries. Consequently, the research highlighted that remittances have constitute a very significant income stream for developing nations. Furthermore, for Asian economies, (CUI et al., 2023) paper examined remittances’ role in eradicating poverty in fifteen selected Asian countries covering panel data from 2000 to 2020, indicating that remittances are instrumental in combating alleviation. Using a dataset from 1990 to 2014 for 103 developing economies, the analysis by (Azizi, 2021) investigated the implications of remittances on inequality. Their analysis demonstrated that remittances contribute to lowering of the Gini coefficient, thereby lowering poverty. Similarly, work by (Djeunankan et al., 2023) investigated the impact of financial transfers by migrants in reference to energy poverty in seventy-nine developing economies; applied dynamic panel estimation techniques, and findings suggested that remittances curb poverty. A similar study

for developing countries by (Barkat et al., 2023) examined the remittance's leverage on energy poverty. Their study concluded that remittances positively influence energy poverty reduction and they discussed five pathways via which remittances contribute in alleviating energy poverty. Additionally, urbanization and financial development have a potential in overcoming energy exclusion. Similarly, for Bangladesh, the function of remittances in overcoming energy poverty was analysed. According to (Hosan et al., 2023), reducing energy costs and using remittance income in modern technologies are needed to overcome energy poverty. Another study by (Acheampong et al., 2021) reviewed the remittances and advancement of financial system in eradicating poverty in forty-four sub-Saharan nations using a data set from 2010 to 2019. Therefore, the findings similarly interpreted that financial development lowers poverty in females and males. Economic growth, FDI, Globalization, and other elements play a prominent function in curbing poverty. Likewise, (Zaman et al., 2021) empirically probed the interplay between remittances received for nine remittance recipient economies utilising panel data ranging from 1990 to 2014, applied ARDL approach. Hence, the study determined that remittances favour economic growth and maintain a statistically significant long-term connection between remittances and economic development. Furthermore, a study by (Shah & Wani, 2024) revealed that remittances and institutional quality both played an auxiliary role in moulding the linkage between poverty and remittances. Further, another work (Ojeyinka & Ibukun, 2024) investigated the nexus between remittances and poverty in Asia, Latin America, and Africa regions using panel data on thirty-eight top recipients of remittances for the period from 1990 to 2021. The study confirmed the positive relationship between poverty and remittances. Additionally, a study by (Khan, 2023) empirically researched the contribution of remittance inflow in tackling poverty in the South Asian territory for the period 1980 to 2021. The outcomes established that remittances have a significant implication for poverty reduction. Additionally, inflation hurts poverty and acts as a barrier in alleviating it, while trade openness in the long run negatively affects poverty. Using statistics from the Socio-Economic Survey in 2014 for Cambodia, (Chea, 2023) investigated the influence of remittances on income disparity and poverty. So, the outcome demonstrated that the GINI coefficient and remittances increase inequality by 1% while the poverty gap is reduced by 2.5%.

3. Data and Methodology

3.1 Data, Variables and Model Framework

In this research, we investigate the impact of remittances on poverty reduction in the dataset ranging from 2000 to 2023 for thirty-one Asian countries.

The model's basic functional specification is:

$$POV_{it} = f(REM_{it}, LFPR_{it}, INF_{it}, GFCF_{it}) \quad \dots 1.0$$

Here in equation 1.0, POV refers to poverty reduction. The proxy used for the same is “households and NPISHs final consumption expenditure per capita (constant 2015 US\$)”; REM refers to “Personal remittances”, LFPR represents “employment to population ratio, 15+, total (%) (modelled ILO estimate)”, INF stands for inflation, “consumer prices (annual %)”, and GFCF presents “gross fixed capital formation (% of GDP)”.

In this model, POV is a dependent variable. The variable definition is mentioned in Table 1. It is estimated using private consumption under constant 2015 prices. Household expenditure refers to the overall market prices of products and services; it incorporates durable products such as, computers, washing machines, and cars and services like payments and fees to governments to attain necessary licenses and permits. REM is an independent variable. Personal remittances consist of salaries of employees and transfer to individuals. Individual transfers account for all existing cash transfers or any kind the household accepts. Compensation of employees depicts income earned by “seasonal” and short-term workers working across an economy different than their country of residence and the income of residents who do jobs for non-resident institutions. Furthermore, three control variables are included in the model. LFPR refers to the “employment-to-population ratio.” It represents the Fraction of a nation’s employed labour persons. In this, employment is defined as “individuals engaged in any activity to manufacture goods and services for profit.” Inflation refers to “the general price rise of a basket of goods and services.” Here, consumer price index (CPI) serves as an inflation measurement; it tracks the annual percentage variation in the cost for a consumer to purchase a set of baskets of goods. Mainly, the Laspeyres formula is used to measure this index. Lastly, to measure capital formation in a nation, the GFCF variable is used. It includes: land enhancements such as setting up fences, drainage, and ditches; plant, machinery purchases, and equipment; the railways, schools, private residential, commercial industrial buildings, roads, medical facilities, and industrial buildings.

The primary regression model is expressed as:

$$POV_{it} = \alpha_{it} + \beta_1 REM_{it} + \beta_2 LFPR_{it} + \beta_3 INF_{it} + \beta_4 GFCF_{it} + \theta_{it} + \epsilon_{it} \quad \dots 2.0$$

Where in equation 2.0, $i = 1, 2, \dots, N$ refers to the economy in data for $t = 1, 2, 3, \dots, N$ that represents time. Additionally, $\beta_1, \beta_2, \beta_3,$ and β_4 indicate elasticity estimates of poverty reduction of REM, LFPR, INF, and GFCF in long-run; and α_{it} and θ_{it} incorporates the country fixed effects and the systematic trend, sequentially.

Table 1 : Description of the Variables

Parameters	Symbols	Indicator	Source
Poverty reduction	POV	“Households and NPISHs Final consumption expenditure per capita (constant 2015 US\$)”	WDI
Personal remittances	REM	“Personal remittances, received (% of GDP)”	WDI
Labour force	LFPR	“Employment to population ratio, 15+, total (%) (modelled ILO estimate)”	WDI
Inflation	INF	“Inflation, consumer prices (annual %)”	WDI
Fixed capital	GFCF	“Gross fixed capital formation (% of GDP)”	WDI

Source: Author’s Work

4. Empirical Strategy

We make use of preliminary methods to verify that the analysed model is stable and reliable.

4.1. Cross-Section Dependence (CSD)

To start with, we implement cross sectional dependence estimation. In our panel data analysis, heterogeneity exists among the panel members. Hence, cross-sectional dependence is a major concern. For this analysis, we incorporate the CSD test (H. Pesaran, 2004), followed by the unit root test. Various tests include “Breusch-Pagan LM” (Breusch & Pagan, 1980), “Pesaran scaled LM” (Baltagi et al., 2012), with “Pesaran CD”. The CSD test postulates that the null hypothesis claims that residuals are independent throughout cross-sections.

The mathematical expression of the CSD test (H. Pesaran, 2004)

$$CD_p = \sqrt{\frac{2T}{C(C-1)}} (\sum_{i=1}^{C-1} \sum_{j=i+1}^C \widehat{p}_{ij}) \rightarrow C(0,1)_{i,j} \quad \dots 3.0$$

$$R = \sqrt{\frac{2T}{C(C-1)}} (\sum_{i=1}^{C-1} \sum_{j=i+1}^C \widehat{p}_{ij}) \frac{(T-k)\widehat{p}_{ij} - E(T-k)\widehat{p}_{ij}^2}{\text{var}(T-k)\widehat{p}_{ij}^2} \quad \dots 4.0$$

Here in this equation, i indicates each individual cross section, t marks the total periods, and C– cross-sectional unit numbers.

4.2. Stationarity Test

To validate stationarity, unit root tests are executed. Typically, first-generation tests are employed but they presume that there is no CSD. If present, then second-generation tests are applied. They account for CSD presence in panel data. In our study, we use two tests (M. H. Pesaran, 2007), “*cross-sectional augmented Dickey-Fuller*” (CADF) and “*cross-sectional augmented Im Pesaran and Shin*” (CIPS).

Test illustrates as:

$$x_i = \alpha_{it} + \beta_i x_{it-1} + \rho_i t + \sum_{j=1}^n \theta_{ij} \Delta x_{i,t-j} + \varepsilon_{it} \quad \dots 5.0$$

In this equation, α_{it} corresponds to the intercept, Δ indicates the difference operator, t stands for time, and ε_{it} captures the error term.

$$CIPS = \frac{1}{N} \sum_{i=1}^N t_i(N, T) \quad \dots 6.0$$

4.3. Cointegration Tests:

In the subsequent phase, the analysis involves verifying cointegration within the chosen variables in the long-run. The cointegration test effectively handles both cross-sectional dependence and heterogeneity. The null hypothesis proposes no cointegration; on the contrary, the alternative claims the presence of a cointegration over the long term in the chosen variables (Westerlund, 2007).

The projection errors equation 7.0 is as follows:

$$\Delta \widehat{y}_{it} = \Delta y_{it} - \widehat{\delta}_i' d_t - \widehat{\lambda}_i' x_{it-1} - \sum_{j=1}^{p_i} \widehat{\alpha}_{ij} \Delta y_{it-j} - \sum_{j=0}^{p_i} \widehat{\theta}_{ij} \Delta x_{it-j} \quad \dots 7.0$$

4.4. CS-ARDL Model

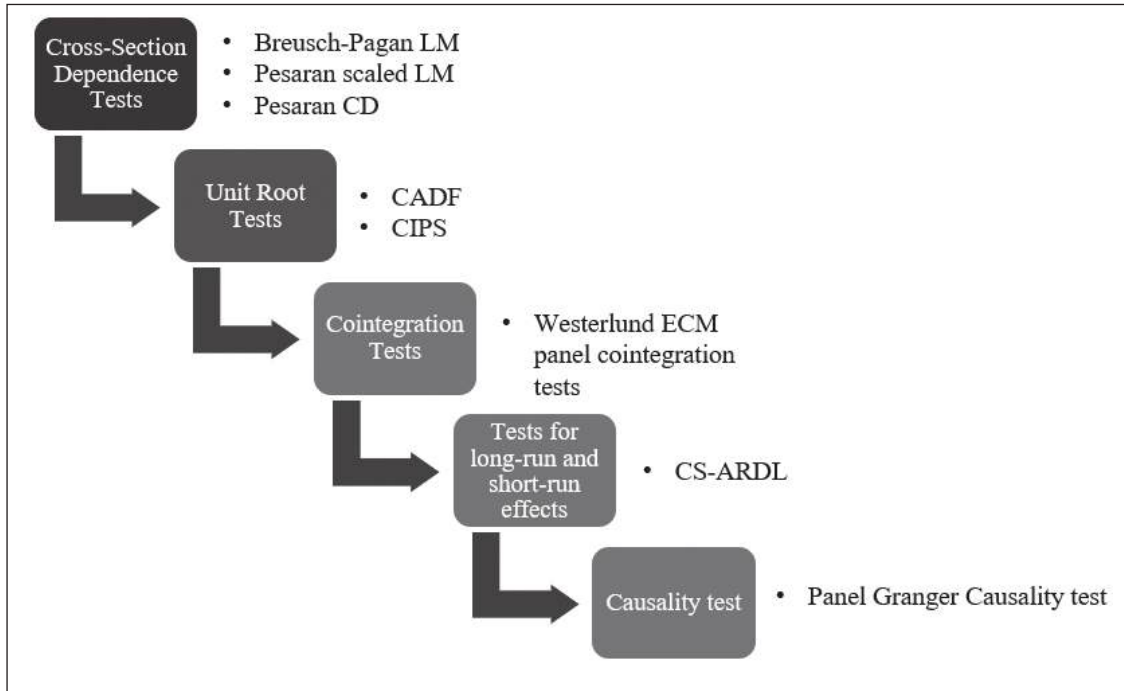
The next step in our analysis is to evaluate the relationship among the variables in long-term and short-term. In our study, we incorporate the CS-ARDL model as it manages serial correlation, endogeneity, and heterogeneity problem in panel data (Chudik & Pesaran, 2015).

$$\ln U_{it} = \sum_{i=0}^p \alpha_{it} U_{it-1} + \sum_{i=0}^p \delta_{it} V_{it-1} + \sum_{i=0}^p Y_{it} \overline{W_{it-1}} + \epsilon_{it} \quad \dots 8.0$$

Where equation 8.0, U_{it} represents our explained variable which is poverty reduction and V_{it-1} refers to independent variables. In our analysis, explanatory variable is remittances and control variables consist inflation, GFCF, and LFPR. In the next step, the Granger causality test serves as a mechanism to test the occurrence of causal link amongst the selected parameters in the research.

Figure 2 outlines the methodological design flowchart for panel data analysis.

Figure 2: Flowchart design for panel data analysis



Source: Author's work

5. Results and Discussions:

Table 2 shows the statistics and pairwise correlation. The mean, maximum, minimum, and standard deviation show the statistical outcomes while Jarque-Bera, skewness, and kurtosis test determine the normality position. The table statistics suggest that the REM value extends from -7.1766 to 3.9099 and the POV value falls between a minimum of -4.0178 to 10.001 maximum. The skewness values show that all variables exhibit negative skewness. POV, LFPR, INF, and GFCF exhibit leptokurtic behaviour, on the other hand, REM shows platykurtic behaviour as its value is less than three. Pairwise correlations show that there is no high pairwise correlation present in the data. This prevents our data from multicollinearity.

Table 2 : Descriptive Statistics and Pairwise Correlation

Variables	POV	REM	LFPR	INF	GFCF
Mean	7.8513	0.1056	3.9654	1.2704	3.1769
Maximum	10.001	3.9099	4.3316	7.1543	4.2562
Minimum	-4.0178	-7.1766	3.2575	-10.6571	-1.2727
Std. dev.	1.2549	2.2143	0.2231	1.6447	0.4609
Skewness	-1.9994	-0.5045	-0.8370	-1.6972	-2.8645
Kurtosis	19.8313	2.5256	3.1001	13.2169	22.7187
Jarque-Bera	8379.998	34.8107	78.7586	3245.435	11806.28
Probability	0.000	0.000	0.000	0.000	0.000
POV	1.0000				
REM	-0.4664	1.0000			
LFPR	0.3229	-0.3781	1.0000		
INF	-0.2650	0.1394	-0.1903	1.0000	
GFCF	-0.0233	-0.2098	0.4092	-0.1191	1.0000

Source: Author's Work

Additionally, the estimates of the cross-sectional dependence (CSD) test reveals that there is a presence of CSD in the variables.

Table 3 : Cross-Sectional Dependence Result

Test	Statistic
Breusch-Pagan LM	4010.783***
Pesaran scaled LM	132.1230***
Pesaran CD	37.6463***
*** $p < 0.01$	

Source: Author's Work

Further, the upcoming step involves examining stationarity through unit root test. Traditionally, first-generation unit root tests are performed given there is cross-sectional independence. But, in this study, due to the presence of CSD, there is a need to apply second-generation unit root tests. Table 4 presents the CIPS and CADF unit root tests. Hence, the variables are stationary at the first level.

Table 4 : Second-Generation Unit Root Approach

Variable	CADF		CIPS	
	Level	1st difference	Level	1st difference
POV	-1.945	-2.628*	-1.632	-3.544*
REM	-1.821	-3.661*	-1.867	-4.567*
LFPR	-1.341	-2.287*	-0.992	-3.440*
INF	-2.508*	-3.572*	-2.594*	-4.674*
GFCF	-1.939	-2.923*	-1.589	-3.737*
* $p < 0.01$				

Source: Author's Work

The forthcoming step in the study is to determine the cointegration among the chosen variables. To examine this, the Westerlund test is applied. This test's null hypothesis presumes that variables do not have a long-run cointegration. Table 5 reveals the result of Westerlund panel cointegration tests. It rejects the null hypothesis and confirms the occurrence of cointegrating relationship in the variables.

Table 5 : Westerlund ECM Panel Cointegration Tests

Statistic	Value	Z-value	Robust p-value
Gt	-1.694	1.464	0.000
Ga	-3.356	4.854	1.000
Pt	-31.849	-18.386	0.000
Pa	-11.896	-4.185	0.000

Source: Author's Work

Moving forward in the analysis, table 6 represents the CS-ARDL results. It shows the short-run (SR) results and long-run (LR) results. Further, a 1% elevation in REM uptick 0.0228% and 0.0148 % poverty alleviation in the SR and LR, sequentially (Acheampong et al., 2021; Azizi, 2021; Chea, 2023; CUI et al., 2023; Ojeyinka & Ibukun, 2024; Zaman et al., 2021). In addition, a 1% elevation in LFPR reduces deprivation by 0.1392 % in the SR and 0.2058 % in the LR (Mannan & Kozlov, 2020; Odhiambo & Manda, 2003). Inflation, alternatively, reveals an inverse relationship with poverty reduction. A one percentage rise in inflation causes an uptick in poverty by 0.0101% and 0.0060% in SR and LR respectively. Inflation reduces the purchasing power of money. Due to higher inflation, people can avail a smaller number of goods and services as compared to earlier. This can be supported by (Cardoso,

1992; Hassan et al., 2016). In addition, the error correction model is 54.03 %. It means that 54.03 % of deviations are adjusted each year from the long-run state equilibrium. Hence, the negative notation confirms the long-run stability connection amongst the variables.

Table 6 : CS-ARDL

Variables	Coef.	Std. Err.
Short-run results		
REM	.0228**	.0222
LFPR	.1392**	.2708
INF	-.0101**	.0106
GFCF	.0874***	.0389
ECM (-1)	-.5403	.0778
Long-run results		
REM	.0148***	.0156
LFPR	.2058***	.1941
INF	-.0060***	.0063
GFCF	.0479***	.0246
Groups	28	
Observation	644	
R-squared(mg)	0.84	
F-stat (p)	1.59	

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Coef. refers to coefficient and Std. Err. refers to standard error

Source: Author's Work

Further in our analysis, the next procedure is to explore the causal alliance amongst variables. So, table 7 represents the outcome of the Granger Causality test. hence, the results illustrate that bi-directional causality exists amongst remittances and poverty, labour force participation rate and remittances, inflation, and poverty. There is no causality exist between poverty and gross fixed capital formation.

Table 7 : Panel Granger Causality Test

Null hypothesis	F-statistic	Prob.	Comments
REM \nleftrightarrow POV	7.4194	0.0007	POV \leftrightarrow REM
POV \nleftrightarrow REM	5.2808	0.0053	
LFPR \nleftrightarrow POV	5.1448	0.0061	POV \leftrightarrow LFPR
POV \nleftrightarrow LFPR	2.4690	0.0854	
INF \nleftrightarrow POV	4.1515	0.0161	POV \leftrightarrow INF
POV \nleftrightarrow INF	3.2132	0.0408	
GFCF \nleftrightarrow POV	1.2383	0.2905	POV \nleftrightarrow GFCF
POV \nleftrightarrow GFCF	1.8659	0.1556	

Source: Author's work

6. Conclusion and Policy Recommendations

This research seeks to assess the influence of remittances on poverty reduction among Asian nations. It takes data set annually from 2000 to 2023. Our analysis, which started with a cross-sectional dependence (CSD) test, confirmed that CSD exists amongst the variables. Accordingly, panel unit roots of the second-generation panel stationarity tests, for example, CIPS and CADF tests are applied to check for stationarity. Then, cointegration tests like the Westerlund test are applied to investigate the identification of a long-run cointegration among the variables. Further, CS-ARDL is used for model estimation. The study highlighted that remittances can alleviate poverty as they can help household families increase income and come out of poverty. Countries like the Philippines experienced remittances that enabled families to afford better healthcare and education; measurable positive impact on poverty reduction. Similarly, Bangladesh has significantly experienced that remittances have reduced poverty levels in rural areas and thus led to better living standards. In Sub-Saharan Africa, remittances directly uplift poor families and improve their lives. Further, gross fixed capital formation (GFCF) enhances economic performance and creates jobs in the construction of roads, railways, and buildings. Moreover, gulf countries do not have enough labour hence to meet their increased demand, the need for migrant workers is there. Further, countries like Singapore and Malaysia have strong GFCF, experience a substantial number of inflows of foreign workers, and send remittances to neighbouring countries. Additionally, labour force participation rates (LFPR) have a positive and significant role in reducing poverty. Asian

countries like India and the Philippines see a large portion of the labour force migrating to other countries in seek of better opportunities in different sectors such as domestic work, construction, and healthcare, and this leads to their significant contribution to remittances flows in India and their home countries.

This study is beneficial to policymakers and concerned public authorities. Various policy recommendations entailing efforts to raising accessibility to sustainable income sources, innovative prospects, and critical productive assets; facilitating universal access to key public social services, expanding community safety system to help those who cannot help themselves; mitigating the unequal burden of poverty on women; and strengthening the international collaboration to end poverty. There is a need to apply sound macroeconomic policies, refine business productivity, and address corruption. It is a crucial measure of emigration confidence that can build a more attractive domain for remittance flows.

This study has several limitations and future scope. It covers only Asian countries as a sample; hence, more regions like MENA and SAARC can be studied. The future research scope is to analyse country-wise and give specific policy recommendations suitable for that country.

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Effect of Corporate Income Tax on Total Factor Productivity of Manufacturing Firms in India

Sankarganesh, K.¹ and Shanmugam, K.R.²

Abstract

This paper investigates the effect of corporate income tax on the productivity of manufacturing firms in India over the period 2005 to 2019. Firm-level productivity is estimated in the first stage using the Woolridge (2009) methodology, which effectively addresses endogeneity concerns in production function estimation. The findings indicate that higher corporate tax rates reduce firm productivity and this adverse effect is higher in public sector firms than in private firms, and stronger in the pre-global financial crisis period than in the years that followed. Additionally, export intensity, imported input usage, and R&D expenditure are positively linked to productivity. These results highlight the need for targeted policy support, particularly for younger, smaller and public sector firms that may be more vulnerable to tax-induced productivity constraints. The study provides practical insights for policy makers, industry stakeholders, and development agencies in designing tax and industrial policies that encourage productivity growth while safeguarding firm-level investment and innovation.

Keywords: Total Factor Productivity, Corporate tax rate, panel data methodology, manufacturing firms

JEL Classification: D24, C23.

1. Introduction

Experts in Public economics argue that all taxes other than lump-sum tax-can generate deadweight loss. For instance, corporate income tax (CIT) can distort firms' resource allocation decisions by affecting relative prices. When firms adjust input levels in response to CIT rather than efficiency considerations, resources are misallocated, leading to economic inefficiency and hindering macroeconomic growth. A high CIT rate may also discourage risk-taking by reducing after-tax profits, causing firms to avoid profitable but risky ventures. This, in turn, dampens potential productivity growth. Moreover, higher CIT can raise user cost of capital, which may deter investment in physical assets and research & development, ultimately slowing technological progress and productivity improvements (Kim, 2013).

¹Additional Commissioner of Income Tax, Mangalore, Email: sankar.kamaa40@gmail.com; Mobile: 9445954190

²Former Director & Honorary Professor, Madras School of Economics, Chennai 600 025 (Corresponding Author) Email: shanmugam@mse.ac.in; Mobile: 9444127681

Empirical macro-level studies by Feldstein (1995) and Goolsbee (2000), demonstrate that higher tax rates reduce taxable income and aggregate productivity. However, macro-level analyzes face three key limitations: (i) Total Factor Productivity (TFP) estimates are subject to aggregation bias; (ii) they are unable to capture heterogeneity across firms (e.g., differences by age or size); and (iii) CIT liability depends on statutory rates and also on firm-specific factors such as depreciation allowances, interest deductibility, investment incentives, and loss carryforwards (Romero-Jordán, et al., 2020)-factors often overlooked in aggregate analyzes.

To address these limitations, firm level data are used in more recent studies. Schwellnus and Arnold (2008) pioneered such work, although they measured CIT using statutory rates. Later research refined this approach by employing forward-looking metrics like the effective marginal and effective average tax rate (King and Fullerton, 1984; Devereux and Griffith, 2003). Notable studies-including Arnold et al., (2011), Kim (2013), and Romero-Jordán et al., (2020)-consistently find a negative impact of CIT on firm-level TFP in OECD countries, Korea, EU countries, China, and Spain. Yet, evidence relating to developing countries like India, remains scarce.

India historically imposed the world's highest CIT rates, raising concerns about the adverse impact on investment and productivity. Expert committees-such as those led by Chelliah, Shome and Kelkar-recommended significant reductions. As a result, the highest (lowest) statutory rate declined from 64.8% (50%) in 1989-90 to 35.7% (35.7%) in 2002-03. Despite fluctuations due to surcharges and cesses, further reductions brought the rates down to 34.9% and 26%, respectively, by 2019-20. This evolving tax environment provides a compelling context to examine how CIT affects firm productivity in India.

This study investigates the effect of CIT on the TFP of manufacturing firms in India during 2005-2019.¹ Its contributions to the limited empirical literature are as follows. To best of our knowledge, this study is the first one using firm-level data to examine the CIT-TEF relationship in India.² While India-specific, the findings carry broader relevance for other developing economics.

¹ In the recent literature, the TFP has two major components: one dealing with measuring the contribution of technical progress and the other dealing with measuring the ability and willingness of the firms to use the 'best practice' techniques of the chosen technology. As the main objective of this study is to examine the impact of CIT on TPF, the former's impact on the components of TPF is not considered for lack of appropriate resources.

² Sankarganesh and Shanmugam (2021), of course, use firm-level data to examine the effect of CIT on investment decisions of Indian manufacturing firms.

Instead of relying on effective marginal rates, this study uses a transparent and firm-specific metric: the ratio of CIT paid to PBT (profit before tax). This measure better captures the true tax burden at the firm level. The study employs the Wooldridge (2009) method to estimate firm-level TFP, offering improvements over traditional approaches such as the residual method, index-based methods, or the Levinsohn and Petrin (2003) technique. Additionally, the study explores whether the CIT's impact on productivity varies by firm size and longevity. It between the pre-and-post-Global Financial Crisis (GFC) periods to assess whether the CIT-TFP relationship shifted after 2008 shock. This distinction allows us to analyze how external crisis interact with tax policy to shape firm productivity outcomes.

The remainder of this paper proceeds as follows. The next section presents a brief review of relevant literature, followed by a discussion of data sources, empirical model and estimation techniques. The subsequent section discusses the empirical findings, and the final section provide concluding remarks.

2. Brief Review of Literature

The effect of taxation on economic growth has long been central to public policy debates. Numerous studies have analyzed the relationship between tax levels and GDP growth (e.g., Barro et al., 1995; Turnovsky, 2004), providing the foundation for subsequent micro- level analyses.

One of the earliest firm-level studies, Schweltnus and Arnold (2008), used data from 21 OECD countries (1971 – 2004) and examined the effect of statutory CIT rates and the user cost of capital on TFP. Using both residual method and the Levinsohn and Petrin (2003) semi-parametric approach, they found that higher CIT reduced TFP across firms, with weaker effects for small and young firms.¹

Vartia (2008) extended the analysis to 21 industries (manufacturing and business services) across 13 OECD nations (1981 – 2001), showing that higher statutory and effective average rates, along with time-varying country-specific tax policies and their interaction with industry characteristics, reduced productivity. Similarly, Kim (2013), analyzing 1,080 Korean firms (listed non-financial firms across 13 industrial sectors) between 1980 and 2010, found that higher corporate taxes reduced TFP, with stronger effects among highly profitable firms.

Firm-level evidence from Europe reinforces this conclusion. Gemmell et al., (2018) examined firms (from both manufacturing and service sectors) in 11 EU countries (1996 – 2005) and

¹Details of the residual approach and other approaches of measuring the TFP are briefly given in Appendix-1

showed that higher statutory rates showed productivity convergence, particularly for large firms. German corporate tax reforms cutting rates by 13 percentage points (2000 – 2001) raised small-firm productivity by 2.2 percentage points. Likewise, Bournakis and Mallick (2018) studied 7400 UK manufacturing firms (2004 – 2011) using alternative measures like the Olley and Pakes (1996) method (OP method), the LP method and other methods to estimate the TFP. They found that both statutory and effective rates negatively affected TFP growth, especially for financially constrained firms. .

Evidence from developing countries is limited but suggestive. Liu and Mao (2019) found that tax incentives boosted productivity in Chinese firms (2005 – 2012) using both OP and LP methods., Romero-Jordan et al., (2020), using Spanish firm data (1996- 2009) reported stronger negative effects of CIT on productivity growth of profit-making firms. Galindo and Pombo (2011), studying 42 developing countries, including India, also found that CIT reduced productivity, particularly in larger firms-though they did not provide country-specific evidence.

In India, several studies have measured productivity but not its link to CIT. Trivedi et al., (2011) reviewed Indian manufacturing productivity studies (1980 – 2010), applying methods such as the residual approach, Olley-Pakes (1996), Levinsohn-Petrin (2003), Akerberg, Caves, and Frazer (2006), and Wooldridge (2009). Singh and Sharma (2020,) analyzing 32 industries (2009 – 2015) confirmed that TFP estimates vary across methods, with the Wooldridge method yielding the most robust results, followed by ACF and LP, based on consistency and robustness checks.

Another source of variation lies in output measurement (Trivedi et al., 2011). Indian studies typically use three proxies: (i) real value added via single deflation, (ii) real value added via double deflation and (iii) real gross output. As Goldar and Kumari (2003) noted, omitting intermediate inputs lead to upward-biased TFP growth estimates. Hence, more comprehensive studies incorporate intermediate inputs such as services (S), energy (E), and raw materials (M) when using gross output.

3. Empirical Model, Data and Estimation

To analyze the effect of CIT on the TFP of manufacturing firms in India during 2005 - 2019, this study first estimates firm-and year specific TFP using the Wooldridge (2009) methodology. The real value added (VA), which is deflated with wholesale price index (WPI) for manufacturing products, is used as the output variable in the TPF estimation. The gross fixed asset at replacement cost (GFARC) is used as the state variable and this is measured utilizing the popular PIM, Perpetual Inventory Method (Srivastava, 1996), and deflated by

the WPI for Plant and Machinery. Compensation to employees (WAGES) serves as the free input variable (as data on employee count is unavailable for many firms), deflated using CPI-IW (Consumer Price Index for industrial Workers). The ENERGY (power and fuel expenses), deflated using the WPI for Fuel and Power. This variable represents a proxy variable.

After estimating the TFP, the study employs the following empirical model to analyze the relationship between CIT and productivity:

$$TFP_{it} = \beta_0 + \beta_1 T_{it} + \beta_2 ES_{it} + \beta_3 IRMC_{it} + \beta_4 R\&D_{it} + \beta_5 AGE_{it} + \beta_6 SIZE_{it} + \lambda_i + \eta_t + e_{it} \quad (1)$$

where,

- TFP_{it} = Estimated total factor productivity for i^{th} firm in t^{th} year;
- T_{it} = Effective tax rate (CIT-profit before tax ratio);
- ES_{it} = Export sales as a share of total sales for i^{th} firm in t^{th} year;
- $IRMC_{it}$ = Imported raw material consumption as a share of total raw materials used;
- $R\&D_{it}$ = Research and Development expenditures as a ratio of total net expenses;
- AGE_{it} = Log of firm age (years since incorporation);
- $SIZE_{it}$ = Log of real net sales (firm size);
- λ_i = Individual firm effects;
- η_t = Year effects.
- e_{it} = Idiosyncratic error term

The primary coefficient of interest, β_1 , captures the effect of CIT on TFP. Unlike statutory rates, the effective tax rate (T) varies across firms due to differences in asset composition, and depreciation methods. This firm-specific variation provides a more accurate measure of tax burden.¹

To control for other firm-level factors influencing productivity, the model incorporates the following variables:

- (i) Following Tapalova and Khandelwal (2011), imported raw material consumption ratio is used to capture the role of tariff reductions and improved access to high quality imported inputs in enhancing productivity.

¹ This variable may be endogenous. However, in our preliminary analysis, we find that this is not a serious issue.

- (ii) Export sales ratio is used a proxy for export orientation.
- (iii) Building on Sharma and Mishra (2015), the R&D expenditure is included due to its well-documented positive effect on manufacturing productivity.
- (iv) Following Arnold et al., (2011) and Romero-Jordán et al., (2020), firm age and size are included.

To test whether tax impact varies by firm characteristics (i.e., heterogenous effects), the model is extended in several ways. First, interaction term between CIT and firm characteristics (firm age and size) are included to test whether tax effects differ across these dimensions. Second, ownership-specific effect are explored by interacting CIT with ownership dummies for private (PRIVATE), public (PUBLIC) and foreign (FOREIGN) firms. Finally, to account for the impact of the GFC, a split-sample analysis compares the pre-crisis period (2005-2008) with post-crisis period (2009-2019).

The analysis employs standard panel data techniques: fixed effects (FE) and random effects (RE). The FE model (it allows correlation between regressors and individual effects), estimated via the Least Squares Dummy Variables (LSDV) method. In contrast, the RE model, estimated through Feasible Generalized Least Square (FGLS), assumes no such correlation. The model choice is guided by standard specification test; the Chow test determines whether one way or two-way effects are appropriate, while the Hausman Specification test is used to decide between FE and RE models.

Firm-level data are sourced from CMIE Prowess database, which provides detailed financial and operational information on Indian incorporated firms. The initial dataset covers approximately 17,000 manufacturing firms for 2005-2019. After filtering for reporting consistency and data completeness, the final unbalanced panel consists of 11,734 firms (6,763 public, 4,969 private and 2 foreign firms, yielding a total of 86,730 firm-year observations. Table 1 presents the means and standard deviations of all study variables.

Table 1 : Means and Standard Deviations of the Study Variables

Variables	Explanation	All Sample (2005 to 2019)	Before Crisis (2005 to 08)	After Crisis (2009 to 2019)
VA	Real Value added (in ₹ million)	702.6366 (3099.709)	488.1797 (2429.274)	764.4205 (3264.835)
GFARC	Real Gross Fixed Capital at Replacement Cost (in ₹ million)	2383.649 (8924.675)	1840.835 (7935.342)	2540.031 (9184.061)
WAGES	Real Compensation to Employees (in ₹ million)	225.8599 (743.2545)	183.7857 (649.8993)	237.9813 (767.6238)
ENERGY	Real Power and Fuel Charges (in ₹ million)	186.8534 (894.940)	157.0979 (815.1708)	195.4258 (916.4606)
TFP	Total Factor Productivity	5.8113 (2.150)	7.2418 (2.5632)	5.5158 (2.0602)
T	Effective Tax Rate (%)	18.7605 (13.737)	15.9313 (13.6673)	19.5756 (13.6491)
ES	Export Sale Ratio (%)	12.4996 (23.912)	13.0736 (24.135)	12.3341 (23.853)
IRMC	Imported Raw Material Consumption Ratio (%)	11.1968 (22.231)	13.7893 (23.3817)	10.4500 (21.8314)
R&D	Research and Development Expenditure Ratio (%)	0.2033 (1.155)	0.1723 (1.0770)	0.2122 (1.177)
AGE	Logarithmic value of Age (in years)	3.0077 (0.7229)	2.9389 (0.7471)	3.0275 (0.7145)
SIZE	Log of Real Net Sales (in ₹ million)	6.6525 (1.836)	6.2892 (1.8051)	6.7572 (1.8321)
PUBLIC	Dummy Variable =1 for public firm and 0 for others	0.6789 (0.467)	0.8298 (0.3757)	0.6355 (0.4812)
PRIVATE	Dummy Variable=1 for private firm and 0 for others	0.3209 (0.467)	0.1701 (0.3757)	0.3644 (0.4812)
FOREIGN	Dummy Variable=1 for foreign entity firm and 0 for others	0.0001 (0.009)	0	0.0001 (0.010)
N	Total Observations	86730	19398	67332

Source: Author's computation using basic data from Prowess.

4. Empirical Results

(i) TFP Estimation

Table 2 reports the estimation results of production function using the Wooldridge method. During the study period (2005–20090), the estimated wage elasticity for Indian manufacturing firms is 0.73, indicating that a 1% increase in WAGES (real compensation to employees) raises real value added (VA) by 0.73%. The estimated capital elasticity is 0.5, suggesting that a 1% increase in real GFARC (gross fixed capital formation) increases VA by 0.5%.

The Wooldridge estimation also generate firm-level TPF values for the entire sample. A disaggregated analysis highlights significant differences between the pre and post 2008 GFC. In the pre-crisis period, wage elasticity is estimated at 0.67 and capital elasticity at 0.84. By contrast, in the post-crisis period, wage elasticity increases to 0.75, while capital elasticity falls sharply to 0.42.

Table 2 : Wooldridge Estimation Results of Production Function

Variables	Full Sample Period (2005 to 19)	Before Crisis (2005 to 2008)	After Crisis (2009 to 2019)
Ln GFARC	0.5008 (43.36)	0.8396 (31.38)	0.4243 (32.63)
Ln WAGES	0.7314 (370.15)	0.6772 (136.92)	0.7520 (343.75)
Wald test on Constant returns to scale (χ^2)	406.60	376.28	184.58
No of Observations	86730	19398	67332

Source: Authour's estimation using STATA Software; Z values in the parentheses.

(ii) Impact of Corporate Tax on Productivity

a. Full Sample Results: Column (1) of Table 3 reports the two-way FE estimation results of equation (1). Column 2 adds the squared tax term to capture potential non-linear relation between the tax and productivity, while Columns (3) and (4) interact the effective tax rate with firm age and firm size respectively. Column (5) includes both (Age and Size) interactions simultaneously and Column (6) introduces interaction terms between the effective tax rate and ownership dummies (public, private, and foreign) to assess heterogeneity by ownership type. In all cases, the Hausman test supports the 2-way FE method as the appropriate specification.

The effective tax rate (T) is the main variable of interest. Across all six specifications, the coefficient of this variable (and its interaction with ownership dummies in Column 6) is consistently negative and statistically significant at the 1% level. This provides strong evidence that in India, the corporate taxation exerts a negative effect on the productivity of manufacturing firms.

The estimated coefficient in Column (1) implies that, a 1-unit increase in the tax rate reduces productivity by 0.004 units, corresponding to an elasticity of -0.0129. In Column (2), the coefficient of linear tax is negative, while the parameter associated with its squared term is positive. However, both are significant at the 1% level, confirming the non-linear relationship between the effective tax rate and productivity (i.e., productivity decreases with higher tax rates, but at an increasing rate). The net effect of tax on productivity is estimated at -0.0029, with an estimated elasticity value of -0.0095.

Column (3) shows that the interaction between tax and firm age is positive and significant, indicating that older firms are less adversely affected. The inclusion of this term increases the tax parameter value to -0.0105. The net impact of tax on TPF, after taking into account the interaction term, is -0.0042, and the estimated elasticity is -0.0135. Similarly, the tax-size interaction in Column (4) is positive and significant, indicating that larger firms experience a weaker negative effect from taxation. The estimated net effect of tax on TPF is -0.0043, with an elasticity of -0.0137.

Column (5) includes both interaction terms (age and size), which remain positive and significant. The net tax effect on TFP is -0.004, with an estimated elasticity of -0.0129. Finally, Column (6) shows the ownership specific effects: the tax interaction is significant and negative for public (-0.0043) and private (-0.0034) firms, both at the 1% level. For foreign firms, the coefficient is much larger in magnitude (-0.0237), but only weakly significant (10%), likely reflecting the very small share of foreign firms in the sample (just 0.01% of total observations).

Overall, the estimated elasticity of TFP (w.r.t the effective tax rate) ranges from -0.0095 to -0.0137. This implies that if the corporation income tax rate increases by 1%, the TPF reduces by 0.0095% to 0.0137%, providing robust evidence of the negative effect of corporate taxation on firm productivity in Indian manufacturing during 2005–2019.

Table 3 : Panel Data Model (2-way FE) Results of Productivity Equation (2005 to 2019)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Effective Tax Rate (T)	-0.0041*** (0.0001)	-0.0068*** (0.0004)	-0.0106*** (0.0005)	-0.013*** (0.0005)	-0.0172*** (0.0006)	
T ²		0.0001*** (0.000)				
T*PUBLIC						-0.0044*** (0.0002)
T*PRIVATE						-0.0034*** (0.0002)
T*FOREIGN						-0.0237 (0.0145)
Export Sales Ratio (ES)	0.0003** (0.0001)	0.0003** (0.0001)	0.0002** (0.0001)	0.0003*** (0.0001)	0.0003*** (0.0001)	0.0003** (0.0001)
Imported Raw Material (IRMC)	0.0004*** (0.0001)	0.0004*** (0.0001)	0.0004*** (0.0001)	0.0004*** (0.0001)	0.0004*** (0.0001)	0.0004*** (0.0001)
R&D Expenses	0.0121*** (0.0019)	0.0121*** (0.0019)	0.012*** (0.0019)	0.0119*** (0.0019)	0.0119*** (0.0019)	0.0121*** (0.0019)
AGE	0.4752*** (0.0086)	0.4738*** (0.0086)	0.4547*** (0.0087)	0.4781*** (0.0085)	0.4623*** (0.0087)	0.4747*** (0.0086)
SIZE	0.634*** (0.0027)	0.6358*** (0.0027)	0.6336*** (0.0027)	0.6148*** (0.0028)	0.616*** (0.0028)	0.6341*** (0.0027)
T*AGE			0.0021*** (0.0002)		0.0016*** (0.0002)	
T*SIZE				0.0014*** (0.0001)	0.0013*** (0.0001)	
Constant	0.0865*** (0.0254)	0.0884*** (0.0254)	0.1563*** (0.026)	0.1997*** (0.026)	0.2438*** (0.0264)	0.0855*** (0.0254)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.6382	0.6385	0.639	0.6402	0.6406	0.6383
Observations	86730	86730	86730	86730	86730	86730

Standard errors are in parentheses

*** $p < .01$, ** $p < .05$, * $p < .1$

Among the control variables, the export sales ratio (ES) is positively and significantly associated with TFP at the 5% level across Columns (1-6). Its coefficient ranges from 0.0002 and 0.0003, indicating that a 1-unit increase in export intensity raises productivity by 0.0002 - 0.0003 units. This supports the well-established view that exporting firms tend to be more productive. Similarly, the imported raw material consumption ratio (IRMC) shows a positive and significant (at 1% level) relationship with TPF in all specifications. A 1-unit increase in this variable rises the productivity by 0.0004 unit, highlighting the productivity gains from integrating into global value chains through imported inputs.

The R&D expenditure also exerts a consistently positive and significant impact on TFP at the 1% level. The magnitude of the coefficient suggests that a 1-unit rise in R&D spending boosts productivity by 0.012, highlighting the vital role played by innovation in improving the productivity of firms. Firm age is another important determinant, with a positive and significant coefficient (at 1% level) across all specifications, implying that age-old firms are generally more productive. In Columns (3) and (5), the interaction between age and the effective tax rate is also positive and significant, suggesting that while older firms are more productive, their tax burden rises with age.

Firm size (proxied by net sales) likewise shows a positive and significant impact on productivity at the 1% level in all columns. In columns (4) and (5), the tax-firm size interaction term is positive and statistically significant, indicating that larger firms not only bear relatively higher effective tax rates but also more productive.

b. Split Sample Results: In Table 4, Columns (1-3) present the two-way FE estimation results for the pre-GFC period (2005-2008). Both the Chow test and the Hausman test support this method of estimation. As expected, the effective rate has a negative and statistically significant impact on TFP at the 1% level in all columns. The estimated elasticity of TFP w.r.t. the tax rate is -0.0120 in Column (1). In Column (2), when tax interacts with both firm size and age, the interaction term coefficients are positive and significant. Taking into the interaction effect, the net tax effect on productivity is -0.0058, with an estimated elasticity of -0.0128.

Column (3) allows the interaction of tax variable with public and private dummies. Both coefficients are negative and significant, indicating that the adverse impact of tax on productivity is more pronounced in publicly owned firms (-0.0121) than in privately owned firms (-0.0110). Interestingly, coefficients of export sales ratio, R&D expenditures and imported raw material usage have similar signs and significance as in full sample analysis. Firm age and size also remain positively and significantly associated with TFP at the 1% level during the pre-crisis period.

Table 1 : Panel Data Model (2-Way FE) Estimation Results of Productivity Equation: 2005 to 2008 and 2009 to 2019

Variables	Before Crisis (2005 to 2008)			After Crisis (2009 to 19)		
	(1)	(2)	(3)	(4)	(5)	(6)
Effective Tax Rate (T)	-0.0055*** (0.0003)	-0.0131*** (0.0016)		-0.0024*** (0.0001)	-0.0104*** (0.0007)	
T*PUBLIC			-0.0055*** (0.0003)			-0.0024*** (0.0002)
T*PRIVATE			-0.0051*** (0.0007)			-0.0023*** (0.0002)
T*FOREIGN						-0.0187 (.012)
Export Sales Ratio (ES)	0.0002 (0.0003)	0.0002 (0.0003)	0.0002 (0.0003)	0.0001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)
Imported Raw Material (IRMC)	0.0005** (0.0003)	0.0005** (0.0003)	0.0005** (0.0003)	0.0005*** (0.0001)	0.0005*** (0.0001)	0.0005*** (0.0001)
R&D Expenses (R&D)	0.0173*** (0.0054)	0.0177*** (0.0054)	0.0173*** (0.0054)	0.0024 (0.0019)	0.0023 (0.0019)	0.0024 (0.0019)
AGE	0.7552*** (0.0335)	0.7548*** (0.0335)	0.755*** (0.0335)	0.3926*** (0.0098)	0.3799*** (0.01)	0.3926*** (0.0098)
SIZE	0.5703*** (0.0074)	0.5643*** (0.0077)	0.5703*** (0.0074)	0.5442*** (0.003)	0.5363*** (0.0031)	0.5442*** (0.003)
T*AGE		0.0012*** (0.0004)			0.0014*** (0.0002)	
T*SIZE		0.0006*** (0.0002)			0.0006*** (0.0001)	
Constant	1.4574*** (0.0976)	1.4942*** (0.0978)	1.4579*** (0.0976)	0.6097*** (0.0302)	0.702*** (0.031)	0.6093*** (0.0302)
Firm Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
F	1545.81	1269.49	1391.19	4235.97	3784.58	3765.42
Hausman stat.	3147.31	3077.80	3463.21	5510.99	5367.21	5794.02
Observations	19398	19398	19398	67332	67332	67332

Standard errors are in parentheses; *** $p < .01$, ** $p < .05$, * $p < .1$.

Columns (4-6) of Table 4 present the results for the post-crisis period (2009-2019). The Chow and Hausman tests continue to validate the use of 2-way FE model estimation across all specifications. As expected, the effective tax rate variable has negative and significant (at 1% level) effect in all columns, although the magnitude of the effect is lower compared to the pre-crisis period. The elasticity of TFP w.r.t to the tax rate is -0.0081 in Column (4). In column (5), both age and size interaction terms with the tax rate have positive and statistically significant coefficients at 5% level, implying that older and larger firms face relatively higher tax rates. The net tax effect on TFP is -0.0027, with an elasticity of -0.0096.

Overall, the adverse impact of taxation on productivity is less severe in the post crisis years. One plausible explanation lies in the increase in the Minimum Alternate Tax (MAT) during this period, which raised effective tax rates but may absorbed differently across firms, thereby moderating the overall productivity impact.

In Column (6), the tax interaction terms between the effective tax rate and public/private ownership dummies are negative and statistically significant, indicating that the adverse effect of taxation on TFP is stronger for public firms than for private firms. The estimated elasticity value for public firms is -0.0085 and private firms is -0.0082. For foreign firms, the tax interaction term is more negative than for both public and private firms, but its statistical significance is only at the 10% level. This lower significance level may be attributed to the very small size of foreign firms, which constitute just 0.01% of the total observations.

The estimated coefficients of R&D expenditures, export intensity and imported raw material use are consistent with the full sample results, showing positive and statistically significant effects on TFP. Similarly, firm age as well as firm size continue to show positive and significant associations with productivity at the 1% level across all four columns during the pre-GFC period (2005 - 2008).

5. Concluding Remarks

This paper has empirically examined the impact of the effective corporate tax rate on the productivity (TPF) of manufacturing firms in India during 2005 to 2019. In the first stage, firm-level TFP is estimated using the Wooldridge (2009) methodology, which addresses endogeneity in the production function estimation. In the second stage, TFP is regressed on the effective corporate tax rate, along with key control variables such as export intensity, imported raw material usage, R&D expenditure, firm age, and firm size.

The results have strongly supported the theoretical expectation that higher corporate tax rates negatively affect firm productivity. The estimated elasticity of TPF with respect to tax rate

has ranged between -0.0095 and -0.0137, suggesting that 1% increase in the tax rate reduces productivity by 0.0095% to 0.0137%. While the magnitude of the effect is somewhat lower than that reported in earlier studies, this may reflect India's relatively low effective average corporate tax rate in India (18.76%), which amounts to about 60% of the statutory rate, because of many deductions and exemptions.

Further analysis has revealed that the adverse impact of is more pronounced in publicly owned firms compared to privately owned firms. Moreover, the pre-GFC period witnessed stronger negative effects of taxation on productivity than the post-crisis period, possibly due to the introduction of the Minimum Alternate Tax (MAT) in the latter period. The R&D expenditures, export intensity, imported raw material usage have a positive and significant association with productivity, highlighting the importance of trade integration and innovation. Older and larger firms tend to be more productive, but they also face a higher effective tax burden, as indicated by positive interaction effects between tax and both age and firm size.

These findings offer several important insights for policymakers. Further reductions in corporate tax may still be warranted, as effective tax burden continue to constrain productivity. Public sector firms may require greater support or targeted incentives, given their higher tax sensitivity. Existing deductions and exemptions, such depreciation allowances, should be preserved to alleviate tax burdens. Young and small firms should be prioritized in policy efforts aimed at improving productivity. Policies that encourage exports, facilitate access to imported inputs and support R&D investment can contribute to higher firm productivity.

Overall, this study provide valuable insights for policy makers, international development agencies and industry experts in designing appropriate strategies to ensure that corporate taxation does not become a barrier to productivity growth in manufacturing sector of India.

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Appendix 1

In the residual approach, the TFP is conceptually defined using a Cobb-Douglas production function, which assumes the following functional form: $Q = AK_{it}^{\alpha} L_{it}^{\beta} M_{it}^{\gamma}$, where Q_{it} is the output of firm i in year t , which is assumed to be produced using three factor inputs (as an example): L -labour, K -capital, and M -material inputs. A is an unobservable productivity term (residual) identified by Solow (1957) as TFP. Solving for A , TPF can be expressed as:

$$TFP = A = Q / (K_{it}^{\alpha} L_{it}^{\beta} M_{it}^{\gamma}).$$

This production function can be estimated using the regular regression method (OLS) or Fixed or Random Effects Model. However, OLS estimates may be biased and inconsistent due to simultaneity bias, as highlighted by Levinsohn and Petrin (2003). This issue arises because productivity shocks, which are partly observed by firm managers, influence input choices. This violates the presumption that residuals are independently and identically distributed (i.i.d), thus violating the BLUE property of OLS.

Consider the log-linearized production function:

$$q_{it} = \alpha_0 + \alpha k_{it} + \beta l_{it} + \gamma m_{it} + \omega_{it} + \varepsilon_{it}$$

where, q , k , l and m indicate log values of output and inputs; ω_{it} is the observed productivity component and ε_{it} is the unobserved random factor.

In order to correct for simultaneity bias, semi-parametric estimation techniques have been developed: Olley and Pakes (1996) introduced investment as a proxy for ω_{it} . However, due to non-linearity and lumpy investment patterns, Levinsohn and Petrin (2003) introduced the usage of intermediate inputs like raw materials or energy as proxies.

In the LP method, the productivity term ω_{it} is assumed to follow a first-order Markov process:

$$\omega_{it} = E[\omega_{it} | \omega_{it-1}] + \xi_{it}$$

where ξ_{it} is an innovation to productivity. But this innovation is uncorrelated with capital but not with labour (l), which is a part of the source of the simultaneity problem.

The LP method employs a two-stage estimation procedure. The production function is expressed as:

$$q_{it} = \alpha_0 + \alpha k_{it} + \beta l_{it} + \gamma m_{it} + \omega_{it} + \varepsilon_{it} = \beta l_{it} + \varphi_{it}(k_{it}, m_{it}) + \varepsilon_{it}$$

where $\varphi(k_{it}, m_{it}) = \alpha_0 + \alpha k_{it} + \gamma m_{it} + \omega_{it}(k_{it}, m_{it})$.

One can substitute a third order polynomial approximation in k_{it} and m_{it} in place of $\varphi_{it}(k_{it}, m_{it})$, and this procedure consistently estimates the parameters of the above function using OLS in stage 1. In the second stage one can identify the coefficient of α by computing φ_{it} using $\varphi_{it} = \hat{q} - \hat{\beta}l_{it}$. For any candidate values of α^* and γ^* , it provides an estimate of ω_{it} for all period t using $\widehat{\omega}_{it} = \widehat{\varphi}_{it} - \alpha^*k_{it} - \gamma^*m_{it}$. With these values, one can obtain a consistent non-parametric approximation to $E[\widehat{\omega}_{it} | \widehat{\omega}_{it-1}]$, given by the predicted values from the regression: $\widehat{\omega}_{it} = \phi_0 + \phi_1 \omega_{it-1} + \phi_2 \omega_{it-1}^2 + \phi_3 \omega_{it-1}^3 + \varepsilon$. Then, it measures the residual for (α^*, γ^*) as: $\widehat{\varepsilon} + \widehat{\xi} = q_{it} - \widehat{\alpha}k_{it} - \widehat{\beta}l_{it} - \widehat{\gamma}m_{it} - E[\widehat{\omega}_{it} | \widehat{\omega}_{it-1}]$. Basically, it estimates the production function by minimizing: $\sum_{it} (q_{it} - \alpha k_{it} - \beta l_{it} + \gamma m_{it} + E[\omega_{it} | \omega_{it-1}])^2$. Finally, it computes the log TFP as: $\omega_{it} = q_{it} - \alpha k_{it} - \beta l_{it} - \gamma m_{it}$.

The Wooldridge measure is an extension of LP method. In the case of two inputs, the LP model estimates the production function by minimizing: $\sum_{it} (q_{it} - \alpha k_{it} - \beta l_{it} + E[\omega_{it} | \omega_{it-1}])^2$ and computes the log TFP as: $\omega_{it} = q_{it} - \alpha k_{it} - \beta l_{it}$.

According to the ACF method, when the variable input (labour) is also a deterministic function of unobserved productivity and state variables, then the coefficient on variable input (β) can be non-parametrically unidentified (Ackerberg, Caves, and Frazer, 2006). This problem will pose collinearity and yield overstated/understated productivity results in the LP method. However, the ACF method suggests that instead of evaluating β in the first stage, one can use it for separating ω from ε . In this method, ω_{it} is assumed to evolve according to a first order Markov process between the sub periods t-1, t-b, and t. Then, the information set at t is I_{it} . In order to identify α and β , this method suggest two independent moment conditions as:

$$\omega_{it} = E(\omega_{it} | I_{it-1}) + \xi_{it} = E(\omega_{it} | \omega_{it-1}) + \xi_{it}.$$

Since the LP method assumes that K_{it} is decided at t-1, this provides the second stage moment condition: $E(\xi_{it} | K_{it}) = 0$. In the information set, K is uncorrelated with ξ_{it} . This implies:

$$E\left(\xi_{it} \mid I_{it-1}^{k_{it}}\right) = 0. \text{ Therefore } E\left(\xi_{it} \cdot \left(I_{it-1}^{k_{it}}\right)\right) = 0. \text{ Thus, ACF method suggests the above}$$

two moments to identify α and β in the estimation. Later, Wooldridge (2009) modifies the relevant moment conditions suggested by ACF method with generalized method of moments (GMM). This method uses the moment restrictions in terms of two equations. One can use the same dependent variable in both equation, but different set of instruments characterize them. This overcomes the identification issue involved in the stage-1 estimation and helps in obtaining robust standard errors accounting for both serial correlation and /or

heteroskedasticity, in place of bootstrap of the standard errors of their estimators in ACF method and LP method. He writes the LP equation as: $\omega_{it} = E(\epsilon_{it} | \omega_{it-1}, k_{it}, l_{it}, m_{it}, k_{it-1}, l_{it-1}, m_{it-1}, \dots, k_{i1}, N_{i1}, M_{i1} = 0)$. Following LP and rewriting this equation, it states: $(\omega_{it} | k_{it}, k_{it-1}, l_{it-1}, m_{it-1}, \dots, k_{i1}, l_{i1}, m_{i1}, F_{it}) = E(\omega_{it} | \omega_{it-1}) = [h(k_{it-1}, m_{it-1})]$. Thus, he shows that the above two equations directly lead to the formulation of two key functions to identify (α, β) :

$$q_{it} = \alpha_0 + \alpha k_{it} + \beta l_{it} + h(k_{it}, m_{it}) + \epsilon_{it} \quad (1)$$

$$q_{it} = \alpha_0 + \alpha k_{it} + \beta l_{it} + f[h(k_{it-1}, m_{it-1})] + \eta_{it} \quad (2)$$

$$\text{where } \eta_{it} = \epsilon_{it} + \omega_{it} \quad (3)$$

Then he provides the following moments to estimate productivity as:

$$\begin{aligned} q_{it} - \alpha_0 - \alpha k_{it} - \beta l_{it} - h(k_{it}, m_{it}) &= \epsilon_{it} \quad \text{and} \\ q_{it} - \theta - \alpha_0 - \alpha k_{it} - \beta l_{it} - h(k_{it-1}, m_{it-1}) &= \eta_{it} \end{aligned} \quad (4)$$

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