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Assessing the Impact of Sectoral Investment on Bihar's Economic Growth.

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Abstract

This study aims to measure the influence of investment in key sectors, namely Agriculture & Allied, Industry, and Services, on Bihar's economic growth. To achieve this, we employ the decomposition methodology introduced by Jalava and Pohjola (2002) by formulating a set of structural relationships and establishing interconnections between the growth of these sectors and the role of investment. Firstly, we examine the stationarity of the variables in these structural relationships using the Augmented Dickey-Fuller test. Next, we estimate the structural relations through Ordinary Least Square (OLS) analysis to investigate the specific contribution of investment in the Agriculture & Allied sector to the overall economic growth rate. Finally, we explore alternate simulation scenarios that support the promotion of public sector investment in the Agriculture & Allied sector. Through this comprehensive analysis, we aim to provide valuable insights into the importance of investing in this sector for Bihar's sustainable economic development.

Keywords: Growth, Inter–Sector Linkages, Stationarity of variables, Augmented Dicky – Fuller Test, Augmentation of Public Investment, Agriculture & Allied Sector.

1. Introduction

1.1. Unleashing Bihar's Economic Growth Potential: Exploring the Role of Investment in Key Sectors

Investment plays a pivotal role in driving economic growth by bolstering productive capacity, creating job opportunities, fostering technological innovations, and contributing to government tax revenue. In India, strategic policy initiatives, such as government-led investments in core sectors during the early Five-Year Plans and the nationalization of banks in 1969, have facilitated an impressive saving-investment profile compared to countries with similar per capita income. Additionally, the opening up of the Indian economy to Foreign Direct Investment has further strengthened this trajectory.

India's investment rate, exceeding 36% of GDP, has propelled a remarkable growth rate of 8.2% during the 11th plan. Even higher growth rates are anticipated in the future, with investment rates of 38.4% and 41.4% outlined in the Approach Paper to the 12th plan. Bihar, a state that historically lagged behind in socio-economic indicators until the tenth plan, managed to surpass national growth rates during the 11th plan. The state aims to continue this trend in subsequent plans to bridge the existing gap. Conducting a meticulous analysis of investment's impact on major sectors, namely Agriculture & Allied, Industries, and Services, can prove instrumental in achieving optimal returns on investment.

The structural transformation of the Indian economy, under different policy regimes, has led to uneven growth patterns and variations in sectoral composition, ultimately influencing economic growth. Post-independence, policymakers made conscious efforts to boost the agricultural sector through initiatives like the green revolution and advancements in cultivation practices. During the liberalization era, the structural transformation shifted from the primary sector to the secondary/tertiary sector, albeit at a comparatively slower pace than previous substitution regimes. Following economic reforms, the roles of the agriculture and service sectors became more interchangeable. Presently, both the Indian and Bihar economies derive a substantial portion of their contributions from the service sector, followed by industry and agriculture, respectively. Monitoring and controlling the sectoral contributions will be crucial, as technology and sector integration play vital roles in driving economic growth. However, the analysis of investment's contribution to economic growth in various sectors does not suggest an optimal path.

Previous studies, such as Mazumdar and Mallick, identified investment growth asymmetry and the dominant role of the industry sector in private investment in India [1, 2]. However, these studies lacked a comprehensive examination of the investment contributions and growth dynamics across major sectors. A similar analysis is missing for Bihar, leaving the state without a justified investment pattern.

This paper aims to fill that gap by measuring the linkages and investment contributions of Bihar's major sectors, including Agriculture & Allied (comprising agriculture, animal husbandry, forestry, and fisheries), Industry (encompassing mining, quarrying,

manufacturing, construction, electricity, gas, and water supply), and Services [covering transport, storage, communication, trade, hotels, restaurants, banking, insurance, real estate, public administration, and other services]. Additionally, it explores alternate scenarios with increased public investment in the Agriculture & Allied sector, which is vital for food security and provides employment for a significant portion of the workforce.

1.2. Unraveling the Contributions of Agriculture & Allied, Industry, and Service Sectors to Economic Growth: An Analytical Approach

In this analysis, we employ the methodology developed by Jalava and Pohjola to dissect the individual contributions of the Agriculture & Allied, Industry, and Service sectors to overall economic growth [3]. This method involves decomposing the aggregate growth of the economy (Y) into three components: (i) the share-weighted output growth of the Agriculture & Allied sector (Ya), (ii) the share-weighted output growth of the Industry sector (Yi), and (iii) the share-weighted output growth of the Service sector (Ys).

To determine these contributions accurately, we assign corresponding weights to each sector's output growth. The weights (wa: Agriculture & Allied; wi: Industry; and ws: Service) represent the proportion of sector-specific value added to the overall aggregate output. By utilizing this approach, we aim to gain insights into the distinct roles played by these sectors in driving economic growth and better understand their relative significance.

$Y = w_a . Y_a + w_i . Y_i + ws . Y_s$;
such that $w_a + w_i + w_s = 1$.

1.3. Analyzing Investment Contributions: A Comprehensive Framework

Numerous studies have demonstrated a robust correlation between the performance of the agriculture and industry sectors. Noteworthy early attempts in India, such as those by Rangarajan, Ahluwalia & Rangarajan, Dhawan & Saxena, and Thamrajakshi, highlighted this relationship. Recent studies, including Kanwar, Bathala , Sastry, Singh, Bhattacharya & Unnikrishnan, Krishnamurthy, Pandit, & Mahanty, and Mani, Bhalachandran & Pandit, further emphasized the significant role of agriculture in determining overall economic growth[4-12]. Drawing on insights from these studies, we have formulated structural relationships to examine the contribution of investment to the economy's overall growth rate. The first step involved estimating a set of relationships to explain the factors responsible for growth in the Agriculture & Allied, Industry, and Service sectors. By establishing these interdependencies, we aim to unravel the specific impact of investment on the overall growth dynamics of the economy. Subsequently, these relationships were utilized to elucidate the rate of growth in the Aggregate GDP, following the framework below:

• The aggregate growth rate (AGr) is influenced by the growth rates in the Agriculture & Allied sector (AAr), Industry (Ir), and Service (Sr) sectors.

▪ $AG_r = \alpha_0 + \alpha_1 AA_r + \alpha_2 I_r + \alpha_3 S_r$ where α's are the constant of the equation. ------- (1)

• (II) Growth rate in Agriculture & Allied sector (AA_r) is dependent on the growth rate of acreage (ACE_r), the spread of optimal rainfall in the monsoon season(RAIN), and the growth rate of Investment in the Agriculture & Allied sector (IAG_r).

• $AA_r = \beta_1 + \beta_2 * ACE_r + \beta_2 * RAIN + \beta_3 * IAG_r$. where β's are the constant of the equation (2)

• Growth rate in the Industry sector (I_r) is dependent on the growth rate of investment in the Industry sector (II_r), the growth rate of the Agriculture & Allied sector(IAG_r), and the Aggregate Government Expenditure (AGE).

• $I_r = \mu_0 + \mu_1 * II_r + \mu_2 * IAG_r + \mu_3 * AGE$. where μ's are the constant of the equation (3)

• Growth rate in the Service sector is dependent on the growth rate of investment in the service sector, the growth rate of Agriculture & Allied and Industry sectors, and the aggregate government expenditure.

• $S_r = \Omega_0 + \Omega_1 * IS_r + \Omega_2 * AA_r + \Omega_3 * I_r + \Omega_4 * AGE$ where Ω's are the constant of the equation (4)

• Private investment in Agriculture & Allied sector (PvIAG) is dependent on public investment (PuIAG) and the growth rate in the sector(AAr).

• $PvIAG = £_0 + £_1 * PuIAG + £_2 * AA_r$ where £'s are the constant of the equation (5)

• Private investment in Industry (PvII)is dependent on public investment in Agriculture & Allied(PuIAG) and Industry (PuII); and the growth rate of the Industry sector().

• $PvII = ¥_0 + ¥_1 * PuIAG + ¥_2 * PuII + ¥_3 * I_r$ where ¥'s are the constant of the equation (6)

1.4. Accounting for Stationarity and Estimating Structural Relations

When dealing with regression models that involve an integrated dependent variable, standard inference procedures may not be applicable. Therefore, in this analysis, we carefully examined the variables in the structural relations to determine their stationarity using the Augmented Dickey-Fuller test. This step allows us to ensure that the series meet the necessary requirements for analysis.

After confirming stationarity, we estimated the structural relations using the Ordinary Least Squares (OLS) method. Each equation was specified in accordance with the stationary requirements identified earlier. By employing these rigorous statistical techniques, we aim to derive reliable and meaningful insights regarding the relationships between the variables and their contributions to the overall growth dynamics.

1.5. Measurement of Capital and Data Sources

In this study, capital is quantified as the net fixed capital stock in the respective sectors, using 2004-05 prices as the reference point. Public investment in the Agriculture & Allied and Industry sectors is assessed by considering net fixed capital formation in these sectors, also at 2004-05 prices. On the other hand, private sector capital formation in Agriculture & Allied and Industry is determined as the residual of total investment after subtracting public investment.

To gauge the output of each sector, we utilize the Gross Domestic Product (GDP) at factor cost, which is available at the sectoral level and for the overall economy through data provided by the Central Statistical Office (CSO) and compiled by the Directorate of Economics and Statistics (DES), Bihar. It is important to note that DES, Bihar does not compile data specifically on net capital formation and capital stock for Bihar. Consequently, the author of this study has employed the Perpetual Inventory Method (PIM) as a methodology for estimating capital formation and capital stock, as outlined in Sinha & Verma, Sinha, Sinha, and Sinha & Sinha[13-18]. These estimates have been incorporated into the analysis.

Additionally, data on the net sown area, serving as a measure of cultivated acreage, and monsoon rainfall are sourced from the DES, Bihar. For the 2020-21 period, the growth rate of the net sown area is extrapolated using a moving average approach, considering the growth rates of the preceding two periods.

By employing these methodologies and data sources, we ensure robust and comprehensive analysis of the capital and sectoral variables, allowing us to draw meaningful conclusions regarding the relationship between investment and economic growth in Bihar[19-25].

2. Analysis & Results

2.1. Analyzing Sectoral Contributions to Economic Growth: Decomposition

Table 1 presents the breakdown of the major sectors' share in the total Gross Domestic Product (GDP) for Bihar and India, calculated at 2004-05 prices. It also includes the annual growth rate for each sector, represented as the semi-logarithmic annualized growth rate. This analysis allows us to delve into the specific contributions of these sectors to overall economic growth.

Sector		Bihar			India		
		Agri+ Allied	Industry	Services	Agri+Allied	Industry	Services
Share of the sectors (%) in the GDP	1980-81	51.74	10.58	37.68	36.54	25.22	38.24
	1990-91	44.98	12.43	42.59	30.21	26.59	43.20
	2000-01	37.72	11.66	50.62	23.22	24.97	51.81
	2010-11	21.99	19.05	58.96	14.98	24.62	60.60
	2020-21	18.19	21.17	60.64	12.19	23.91	63.90
Semi-logarithm annualized growth rate (%)	1980-81 to1995-96	2.06	24.59	6.11	3.24	7.95	4.74
	1996-97 to 2006-2007	(-)3.11	(-)9.80	3.29	2.46	4.33	5.85
	2007-08 to 2020-21	(-)0.82	(-)2.06	6.47	2.48	7.89	5.84

Source: Author's calculation.

Table 1: Share and semi-logarithm annualized growth rate of the major sectors in the total GDP at 2004-05 prices for Bihar and India.

Table 1 provides valuable insights into the changing structure of the sectoral composition and the annualized growth rates of the three major sectors in Bihar and India, measured at 2004-05 prices by assessing the sectoral composition and growth dynamics. Notably, the Agriculture sector's share has declined in both Bihar and India. While the growth rate of Agriculture has slightly decreased in India over the given period, it has turned negative in Bihar, which raises significant concerns.

Similarly, the Industry sector has experienced predominantly negative growth. On the other hand, the Service sector has shown satisfactory growth, with both its composition share and growth rates displaying positive trends.

To delve deeper into these patterns, Table 2 presents the average share of value-added and the contribution to logarithmic annualized growth for the Agriculture & Allied, Industry, and Services sectors in the GDP of Bihar and India, utilizing 2004-05 prices. This analysis provides further insights into the relative significance and contributions of these sectors to the overall economic dynamics of Bihar and India.

Period		The average share of value added			Contribution to the growth rate			
		w_a	w_m	w_s	Agri+Allied	Industry	Service	Aggregate
BIHAR	1980-81 to 1995-96	0.42	0.16	0.42	1.32	0.02	2.16	4.32
	1996-97 to 2006-2007	0.33	0.20	0.47	0.05	(-)0.01	0.36	0.54
	2007-08 to 2020-21	0.25	0.19	0.56	0.22	0.01	3.32	4.56

INDIA	1980-81to 1995-96	0.28	0.30	0.42	0.52	0.26	2.37	4.80
	1996-97to 2006-2007	0.23	0.29	0.48	0.53	0.39	2.67	4.67
	2007-08 to 2020-21	0.17	0.25	0.58	0.75	0.24	4.13	6.67

Source: Author's calculation.

Table 2: Average share of value-added and contribution in the growth rate of the Agri+Allied, Industry, and Service sectors in GDP of Bihar & India at 2004-05 prices.

Table 2 provides important insights into the contribution of major sectors to the growth rates of the economy by analyzing sectoral contribution to growth. In particular, it highlights the disparity between the share of the Agriculture & Allied sector in the GDP and its contribution to the annualized growth rate. Despite the decline in the sector's share in both Bihar and India, its contribution to the growth rate remained at 11% for India. However, in Bihar, the sector's contribution dwindled significantly from 30% to 5%, indicating a pressing concern that necessitates immediate attention.

The Industry sector's share and contribution to the growth rate were negligible in Bihar, whereas at the national level, its contribution to the growth rate slightly lagged behind its share in the GDP.

On the other hand, the Service sector consistently exhibited a contribution to the growth rate that surpassed its share in the GDP, both in Bihar and India. Notably, the Service sector's contribution to the growth rate showed a faster acceleration in Bihar compared to India during the study period. This firmly establishes the Service sector as a pivotal component driving growth phenomena in both Bihar and India.

Overall, the findings from Table 2 underscore the importance of sectoral contributions to the growth rates of the economy, emphasizing the critical role of the Agriculture & Allied and Service sectors in shaping the growth dynamics in Bihar and India.

2.2. Examining the Relationship Between Public Sector Investment and Sectoral Growth: Table Analysis

Table 3 provides valuable information regarding the average rate of public sector investment and the growth rate in the agriculture, industry, and service sectors over a span of three decades from 1980-81 to 2020-21. This data offers insights into the close association between the rate of public sector investment (expressed as the percentage share of sectoral Gross Fixed Capital Formation to sectoral GDP) and the contribution of these sectors to both their own growth rate and the overall growth rate of the economy.

The table presents the average rate of investment and growth rate for each sector, highlighting the trends in Bihar and India. By examining this data, we can gain a better understanding of the relationship between public sector investment and the performance of the agriculture, industry, and service sectors.

		Rate of Investment			**Growth rate**			
		Agri.	**Industry**	**Services**	**Agri.**	**Industry**	**Services**	**Aggregate**
INDIA	1980-81 to 1982-83	1.84	4.37	7.43	5.86	4.25	5.35	5.37
	1983-84 to 1985-86	1.58	4.82	7.11	6.42	4.63	5.86	5.45
	1986-87 to 1988-89	1.37	3.47	6.74	3.43	5.37	7.01	5.67
	1989-90 to 1991-92	1.31	3.92	6.32	3.21	6.23	7.57	5.76
	1992-93 to 1994-95	0.98	4.14	7.34	2.96	6.21	5.26	3.95
	1995-96 to 1997-98	0.65	5.11	7.11	2.57	6.08	6.01	5.98
	1998-99 to 2000-01	0.84	5.32	6.95	3.02	3.47	7.53	5.73
	2001-02 to 2003-04	0.98	4.88	6.79	2.06	3.78	8.51	7.38
	2004-05 to 2006-07	1.32	3.52	7.32	1.84	9.32	8.63	7.63
	2007-08 to 2009-10	1.23	8.64	7.65	3.04	8.27	9.64	7.53

	2010-11 to 2012-13	1.29	8.35	8.94	3.45	7.28	9.74	7.76
	2013-14 to 2015-16	1.31	3.92	6.32	3.21	6.23	7.57	5.76
	2016-17 to 2018-19	0.98	4.14	7.34	2.96	6.21	5.26	3.95
	2019-20 to 2020- 21	0.65	5.11	7.11	2.57	6.08	6.01	5.98
BIHAR	1980-81 to 1982-83	1.01	0.82	5.73	7.45	4.52	5.79	6.48
	1983-84 to 1985-86	1.23	0.96	6.54	8.56	4.65	5.96	6.84
	1986-87 to 1988-89	1.12	0.87	6.76	-1.75	5.16	4.81	2.17
	1989-90 to 1991-92	1.35	1.04	6.83	-1.45	5.61	4.32	2.78
	1992-93 to 1994-95	1.33	1.54	6.94	2.76	2.17	3.45	2.95
	1995-96 to 1997-98	1.12	1.63	6.98	2.51	-2.22	4.23	3.13
	1998-99 to 2000-01	1.64	1.87	7.03	-2.12	2.69	5.27	3.91
	2001-02 to 2003-04	1.77	1.99	7.13	6.44	2.82	4.23	3.43
	2004-05 to 2006-07	2.43	3.12	8.76	7.44	3.21	6.86	7.75
	2007-08 to 2009-10	2.77	4.44	9.32	3.43	1.48	12.11	8.75
	2010-11 to 2012-13	3.12	4.58	9.76	4.33	8,96	12.44	9.08
	2013-14 to 2015-16	3.29	8.35	8.94	4.45	8.28	11.74	8.76
	2016-17 to2018-19	3.31	7.92	8.32	4.21	8.23	11.57	7.76
	2019-20 to 2020-21	2.98	6.14	6.34	3.96	6.21	6.26	5.95

Source: Author's calculation.

Table 3: Average rate of public investment and growth rate – Bihar & India.

Analyzing Public Sector Investment Table 3 sheds light on the rate of public investment in different sectors, particularly Agriculture & Allied, Industry, and Service sectors, in both India and Bihar. The data highlights notable patterns and variations in public sector investment between these sectors.

Notably, the table reveals that the rate of public investment in the Agriculture & Allied sectors was relatively low, both at the national level and in Bihar. However, there has been an upward trend in Bihar since 1998-99, with the current rate surpassing twice the national level. It is worth mentioning that this increase might include capital expenditure dedicated to flood protection, which could contribute to higher investment in the sector.

In the case of the Industry sector, the rate of public investment was historically low, particularly until 2003-04. However, there has been improvement in subsequent years, indicating efforts to sustain and enhance investment in this sector.

Comparatively, the rate of investment in the Service sector in Bihar aligns with the national level, suggesting a similar level of attention and commitment to public sector investment.

Overall, the data from Table 3 highlights the disparities and developments in public sector investment across different sectors in Bihar and India. It provides insights into the levels of investment and underscores the need for targeted efforts to promote investment in the Agriculture & Allied and Industry sectors while maintaining the momentum in the Service sector.

2.3. Assessing Stationarity: Augmented Dickey-Fuller Test Results

Before proceeding with the estimation of the structural relations, it was crucial to examine the stationarity of the relevant variables. This was achieved through the application of the Augmented Dickey-Fuller (ADF) test, which provides insights into the presence or absence of unit roots in the time series data.

The results of the ADF test, outlining the stationarity of the variables, are presented in Table 4. These results play a pivotal role in ensuring the validity of the subsequent estimations and analysis. By assessing stationarity, we can gain a better understanding of the dynamics and behavior of the variables involved in the study.

Variable	level	First Difference	Inference
NDP in Agriculture	-2.203	-9.221	Nonstationary –I(1)
Growth rate Agri. GDP	-7.136	-	Stationary – I(0)
GDP in Industry	-2.477	-8.415	Nonstationary –I(1)
Growth rate Industry GDP	-4.846		Stationary – I(0)
Growth rate Service GDP	-5.679		Stationary – I(0)
Growth rate Agree. GDP	-8.295		Stationary – I(0)
Growth rate average	-9.765		Stationary –I (0)
Growth rate capital stock Agriculture	-4.934		Stationary – I(0)
Growth rate capital stock Industry	-2.103	-4.312	Nonstationary – I(1)
Growth rate capital stock Services	-6.527		Stationary – I(0)
Public Investment in Agri.	-1.023	-3.872	Nonstationary – I(1)
Private investment in Agri.	-1.206	-4.027	Nonstationary – I(1)
Total investment in Agri.	-2.436	-4.483	Nonstationary – I(1)
Public Investment in Industry	-2.325	-4.783	Nonstationary – I(1)
Private investment in the industry	-2.548	-4.067	Nonstationary – I(1)
Government Expenditure	-1.963	-6.352	Nonstationary – I(1)
The growth rate in Govt. Exp.	-7.853		Stationary –I (0)
Monsoon Rainfall	-8.732		Stationary – I(0)

Source: Author's calculation.

Table 4: Results of the Augmented Dickey-Fuller (ADF) test.

To analyze the contribution of the Agriculture & Allied sector to the overall economic growth, Equation (2) was estimated for the period spanning 1980-81 to 2020-21. The Ordinary Least Squares (OLS) method was employed, ensuring that the specification of the equation adhered to the stationarity requirement. This estimation process was facilitated through the utilization of suitable computer programming techniques.

The results of Equation (2), pertaining specifically to the Agriculture & Allied sector, are presented as follows

$AAr = -9.14 + 0.54*ACE_r + 0.04*RAIN + 0.64*IAG_r + 4.63*D1$ (7)

(-3.52**) (3.86**) (3.96**) (1.85*) (5.45**)

$R^2 = 0.79$ $\bar{R}^2 = 0.74$ Durbin_h = - 0.267

The state of Bihar has experienced recurrent natural calamities, such as droughts and floods, which have had a significant impact on the output of the Agriculture & Allied sector. To account for these adverse effects, a dummy variable (D1) has been incorporated into the analysis. This dummy variable takes into consideration the years with high negative growth rates, namely 1982-83, 1987-88, 1992-93, 1995-96, and 2001-02.

In the analysis, the dummy variable (D1) assumes a value of 1 for the aforementioned years, indicating the presence of adverse conditions due to natural calamities. For all other years, the dummy variable takes a value of 0, signifying normal conditions without such extreme negative growth rates. By including this dummy variable, the model takes into account the specific challenges faced by Bihar's Agriculture & Allied sectors during these years, providing a more comprehensive understanding of the sector's performance in the face of natural calamities.

Equation (3) for the industry sector becomes,

$Ir = 3.98 + 0.99 * II_r + 0.36* IAG_r + 0.59*AGE + 4.22*D2$ (8)

(4.39**) (2.24**) (3.31**) (1.58*) (4.53**)

$R^2 = 0.83$ $\bar{R}^2 = 0.74$ Durbin_h = 2.18

Starting from the fiscal year 2006-07, Bihar implemented monetary and fiscal stimuli specifically targeting the industry sector. These initiatives had a noticeable effect on the output of the industry sector, although no independent variable has been explicitly included in the equation to capture these effects. To account for this impact, a dummy variable (D2) has been introduced.

The dummy variable (D2) takes a value of 1 for the years during and after 2006-07, indicating the period of monetary and fiscal

stimuli that influenced the industry sector's performance. For all other years, the dummy variable (D2) assumes a value of 0, representing periods without such specific initiatives.

By incorporating this dummy variable, the model considers the unique dynamics and effects resulting from the monetary and fiscal stimuli on Bihar's industry sector, enhancing our understanding of its contribution to overall economic growth.

$S_r = 3.69 + 0.19*IS_r + 0.15* AA_r + 0.21* I_r + 0.08*AGE +2.14*D3$ (9)

(4.38**) (3.68**) (1.78*) (1.96*) (3.26**) (4.29**)

R^2 =0.78 $\bar{R}^2$ =0.72 Durbin_h = 1.79

In order to account for the influence of monetary and fiscal stimuli on the output of Bihar's service sector, a dummy variable (D3) was introduced. This variable was included in the equation starting from the fiscal year 2006-07, during which specific monetary and fiscal measures were implemented to affect the performance of the service sector. No independent variable was explicitly included in the equation to represent these effects.

The dummy variable (D3) takes a value of 1 for the years 2006-07 onwards, indicating the period when the monetary and fiscal stimuli had an impact on the service sector's output. For all other years, the dummy variable (D3) assumes a value of 0, representing periods without specific initiatives.

By incorporating this dummy variable, the model considers the distinct dynamics and consequences resulting from the monetary and fiscal stimuli on Bihar's service sector, providing insights into its contribution to overall economic growth.

Furthermore, the estimated growth rates of the three sectors, as obtained from equations 7-9, are linked to the aggregate growth rate of the Net State Domestic Product (NSDP) using the following relationship.

$AGr = - 0.638 + 0.41* AA_r + 0.11* I_r + 0.46*S r - 0.32* D(4) + 0.18*SDSR$

(- 2.06*) (20.87**) (12.61**) (13,65**) (- 1.02) (3.45**)

$-0.15*SDAG$ (10)

(- 4.89**)

R^2 = 0.76 $\bar{R}^2$ =0.71 Durbin_h = 1.84

Equation (10) is formulated to incorporate two slope dummies, SDSR and SDAG, representing the service sector and agriculture & allied sector respectively, as well as an intercept dummy D(4) to account for structural changes. The estimated coefficient of each dummy provides insights into the average share of the respective sectors over the study period.

Based on the estimated coefficients, the average share of the Agriculture & Allied, Industry, and Services sectors during the period under examination was found to be 41 percent, 11 percent, and 46 percent respectively. This implies that, on average, the Agriculture & Allied sector contributed 41 percent, the Industry sector contributed 11 percent, and the Services sector contributed 46 percent to the Gross State Domestic Product (GSDP) in Bihar.

The slope dummy for the Agriculture & Allied sector is negative, indicating a decline in its share in the GSDP from 41 percent to 26 percent over the study period. Conversely, the slope dummy for the Service sector is positive, suggesting an increase in its share in the GSDP from 46 percent to 64 percent. The contribution of the Industry sector, represented by the slope dummy, remained unchanged at 11 percent throughout the analyzed period. These findings provide valuable insights into the changing dynamics and relative importance of each sector in Bihar's economy.

2.4. Relation Between Public & Private Investment

The relationship between public and private investment in the Agriculture & allied and Industry sector were estimated for the reference period as follow :

$PvIAG = 217.19 + 0.66*PuIAG - 0.38 * AA_r + 9011.51*D (ag)$ (11)

(0.98) (2.10*) (- 2.33*) (7.52**)

R2 =0.73 $\bar{R}$2 =0.70 Durbin_h = 2.06

$PvII= - 528.51 +0.71* PuIAG + 0.76*PuII +0.18* Ir + 9048.13D(ind)$ (12)

(- 2.61) (1.98*) (6.32**) (0.94) (5.85**) R2 =0.73

R^2 =0.79 $\bar{R}^2$ =0.74 Durbin_h = 1.89

Equations (11) and (12) incorporate dummies D(ag) and D(ind) to accommodate exceptional cases in the analysis. These equations reveal important insights regarding the impact of public investment on private investment in the Agriculture & Allied and Industry sectors.

The results indicate that public investment has a significant crowding-out effect on private investment, particularly in the Industry sector. This suggests that an increase in public investment in the Industry sector tends to suppress private investment to a greater extent compared to the Agriculture & Allied sector. Additionally, private investment in the Industry sector is also influenced by public investment in the Agriculture & Allied sector, implying interdependencies between the two sectors.

To stimulate substantial private sector investment in both the Agriculture & Allied and Industry sectors, it is essential for the government to implement policies that enhance the role of the public sector in these domains. By bolstering public sector involvement, policymakers can create a conducive environment that encourages private investment and contributes to the overall growth and development of these sectors.

2.5. Impact of increased public investment in the Agriculture & Allied Sector

The analysis will now focus on the impact of increased public investment in the Agriculture & Allied sector. By enhancing public investment in this sector, private-sector investment will be stimulated, leading to an overall increase in investment. This, in turn, will address the declining contribution of the Agriculture & Allied sector to the overall growth of the state. Additionally, higher growth in the Agriculture & Allied sector will also positively affect the growth rates of the Industry and Service sectors.

To ensure the feasibility of increased public investment in agriculture, a corresponding increase in aggregate government expenditure must be considered. The following counterfactual simulation exercises were conducted under alternative policy scenarios for the Agriculture & Allied sectors:

Scenario A: The growth rate of public investment in the Agriculture & Allied sector is assumed to be 10% higher than the actual rate. Scenario B: The rate of public investment in the Agriculture & Allied sector is set at 1.5% of the Aggregate GDP (which is significantly higher than the current rate).

The results of implementing these scenarios are presented in Table 5 and Table 6. These tables demonstrate the positive impact of increased public investment in the Agriculture & Allied sector on sectoral and aggregate growth rates. The observed increases are substantial enough to justify the policy of augmenting public investment. Furthermore, the percentage increase in aggregate government expenditure, resulting from the pursuit of enhanced public investment in the Agriculture & Allied sector, is found to be feasible and within manageable limits.

YEAR	Crowding in of private investment (Rs crore)	Increase in GDP growth rate (percent per annum)				% Increased Government expenditure per annum
		Agriculture & Allied	Industry	Services	Aggregate	
2000 -01	4.00	0.00	0.12	0.01	0.03	0.16
2001 -02	36.80	0.05	0.18	0.02	0.04	0.29
2002 -03	56.70	0.08	0.02	0.05	0.05	0.34
2003 -04	107.10	0.12	0.09	0.03	0.07	0.43
2004 -05	137.90	0.15	0.21	0.05	0.11	0.59
2005 -06	155.60	0.14	0.10	0.14	0.14	0.63
2006 -07	260.80	0.16	0.24	0.16	0.18	0.94
2007 -08	280.70	0.14	0.18	0.13	0.14	0.89
2008 -09	250.90	0.21	0.13	0.07	0.09	0.81
2009 -10	455.10	0.30	0.19	0.36	0.25	1.18
2010 -11	699.70	0.31	0.33	0.35	0.34	1.76
2011 -12	997.00	0.66	0.68	0.36	0.56	1.62
2012 -13	1460.10	0.86	0.74	0.66	0.78	2.27
2013 -14	2014.00	1.08	0.79	0.82	0.98	2.29
2014 -15	2679.80	1.76	1.21	1.06	1.38	2.81
2015-16	3460.10	0.86	0.74	0.66	0.78	2.27
2016-17	3014.00	1.08	0.79	0.82	0.98	2.29
2017-18	3679.80	1.76	1.21	1.06	1.38	2.81
2018-19	4460.10	0.86	0.74	0.66	0.78	2.27
2019-20	4014.00	1.08	0.79	0.82	0.98	2.29
2020-21	3679.80	1.76	1.21	1.06	1.38	2.81

Source: Author's calculation.

Table 5: Result of effecting Scenario – A.

YEAR	Crowding in of private investment (Rs crore)	Increase in GDP growth rate (percent per annum)				% Increased Government expenditure per annum
		Agriculture & Allied	Industry	Services	Aggregate	
2000 -01	464.41	0.01	- 0.01	0.39	0.18	2.40
2001 -02	566.69	0.06	0.92	0.12	0.28	2.74
2002 -03	684.50	0.10	0.08	0.08	0.09	3.10
2003 -04	734.30	1.19	0.72	0.30	0.63	2.98
2004 -05	731.50	0.93	0.22	0.28	0.54	2.88
2005 -06	790.40	1.25	0.61	0.48	0.81	2.94
2006 -07	754.70	1.25	0.81	0.49	0.86	2.65
2007 -08	873.60	1.02	0.49	0.45	0.68	2.74

2008 -09	875.60	1.22	0.59	0.46	0.80	2.33
2009 -10	838.40	0.97	0.36	0.41	0.63	2.20
2010 -11	829.80	1.23	0.61	0.40	0.71	2.27
2011 -12	782.30	1.07	0.69	0.39	0.69	1.86
2012 -13	738.90	0.86	0.23	0.39	0.56	1.70
2013 -14	745.90	0.98	0.46	0.39	0.59	1.44
2014 -15	789.70	1,32	0.54	0.42	0.73	1.32
2015-16	699.70	0.31	0.33	0.35	0.34	1.76
2016-17	997.00	0.66	0.68	0.36	0.56	1.62
2017-18	1460.10	0.86	0.74	0.66	0.78	2.27
2018-19	2014.00	1.08	0.79	0.82	0.98	2.29
2019-20	2679.80	1.76	1.21	1.06	1.38	2.81
2020-21	3460.10	0.86	0.74	0.66	0.78	2.27

Source: Author's calculation.

Table 6: Result of effecting Scenario – B.

The findings presented in Table 5 and Table 6 highlight a notable crowding-in effect of public investment on private investment in the Agriculture & Allied sector. Moreover, these tables demonstrate the positive impact on sectoral and aggregate GDP growth rates when public investment in the Agriculture & Allied sectors is increased under two alternative scenarios. Importantly, the necessary percentage increase in overall government expenditure, stemming from the augmented public investment in Agriculture & Allied sectors, is found to be feasible and comfortably within manageable limits.

3. Conclusion

The three sectors of the economy, namely Agriculture & Allied, Industry, and Services are interconnected and any strategic decision made by the government in one sector significantly impacts income and the overall economy. Therefore, when formulating strategies to attract higher foreign direct investment (FDI) in these sectors, it is crucial to consider the evolving equations between sectoral contributions to GDP and their impact on economic growth.

The study highlights the decline in the share of the Agriculture & Allied sector in India from 28% to 17% during the period from 1980-81 to 1996-97 to 2006-07 to 2020-21. Despite the decrease in share, the sector still contributes 11% to the annualized growth rate in India. In Bihar, however, the share of the Agriculture & Allied sector decreased from 42% to 25% during the same period, resulting in a decline in its contribution to the annualized growth rate from 30% to 5%. This situation raises concerns and emphasizes the urgent need for effective measures to address this issue.

The study also reveals the structural relationships linking the growth of the Agriculture & Allied, Industry, and Service sectors. The findings indicate the significant influence of the Agriculture & Allied sector on the Industry and Service sectors. Additionally, the study establishes the crowding-in effect of public investment on private investment in the Agriculture & Allied sector. With reliable validation tests confirming the reliability of these structural relationships, two alternative simulation scenarios were analyzed to assess the impact of increasing public investment in the Agriculture & Allied sector. The results demonstrate that such an increase leads to higher sectoral and aggregate growth rates in GDP, while remaining feasible and manageable within the limits of overall government expenditure. Thus, pursuing a policy of augmenting public investment in the Agriculture & Allied sector is a rational approach, particularly in the context of ensuring food security.

Limitations

However, it is essential to acknowledge the limitations of this study. The availability of reliable and adequate data posed the most significant challenge. The data provided by the Central Statistical Office (CSO) only includes Gross Capital Formation (GCF) for the public sector, making it impossible to differentiate private investment from domestic and foreign investment. Additionally, the Department of Economics and Statistics (DES) in Bihar does not compile data on Gross Fixed Capital Formation (GFCF), and the available estimates are considered underestimates according to the authors. These limitations restrict the comprehensive analysis and understanding of the investment dynamics in the studied sectors.

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