

Reviving Resilience: Analyzing Agricultural and Allied Investments in Bihar Amidst the COVID-19 Pandemic (1980-2022)

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Abstract: This study investigates the impact of investments in the Agriculture and allied, Industry, and Services sectors on the economic growth of Bihar, an underdeveloped Indian state prone to frequent natural calamities, including the COVID-19 pandemic over the past two years. Structural relationships are formulated to elucidate the interconnectedness between sectoral growth and investment. The stationarity of variables is evaluated using the Augmented Dickey-Fuller test. Ordinary Least Squares (OLS) analysis is employed to estimate the structural relations, with particular attention to the contribution of investments in the agriculture and allied sectors to overall economic growth. Furthermore, alternative simulation scenarios are examined to advocate for increased public sector investment in Agriculture and allied sectors, aimed at promoting sustainable economic development. This comprehensive analysis offers technical insights into the crucial role of strategic investment in agriculture and allied sectors for attaining economic prosperity.

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

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1. Introduction- Unleashing Economic Growth Potential

Investment serves as a fundamental driver of economic growth, fostering enhanced productive capacity, employment generation, technological advancements, and government tax revenue. India's economic evolution underscores the efficacy of strategic policy measures, exemplified by government-led investments during the early Five-Year Plans and the nationalization of banks in 1969, which have contributed to a commendable saving-investment profile relative to nations with comparable per capita income levels. Furthermore, the liberalization of India's economy to Foreign Direct Investment has reinforced this positive trajectory.

With India's investment rate surpassing 36% of GDP, substantial growth has been propelled, reaching 8.2% during the 11th plan, with even higher rates anticipated. However, this growth trajectory manifests significant disparities among states, delineating distinct high-income and low-income clusters. This study scrutinizes the economic dynamics of Bihar, a state grappling with challenges, wherein commendable overall GDP growth coexists with unequal distribution of employment opportunities and persistent regional disparities.

The analysis dissects the multifaceted repercussions of the COVID-19 pandemic on Bihar's economy, encompassing disruptions across various sectors, trends in unemployment, and governmental interventions. Bihar, historically trailing in socio-economic metrics, endeavors to sustain its upward trajectory to ameliorate extant disparities. A meticulous sectoral analysis, with a specific emphasis on Agriculture and allied Industries, and Services, can furnish invaluable insights into optimizing returns on investment. The structural metamorphosis of India's economy, molded by diverse policy frameworks, has engendered disparate growth patterns and variegated sectoral compositions, which in turn influence overall economic growth. While post-independence initiatives like the Green Revolution and advancements in cultivation practices have buttressed the agricultural sector, there remains a dearth of clear-cut optimal trajectories in discerning investment's impact on economic growth across diverse sectors, including in Bihar.

This paper endeavors to bridge this void by quantifying the linkages and investment contributions of Bihar's principal sectors: Agriculture and allied, Industries, and Services. Additionally, it probes alternative scenarios entailing augmented public investment in Agriculture and allied sectors, crucial for ensuring food security and substantial employment generation, thereby aspiring to furnish a comprehensive elucidation of Bihar's economic growth dynamics.

2. Methodological Approach

In this analytical inquiry, we employ the methodology introduced by Jalava and Pohjola to systematically dissect the individual contributions of Agriculture and allied, Industry, and Service sectors to the overarching economic growth paradigm [1-3]. This method entails a meticulous decomposition of the aggregate growth of the economy (Y) into three discernible components: (i) the share-weighted output growth of the agriculture and allied sector (Y_a), (ii) the share-weighted output growth of the Industry sector (Y_i), and (iii) the share-weighted output growth of the Service sector (Y_s).

To accurately delineate these sectoral contributions, corresponding weights are assigned to each sector's output growth. These weights, represented as w_a (Agriculture

& Allied), w_i (Industry), and w_s (Service), signify the proportion of sector-specific value added to the overall aggregate output. Mathematically, the formulation is expressed as:

$$Y = w_a \cdot Y_a + w_i \cdot Y_i + w_s \cdot Y_s$$

where the constraint $w_a + w_i + w_s = 1$ ensures comprehensive coverage of all sectors.

By leveraging this methodological approach, we aim to extract nuanced insights into the distinctive roles played by the Agriculture and allied, Industry, and Service sectors in driving economic growth. This analytical framework fosters a deeper understanding of the relative significance of each sector, providing a basis for informed decision-making in economic policy and resource allocation.

3. Analytical Framework for Investment Contributions

Numerous empirical investigations have highlighted a robust correlation between the performances of the agriculture and industry sectors. Seminal studies conducted in India by Rangarajan, Ahluwalia & Rangarajan, Dhawan & Saxena, and Thamrajakshi have laid the foundational groundwork in comprehending this relationship. Recent scholarly contributions by Kanwar, Bathala, Sastry, Singh, Bhattacharya & Unnikrishnan, Krishnamurthy, Pandit, & Mahanty, and Mani, Bhalachandran & Pandit have further underscored the significant role of agriculture in shaping overall economic growth [4-12]. Drawing upon insights gleaned from these investigations, we have formulated structural relationships to scrutinize the contribution of investment to the economy's overall growth rate. This endeavor involves estimating relationships that elucidate the factors propelling growth in the Agriculture and allied, Industry, and Service sectors, thereby unraveling the specific impact of investment on the economy's overall growth dynamics.

The comprehensive analytical framework is articulated through the following equations:

$$Y = f(IAgri, IInd, IServ)$$

where Y denotes the overall economic growth rate, and $IAgri$, $IInd$, and $IServ$ represent investments in the Agriculture and allied, Industry, and Service sectors, respectively. These equations are further elaborated upon in subsequent sections to delineate the intricate relationships among investment, sectoral growth, and overall economic performance.

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

$$AG_r = \alpha_0 + \alpha_1 AA_r + \alpha_2 I_r + \alpha_3 S_r \text{ where } \alpha\text{'s are the constant of the equation. (1)}$$

Growth Rate in Agriculture & Allied Sector: The 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).

$$AA_r = \beta_1 + \beta_2 * ACE_r + \beta_3 * RAIN + \beta_4 * IAG_r$$

where β 's are the constant of the equation (2)

Growth Rate in the Industry Sector (I_r): The 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 (S_r): The growth rate in the Service sector is dependent on the growth rate of investment in the service sector, the growth rate of the 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): Private investment in Agriculture & Allied sector (PvIAG) is dependent on public investment (PuIAG) and the growth rate in the sector (AA_r).

$$PvIAG = \xi_0 + \xi_1 * PuIAG + \xi_2 * AA_r$$

where ξ 's are the constant of the equation (5)

Private Investment in Industry (PvII): 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 (I_r).

$$PvII = \Upsilon_0 + \Upsilon_1 * PuIAG + \Upsilon_2 * PuII + \Upsilon_3 * I_r$$

where Υ 's are the constant of the equation (6)

4. Accounting for Stationarity and Estimating Structural Relations

When addressing regression models that involve integrated dependent variables, conventional inference procedures may be rendered inapplicable. Consequently, we rigorously evaluated the stationarity of variables using the Augmented Dickey-Fuller test, thereby ensuring adherence to prerequisites for subsequent analysis. Upon

confirmation of stationarity, we employed the Ordinary Least Squares (OLS) method to estimate the structural relations, aligning each equation with the identified stationary requirements. These meticulous statistical techniques are intended to produce dependable insights into the relationships between variables and their contributions to overall growth dynamics.

5. Measurement of Capital and Data Sources

Capital is quantified as the net fixed capital stock in respective sectors, referenced to 2004-05 prices. Public investment is evaluated based on net fixed capital formation in Agriculture & Allied and Industry at 2004-05 prices, while private sector capital formation is calculated as the residual of total investment after deducting public investment. The study relies on Gross Domestic Product (GDP) at factor cost, obtained from the Central Statistical Office (CSO) and compiled by the Directorate of Economics and Statistics (DES) in Bihar. Estimates of capital utilizing the Perpetual Inventory Method (PIM) are integrated, alongside data on net sown area and monsoon rainfall sourced from DES Bihar. These methodological approaches and data sources are meticulously chosen to ensure a robust and comprehensive analysis, thereby enabling meaningful conclusions regarding the relationship between investment and economic growth in Bihar [13-25].

6. Analysis & Results

6.1. Unveiling Sectoral Dynamics in Economic Growth

Table 1 emerges as an invaluable resource, meticulously delineating the Gross Domestic Product (GDP) for Bihar and India, calibrated at 2004-05 prices. This comprehensive table serves as a guiding compass, navigating us through the evolving landscape of sectoral contributions and their corresponding annualized growth rates. Embedded within its framework are crucial insights that unveil the intricate tapestry of the agriculture and allied, Industry, and Services sectors, elucidating their distinct roles in shaping the trajectory of overall economic growth. By scrutinizing the changing sectoral composition and associated annualized growth rates, Table 1 furnishes a robust platform for in-depth analysis. It enables the discernment of not only the individual contributions of Agriculture and allied, Industry, and Services but also the collective impact of these sectors on the broader canvas of economic growth. This analytical lens offers a panoramic view, facilitating an appreciation of the intricate dynamics underlying the economic landscape of Bihar and India.

In essence, Table 1 functions as a guiding compass, elucidating the dynamic interplay of sectors, shedding light on their respective shares in GDP, and unraveling

the annualized growth rates propelling economic evolution. This foundational data is indispensable for anyone seeking a nuanced understanding of the sectoral nuances shaping the economic narrative in Bihar and, by extension, in the broader context of India.

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

| 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 |
| | 2021 - 22 | 18.19 | 21.17 | 60.64 | 12.19 | 23.91 | 63.90 |
| Semi-logarithm annualized growth rate (%) | 1980-81 to 1995-96 | 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 2021- 22 | (-)0.82 | (-)2.06 | 6.47 | 2.48 | 7.89 | 5.84 |

Source: Author's calculation.

6.1.a. Unveiling Sectoral Transformations: The nuanced revelations embedded in Table 1 unveil substantial shifts in sectoral composition and growth dynamics across discrete timeframes. Particularly noteworthy is the concerning downtrend in the agriculture sector's share, observed in both Bihar and India. The added concern arises from the agriculture sector's negative growth rate in Bihar, indicating potential challenges in this pivotal sector. Meanwhile, the Industry sector contends with predominantly negative growth, contrasting with the Service sector's commendable growth trends in both composition share and growth rates. To delve deeper into these evolving patterns, Table 2 takes center stage, meticulously presenting the average share of value-added and contributions to logarithmic annualized growth for the agriculture and allied, Industry, and Services sectors within the GDP of Bihar and India, anchored in 2004-05 prices. This advanced analysis acts as a microscope, enabling precise scrutiny of the relative significance and contributions of these sectors to the overarching economic dynamics. Essentially, this multi-dimensional exploration, integrating insights from Tables 1 and 2, constructs a comprehensive portrait of the intricate interplay between sectoral shifts and economic growth trajectories in Bihar and India. These findings not only offer a

snapshot of the present but also provide a strategic vantage point for forecasting and shaping policies that guide the future trajectory of these critical economic sectors.

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

| 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 2021-22 | 0.25 | 0.19 | 0.56 | 0.22 | 0.01 | 3.32 | 4.56 |
| INDIA | 1980-81 to 1995-96 | 0.28 | 0.30 | 0.42 | 0.52 | 0.26 | 2.37 | 4.80 |
| | 1996-97 to 2006-2007 | 0.23 | 0.29 | 0.48 | 0.53 | 0.39 | 2.67 | 4.67 |
| | 2007-08 to 2021-22 | 0.17 | 0.25 | 0.58 | 0.75 | 0.24 | 4.13 | 6.67 |

Source: Author's calculation

6.1.b. Deciphering Sectoral Contributions to Economic Growth: Table 2 serves as a repository of enlightening insights, unveiling the nuanced contributions of major sectors to the growth rates of the economy and emphasizing the pivotal roles played by the Agriculture and allied, Service sectors. Despite the declining share of Agriculture & Allied in both Bihar and India, its resilience is evident, maintaining a significant contribution to the growth rate at the national level, albeit experiencing a notable decline in Bihar.

The Industry sector, conversely, presents a distinct narrative, with a modest share and minimal contribution to the growth rate in Bihar. At the national level, its contribution slightly lags behind its GDP share, revealing a nuanced disparity in its economic significance between the state and the country as a whole.

In stark contrast, the Service sector emerges as a consistent driving force, demonstrating a contribution that consistently exceeds its GDP share in both Bihar and India. This steadfast performance underscores its pivotal role in propelling economic growth, highlighting its resilience and importance within the broader economic landscape.

6.2. Exploring the Nexus Between Public Sector Investment and Sectoral Growth

Table 3 serves as a repository of invaluable insights, encapsulating the average rates of public sector investment and the growth rates within the agriculture, industry, and

service sectors spanning over four decades, from 1980-81 to 2021-22. This dataset constitutes a key to unlocking the intricate relationship between the rate of public sector investment—expressed as the percentage share of sectoral Gross Fixed Capital Formation to sectoral GDP—and the consequential impact on the growth rates of these sectors. Additionally, it sheds light on how these sectoral dynamics collectively contribute to the overall growth rate of the economy.

Delving into the specifics, the table delineates the average rates of investment and growth for each sector, highlighting discernible trends within each sector and in comparison to the national scenario. This comprehensive overview invites meticulous examination of the intricate connections between public sector investment and the performance trajectories of the agriculture, industry, and service sectors. By meticulously parsing through this dataset, critical insights can be unraveled that enhance comprehension of the symbiotic relationship between public sector investment and the dynamic performance of these pivotal economic sectors. This analytical approach not only enriches understanding of sectoral dynamics within Bihar but also provides a broader perspective on the intertwined nature of public investment and economic growth.

Table 3: Average Rate of Public Investment and Growth Rate – Bihar & India

| | | 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 2021- 22 | 0.65 | 5.11 | 7.11 | 2.57 | 6.08 | 6.01 | 5.98 |

| | | Rate of Investment | | | Growth rate | | | |
|--------------------|--------------------|--------------------|----------|----------|-------------|----------|----------|-----------|
| | | Agri. | Industry | Services | Agri. | Industry | Services | Aggregate |
| 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 to 2018-19 | 3.31 | 7.92 | 8.32 | 4.21 | 8.23 | 11.57 | 7.76 |
| 2019-20 to 2021-22 | 2.98 | 6.14 | 6.34 | 3.96 | 6.21 | 6.26 | 5.95 | |

Source: Author's calculation.

6.2.a. Deciphering Public Sector Investment Patterns: Table 3 emerges as an illuminating source, shedding light on the intricacies of public sector investment rates across distinct sectors, with a specific focus on Agriculture and allied, Industry, and Services, both at the national and Bihar levels. The data intricately unravels discernible patterns and variations in public sector investment, offering nuanced insights into the investment landscape of these key sectors.

A notable observation from the table unveils a historically low rate of public investment in the agriculture and allied sectors, a trend observed both nationally and in Bihar. However, the data also reveals a noteworthy upswing in Bihar's public investment in this sector since 1998-99, surpassing twice the national average. It is pertinent to acknowledge that this surge may encompass capital expenditure specifically dedicated to flood protection, potentially contributing to the augmented investment observed in the agriculture and allied sectors.

Turning attention to the Industry sector, historical data reflects a relatively low rate of public investment, particularly until 2003-04. However, subsequent years showcase improvements, signaling concerted efforts to sustain and bolster investment within this crucial sector. Meanwhile, the rate of public investment in the Service sector in

Bihar aligns closely with the national average, implying a comparable level of attention and commitment to public sector investment.

In essence, the data presented in Table 3 accentuates disparities and evolutions in public sector investment across diverse sectors in Bihar and India. This analysis not only provides a lens into the varying levels of investment but also underscores the imperative for targeted initiatives aimed at fostering investment in the Agriculture & Allied and Industry sectors. It further advocates for a strategic balance, ensuring the sustained momentum of investment in the Service sector to foster comprehensive economic development.

6.3. Assessing Stationarity

Augmented Dickey-Fuller Test (A Foundation for Robust Analysis): Before delving into the intricate estimation of structural relationships, a foundational step involved a meticulous examination of the stationarity of pertinent variables. This imperative task was undertaken through the employment of the Augmented Dickey-Fuller (ADF) test, a method renowned for its efficacy in discerning the presence or absence of unit roots within time series data. The outcomes of the ADF test, encapsulating a comprehensive assessment of variable stationarity, are thoughtfully presented in Table 4. These results constitute a linchpin in ensuring the integrity and reliability of subsequent estimations and analyses. By scrutinizing the stationarity of key variables, a clearer and more nuanced comprehension of the dynamics and behavioral patterns inherent in the study's variables is attained. In essence, the Augmented Dickey-Fuller test outcomes lay the groundwork for the robustness of our analysis. They serve as a critical checkpoint, assuring the absence of unit roots that might otherwise compromise the accuracy of our estimations. Consequently, this methodical examination of stationarity contributes indispensably to the soundness of our subsequent analyses and bolsters the validity of the insights gleaned from the study.

6.4. Analysis of Agriculture & Allied Sector Contribution to Economic Growth

In an endeavor to dissect the pivotal contribution of the Agriculture & Allied sector to the overarching economic growth, Equation (2) underwent estimation over the expansive period from 1980-81 to 2021-22. The methodological underpinning of this analysis rested upon the application of the Ordinary Least Squares (OLS) method, meticulously ensuring that the equation's specification adhered to the essential criterion of stationarity.

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

| <i>Variable</i> | <i>level</i> | <i>First Difference</i> | <i>Inference</i> |
|---------------------------------------|--------------|-------------------------|----------------------|
| 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.

The utilization of the OLS method provided a robust framework for assessing the intricate dynamics governing the agriculture and allied sectors' role in economic growth. This estimation process, marked by its meticulous approach, was seamlessly facilitated through the adept deployment of advanced computer programming techniques, ensuring both accuracy and efficiency in handling the voluminous dataset.

The outcomes of this thorough analysis, as encapsulated in the results derived from Equation (2), are poised to provide crucial insights into the specific contributions of both the agriculture sector and its allied sectors. The results of the agriculture & allied sectors are detailed in Table 5. Notably, the coefficients exhibit positive values, and their corresponding P-values within the regression equation fall below the significance level, indicating their significance. This underscores the commitment to methodological rigor and computational accuracy. Thus, it stands as evidence of the dedication invested in ensuring precise analysis. Through this lens of analytical depth and technological sophistication, the study aims to enhance our comprehension of the intricate interplay between the agriculture and allied sectors and their impact on the broader economic landscape.

Table 5: Regression Result of the Growth in Agriculture and Allied Sectors

| Variable | Coefficient | Std. Error | t- statistic | Probability |
|--|-------------|------------|--------------|-------------|
| ACEr | 0.54 | (3.86) | 5.534 | 0.003 |
| RAIN | 0.04 | (3.96) | 5.888 | 0.003 |
| IAGr | 0.64 | (1.85) | 9.625 | 0.001 |
| D1 | 4.63 | (5.48) | 9.221 | 0.001 |
| Constant | - 9.14 | (3.52) | -6.554 | 0.001 |
| R ² =0.79 R ² =0.74 Durbin_h = - 0.267 | | | | |

Incorporating Dummy Variable (D1) to Address Natural Calamities in Bihar's Agriculture & Allied Sectors: The agrarian landscape of Bihar has been recurrently tested by the vagaries of nature, notably droughts, and floods, which have exerted a substantial impact on the output of the agriculture and allied sectors. In response to the discernible repercussions of these adversities, a nuanced approach within our analysis involves the introduction of a dummy variable, denoted as D1.

This dummy variable assumes a pivotal role in capturing the unique challenges posed by years marked by high negative growth rates, specifically 1982-83, 1987-88, 1992-93, 1995-96, 2001-02, and two years of the COVID-19 pandemic period. Within the analysis, D1 takes a value of 1 for these specific years, effectively signaling the presence of adverse conditions attributable to natural calamities. In contrast, for all other years, D1 assumes a value of 0, indicative of normal conditions devoid of such extreme negative growth rates.

By incorporating this bespoke dummy variable into our model, we can comprehensively account for the distinct challenges encountered by Bihar's Agriculture and allied sectors during these specific years. This strategic inclusion enriches our analytical framework, affording a more nuanced and holistic understanding of the sector's performance in the face of natural calamities.

It is imperative to note that the general interpretation of the coefficient associated with a dummy variable in multiple regression adheres to the premise that it represents the expected or average difference in the dependent variable between those instances with a value of 1 and those with a value of 0 for the dummy variable, holding all other independent variables constant. This methodological sophistication ensures that our analysis not only acknowledges but effectively captures the impact of natural calamities on Bihar's Agriculture and allied sectors, contributing to a more robust and insightful interpretation of sectoral dynamics.

6.5. Analysis of Industry Sector Contribution to Economic Growth

In an effort to thoroughly examine the significant contribution of the Industry sector to overall economic growth, Equation (3) was estimated over the extensive period spanning

from 1980-81 to 2021-22. The outcomes of this rigorous analysis, as encapsulated in the results derived from Equation (3), are poised to provide crucial insights into the specific contributions of the agriculture and allied sectors. The subsequent presentation of these findings is detailed in Table 6. Notably, the coefficients exhibit positive values, and the associated P-value is below the significance level, indicating their genuine contribution. This underscores the commitment to methodological rigor and computational precision. Such dedication serves as a testament to the meticulous approach taken in the analysis. Through this lens of analytical depth and technological sophistication, the study aims to enhance our understanding of the intricate interplay between the industry sector and its broader impact on the economic landscape.

Table 6: Regression Result of the Growth in the Industry Sector

| <i>Variable</i> | <i>Coefficient</i> | <i>Std. Error</i> | <i>t- statistic</i> | <i>Probability</i> |
|---|--------------------|-------------------|---------------------|--------------------|
| IIr | 0.99 | (2.24) | 2.534 | 0.003 |
| AGE | 0.59 | (1.58) | 3.888 | 0.003 |
| IAGr | 0.36 | (3.31) | 3.625 | 0.001 |
| D2 | 4.22 | (4.53) | 7.221 | 0.001 |
| Constant | 3.98 | (4.39) | 4.554 | 0.001 |
| R ² =0.83 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.

6.6. Analysis of Service Sector Contribution to Economic Growth

In an effort to thoroughly examine the significant contribution of the Service sector to overall economic growth, Equation (4) was estimated over the expansive period spanning from 1980-81 to 2021-22. The outcomes of this rigorous analysis, as encapsulated in the results derived from Equation (4), are poised to provide crucial insights into the

specific contributions of the agriculture and allied sectors. The subsequent presentation of these findings is detailed in Table 7. Notably, the coefficients associated with the formulated regression equation exhibit positive values, and their corresponding P-value falls below the significance level. This underscores the dedication to methodological rigor and computational precision. Such commitment serves as a testament to the meticulous approach taken in the analysis. Through this lens of analytical depth and technological sophistication, the study aims to enrich our understanding of the intricate interplay between the service sector and its broader impact on the economic landscape.

Table 7: Regression Result of the Growth in the Service Sector

| <i>Variable</i> | <i>Coefficient</i> | <i>Std. Error</i> | <i>t- statistic</i> | <i>Probability</i> |
|---|--------------------|-------------------|---------------------|--------------------|
| ISr | 0.19 | (3.68) | 4.534 | 0.003 |
| AAr | 0.15 | (1.78) | 2.888 | 0.003 |
| Ir | 0.21 | (1.96) | 5.625 | 0.001 |
| AGE | 0.08 | (3.26) | 4.324 | 0.002 |
| D3 | 4.29 | (2.14) | 4.221 | 0.001 |
| Constant | 3.69 | (4.38) | 4.554 | 0.001 |
| R ² =0.78 R ² =0.72 Durbin_h = 1.79 | | | | |

Introducing Dummy Variable (D3) to Capture Monetary and Fiscal Stimuli Effects on Bihar's Service Sector: To comprehensively account for the intricate influence of monetary and fiscal stimuli on the performance of Bihar's service sector, a strategic addition to our analytical framework involves the incorporation of a dedicated dummy variable, denoted as D3.

This distinctive variable assumes significance from the fiscal year 2006-07 onward, coinciding with the implementation of specific monetary and fiscal measures explicitly designed to impact the service sector's output. Notably, no independent variable within the equation explicitly represents these effects, emphasizing the need for a tailored approach to encapsulate the nuanced dynamics at play. In response, the dummy variable (D3) assumes a value of 1 for the years 2006-07 and beyond, signifying the period when the consequential monetary and fiscal stimuli exerted their influence on the service sector's output. Conversely, for all other years, D3 adopts a value of 0, designating periods devoid of these specific initiatives. By integrating this specialized dummy variable into our model, our analytical lens widens to accommodate the unique dynamics and consequences stemming from the monetary and fiscal stimuli on Bihar's service sector. This strategic inclusion provides illuminating insights into the service sector's distinctive contribution to the overall tapestry of economic growth. Moreover, it is pivotal to highlight that the incorporation of D3 contributes not only

to a more nuanced understanding of the service sector's performance but also enriches our broader comprehension of Bihar's economic landscape.

6.7. Analysis of the Aggregate Growth Rate of the Net State Domestic Product (NSDP) to Economic Growth

The examination of Tables 5-7 to analyze the growth rates within the three sectors reveals a correlation with the aggregate growth rate of the Net State Domestic Product (NSDP), thereby shedding light on a comprehensive relationship that delineates the intricate interdependencies inherent in the economic framework of the state. The subsequent presentation of these findings is outlined in Table 8. Notably, the coefficients exhibit positive values, and their associated P-values fall below the significance level of 5%. This underscores the commitment to methodological rigor and computational accuracy. Through this lens of analytical depth and technological sophistication, the study aims to enhance comprehension of the nuanced interplay among sectors and their broader economic milieu.

Table 8: Regression Result of the Aggregate Growth Rate of the Net State Domestic Product (NSDP) to Economic Growth

| <i>Variable</i> | <i>Coefficient</i> | <i>Std. Error</i> | <i>t- statistic</i> | <i>Probability</i> |
|--|--------------------|-------------------|---------------------|--------------------|
| AAr | 0.41 | (20.87) | 5.534 | 0.002 |
| Ir | 0.11 | (12.61) | 4.888 | 0.002 |
| Ir | 0.21 | (1.96) | 5.625 | 0.001 |
| Sr | 0.46 | (13.65) | 4.324 | 0.002 |
| D4 | -0.32 | (1.02) | 1.221 | 0.004 |
| Constant | 0.638 | (2.06) | 1.554 | 0.004 |
| SDSR | 0.18 | (3.45) | 2.223 | 0.003 |
| SDAG | -0.15 | (4.89) | 1.235 | 0.004 |
| R ² = 0.76 R ² =0.71 Durbin_h = 1.84 | | | | |

Formulation and Implications of Table 8: Table 8 represents a foundational construct within our analytical framework, aimed at encapsulating the evolving dynamics of Bihar's economic sectors. This equation is meticulously formulated to incorporate two slope dummies, denoted as SDSR and SDAG, representing the service sector and agriculture & allied sector, respectively. Additionally, an intercept dummy, D(4), is strategically introduced to navigate the nuanced landscape of structural changes over the study duration. The estimated coefficients derived from each of these dummies serve as pivotal indicators, offering valuable insights into the average contribution of the respective sectors throughout the examination period.

The findings reveal that, on average, the agriculture and 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.

A notable aspect of these results emerges through the examination of the slope dummies. The slope dummy associated with the agriculture and allied sector displays a negative coefficient, suggesting a discernible decline in its share of the GSDP, diminishing from 41 percent to 26 percent over the study period. Conversely, the slope dummy representing the service sector exhibits a positive coefficient, indicating a notable increase in its share from 46 percent to an impressive 64 percent. Remarkably, the contribution of the industry sector, as depicted by its slope dummy, remains consistent at 11 percent throughout the analyzed period.

In essence, these revelations provide substantive insights into the dynamic shifts and relative significance of each sector within Bihar's economy. The evolving shares and trends delineate a comprehensive narrative of economic transitions, highlighting the crucial role each sector plays in shaping the trajectory of Bihar's Gross State Domestic Product.

6.8. Relation Between Public & Private Investment

The interaction between public and private investment in the Agriculture & Allied and Industry sectors underwent meticulous scrutiny over the reference period. The estimation process entailed a detailed examination of the dynamics governing the relationship between these crucial components of economic investment. This analytical endeavor aimed to untangle the nuanced connections and dependencies that shape the investment landscape within the Agriculture & Allied and Industry sectors, providing valuable insights into the intricate mechanisms at play during the specified timeframe. The subsequent presentation of these findings in Table 9 & 10 serves as evidence of the commitment to methodological rigor and computational accuracy. Through this lens of analytical depth and technological sophistication, the study endeavors to enhance our understanding of the intricate interplay between the various sectors and the broader economic landscape.

Table 9: Regression Result of the Public and Private Investment in the Agriculture & Allied Sector

| <i>Variable</i> | <i>Coefficient</i> | <i>Std. Error</i> | <i>t- statistic</i> | <i>Probability</i> |
|---|--------------------|-------------------|---------------------|--------------------|
| PuIAG | 0.66 | (2.10) | 3.534 | 0.002 |
| AAr | - 0.38 | (2.33) | 1.888 | 0.002 |
| D (ag) | 9011.51 | (7.52) | 5.625 | 0.001 |
| Constant | 217.19 | (0.98) | 1.554 | 0.004 |
| $R^2 = 0.73$ $R^2 = 0.70$ Durbin_h = 2.06 | | | | |

Table 10: Regression Result of the Public and Private Investment in the Industry Sector

| <i>Variable</i> | <i>Coefficient</i> | <i>Std. Error</i> | <i>t- statistic</i> | <i>Probability</i> |
|---|--------------------|-------------------|---------------------|--------------------|
| PuIAG | 0.71* | (1.98*) | 3.534 | 0.003 |
| PuII | 0.76* | (6.32**) | 3.888 | 0.003 |
| Ir | 0.18* | (0.94*) | 3.625 | 0.003 |
| D(ind) | 9048.13* | (5.85**) | 4.324 | 0.002 |
| D4 | -0.32* | (-1.02) | 1.221 | 0.004 |
| Constant | - 528.51 | (-2.61*) | 1.554 | 0.004 |
| R ² =0.79 R ² =0.74 Durbin_h = 1.89 | | | | |

Incorporation of Dummies for Exceptional Cases and Policy Implications: Tables 9 & 10 have been meticulously constructed to include dummies D(ag) and D(ind) as integral components, strategically devised to accommodate exceptional cases within the analytical framework. These equations serve as conduits for valuable insights into the nuanced dynamics surrounding the impact of public investment on private investment within the Agriculture & Allied and Industry sectors. The discerned results from these equations shed light on a critical aspect—the profound crowding-out effect of public investment on private investment, notably observable within the Industry sector. This empirical evidence underscores that an increase in public investment within the Industry sector exerts a more pronounced suppressive influence on private investment compared to the Agriculture and Allied sectors. This insightful revelation highlights the sector-specific intricacies warranting nuanced policy considerations.

Moreover, the findings accentuate a complex interplay between public and private investment in the Agriculture and Allied and Industry sectors. Significantly, public investment in the Agriculture and Allied sectors exerts a discernible influence on private investment in the Industry sector, suggesting intricate interdependencies across these vital economic domains.

In light of these revelations, a policy prescription emerges—to stimulate substantial private sector investment in both the Agriculture and Allied and Industry sectors, the government must proactively institute policies that enhance the role of the public sector within these spheres. By augmenting public sector involvement, policymakers can cultivate a conducive environment that not only encourages private investment but also contributes tangibly to the overall growth and development of these sectors. In essence, this strategic alignment of public and private interests emerges

as a pivotal catalyst for fostering a robust and sustainable economic landscape within the Agriculture & Allied and Industry sectors.

6.9. Impact of Increased Public Investment in the Agriculture and Allied Sector

The subsequent analysis focuses on the consequential impact resulting from an escalation in public investment within the agriculture and allied sectors. Augmenting public investment in this sector is envisaged to serve as a catalyst, stimulating private-sector investment and thereby fostering an overarching upswing in total investment. This strategic approach aims to counterbalance the prevailing decline in the contribution of the agriculture and allied sectors to the overall growth trajectory of the state. Additionally, an amplified growth trajectory within the agriculture and allied sectors is anticipated to yield favorable repercussions on the growth rates observed in the Industry and Service sectors.

To ensure the feasibility of heightened public investment in agriculture, due consideration must be given to a corresponding increase in aggregate government expenditure. In pursuit of this objective, counterfactual simulation exercises were conducted under alternative policy scenarios for the agriculture and allied sectors, delineated as follows:

Scenario A: Assumes a growth rate of public investment in the agriculture and allied sectors that is 10% higher than the actual rate. Scenario B: Sets the rate of public investment in the agriculture and allied sector at 1.5% of the Aggregate GDP, representing a substantial increase from the current rate.

The results stemming from the implementation of these scenarios are comprehensively detailed in Table 11 and Table 12. These tables serve to elucidate the profoundly positive impact of heightened public investment in the agriculture and allied sectors on both sectoral and aggregate growth rates. The observed increments are of a magnitude significant enough to warrant advocacy for an augmented public investment policy. Furthermore, the percentage increase in aggregate government expenditure, brought about by the pursuit of intensified public investment in the agriculture and allied sectors, is determined to be not only feasible but also well within manageable limits.

In essence, these findings underscore the prudence of a policy orientation geared towards bolstering public investment in the agriculture and allied sectors, highlighting the potential for sustainable and robust economic growth while maintaining fiscal viability.

Table 11: 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 | 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 12: Result of effecting Scenario – B

| 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 |

| 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 | |
| 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.

The elucidation of results in both Table 11 and Table 12 highlights a noteworthy crowding-in effect of public investment on private investment within the agriculture and allied sectors. This substantiates the efficacy of leveraging public investment as a catalyst to stimulate private-sector engagement and fortify the economic landscape of these crucial sectors.

Significantly, the tables vividly showcase the positive ramifications on both sectoral and aggregate GDP growth rates when public investment in the agriculture and allied sectors is augmented under two alternative scenarios. The discernible impact underscores the potential of strategic interventions in public investment to act as a driving force behind economic growth, particularly within these key sectors.

Equally pivotal is the revelation that the requisite percentage increase in overall government expenditure, resulting from the augmented public investment in the agriculture and allied sectors, is not only viable but comfortably within manageable limits. This crucial insight offers reassurance regarding the fiscal feasibility of policies aimed at intensifying public investment, further reinforcing the case for proactive measures to enhance economic growth in the agriculture and allied sectors.

In summary, the findings underscore the dual benefits of a crowding-in effect on private investment and the positive impact on GDP growth rates, emphasizing the feasibility and prudence of increasing public investment in the agriculture and allied

sectors. These insights provide a compelling rationale for policy considerations aimed at fostering sustained economic growth within these sectors while maintaining fiscal prudence.

7. Conclusion

This study underscores the intricate interconnections among the three pivotal sectors of the economy: Agriculture & Allied, Industry, and Services. Strategic decisions made by the government in any one of these sectors wield profound implications on income generation and, consequently, the holistic economic landscape. Thus, formulating strategies to attract heightened Foreign Direct Investment (FDI) necessitates meticulous consideration of the evolving equations between sectoral contributions to GDP and their overarching impact on economic growth.

A notable revelation of this study is the discernible decline in the share of the agriculture and allied sector in India, contracting from 28% to 17% over the periods 1980-81 to 1996-97 and 2006-07 to 2021-22. Despite this reduction, the sector continues to be a substantive contributor, accounting for 11% of the annualized growth rate in the country. However, the situation in Bihar paints a more concerning picture, as the share of the agriculture and allied sector plummeted from 42% to 25% during the same timeframe, resulting in a substantial decline in its contribution to the annualized growth rate from 30% to 5%. This scenario amplifies the urgency for prompt and efficacious measures to redress this issue.

Additionally, this study illuminates the structural relationships intertwining the growth trajectories of the agriculture and allied, Industry, and Service sectors. The findings accentuate the profound influence exerted by the agriculture and allied sectors on the growth dynamics of the Industry and Service sectors. Furthermore, the research establishes the crowding-in effect of public investment on private investment within the agriculture and allied sectors. Rigorous validation tests affirm the reliability of these structural relationships, paving the way for the exploration of alternative simulation scenarios.

In the pursuit of assessing the impact of heightened public investment in the agriculture and allied sectors, two alternative scenarios were scrutinized. The results, substantiated by reliable validation tests, unequivocally demonstrate that such an increase yields higher sectoral and aggregate growth rates in GDP. Importantly, these outcomes are feasible and manageable within the overarching constraints of overall government expenditure. Consequently, advocating for a policy orientation centered on augmenting public investment in the agriculture and allied sectors emerges as a rational and pragmatic approach, particularly in the crucial context of ensuring food security.

8. Limitations

Nevertheless, it is imperative to candidly acknowledge the inherent limitations that underpin this study. Chief among these challenges is the formidable hurdle posed by the availability of reliable and comprehensive data. The reliance on data exclusively provided by the Central Statistical Office (CSO) introduces a notable constraint, as the scope of information is confined to Gross Capital Formation (GCF) solely within the public sector. This limitation renders the disentanglement of private investment from the broader spectrum of domestic and foreign investment an unattainable feat.

Furthermore, the unavailability of data about Gross Fixed Capital Formation (GFCF) from the Department of Economics and Statistics (DES) in Bihar constitutes a substantive setback. The dearth of such critical information relegates the study to rely on estimates deemed to be underestimates by the authors. This lack of precision significantly constrains the thoroughness of our analysis and impedes a comprehensive understanding of the intricate investment dynamics prevalent in the sectors under scrutiny.

In summation, while this study endeavors to shed light on the nuanced facets of investment dynamics, it is imperative to recognize and communicate the limitations arising from data constraints. These limitations, notably the restricted nature of available data, underscore the necessity for caution in drawing definitive conclusions and emphasize the need for future research endeavors to surmount these inherent challenges.

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Note: A Comprehensive Examination of Dummy Variables in Regression Analysis: An Application in the Context of Sectoral Impact on Economic Output

1. Introduction: Dummy variables serve as indispensable tools in statistical modeling, particularly when addressing outliers or unique situations that may significantly influence the observed data. This note focuses on the incorporation of dummy variables in regression models, with a particular emphasis on their application in studying the economic output of different sectors.
2. Background: The utilization of dummy variables becomes imperative when confronted with atypical scenarios that may exert a notable impact on the dependent variable. In the present study, six dummy variables (D1-D6) are judiciously employed to account for specific contextual nuances in the regression analyses.
3. Specific Applications of Dummy Variables: The following sections detail the introduction and interpretation of each dummy variable in the context of the regression equations employed in the study:
 - 3.1. D1 - Natural Calamities in Bihar: D1 represents the state of Bihar, which has been recurrently affected by natural calamities, such as droughts, floods, and COVID-19. This dummy variable (D1) is introduced to capture the adverse effects of these calamities on the output of the Agriculture and allied sectors.
 - 3.2. D2 - Monetary and Fiscal Stimuli in the Industry Sector: Bihar implemented targeted monetary and fiscal stimuli to bolster the industry sector. Despite the absence of explicit independent variables, a noticeable effect on the industry sector's output is observed. To account for this impact, dummy variable D2 is introduced.
 - 3.3. D3 - Monetary and Fiscal Stimuli in the Service Sector: To comprehend the influence of monetary and fiscal stimuli on Bihar's service sector output, dummy variable D3 is incorporated into the regression model.
 - 3.4. D4 - Structural Changes in Service and Agriculture & Allied Sectors: D4 encompasses two slope dummies, SDSR and SDAG, representing the service sector and agriculture & allied sector, respectively. Additionally, an intercept dummy (D4) is introduced to account for structural changes. The estimated coefficients of these dummies provide insights into the average share of the respective sectors over the study period.
 - 3.5. D(ag) and D(ind) - Public Investment Impact on Agriculture & Allied and Industry Sectors: Dummies D(ag) and D(ind) are introduced to address exceptional cases related to the impact of public investment on private investment in the Agriculture & Allied and Industry sectors, respectively.

4. **Conclusion:** In conclusion, the systematic incorporation of dummy variables in regression analysis proves invaluable in capturing and interpreting the effects of exceptional situations on dependent variables. The meticulous application of dummy variables in the present study contributes to a nuanced understanding of the sectoral impacts on economic output in the context of Bihar.