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An Econometric Analysis Of Sectoral Contributions To Uttarakhand's GSDP: A Var Approach In The Context Of A Himalayan State Of India

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Abstract: The research article investigates the economic dynamics in Uttarakhand, focusing on the Gross State Domestic Product and sectoral contributions from 2000 to 2023. Utilizing data from the Directorate of Economics and Statistics, the study applies a Vector Autoregressive (VAR) approach and concludes that only the Secondary Sector (SS) significantly influences GSDP. The Primary (PS) and Tertiary (TS) Sectors do not exhibit significant causal relationships with GSDP or with each other. These findings, verified through Granger causality tests and VAR model estimations, offer valuable insights for policymakers promoting sustainable economic growth in Uttarakhand.

Key Words: Sectoral contribution, Vector Autoregressive (VAR) Model, Gross State Domestic Product (GSDP), Economic Dynamics
JEL Classification: C32, R11, R58

Introduction

Having up-to-date information about the prevailing economic conditions is vital for policymaking, as determining the most suitable policy approach depends on having an accurate understanding of the macroeconomic landscape (Roberto and Giuseppe 2004). The agriculture sector's contribution is falling in favor of the industrial sector and more in favor of the service sector in India. The real GDP growth in the Indian economy was 7.6 percent in 2023-24 percent compared to 7.0 percent in 2022-23 (Ministry of Statistics & Programme Implementation 2024). From the structural point of view, the primary, secondary, and tertiary sector's contributions were 20.96, 25.63, and 53.41 percent in the years 2022-23 in the Indian economy (Economic Survey 2023). Uttarakhand, established on November 9, 2000, as the 27th state of India, was created by separating it from northern Uttar Pradesh, situated at the foothills of the Himalayan Mountain ranges. Uttarakhand's GSDP contribution to the national GDP is 1.178 percent in 2024 (CEIC Data). Gross State Domestic Product (GSDP), or state income, is the best criterion for any state's economic development. This estimate of the state reflects the size of the economy. The economy is primarily divided into three parts: the primary sector, the secondary sector, and the tertiary sector. According to the sector-wise analysis of the state economy, as per the revised estimates for the years 2011-12 and 2021-22, the total state gross value added (at current prices) and the comparative contribution of the primary, the secondary, and the tertiary sectors are shown in Figures 1 and 2.

The data in Figures 1 and 2 illustrate the contribution of the economy's primary, secondary, and tertiary sectors at current prices (in percent) for 2011-12 and 2021-22, respectively. In 2011-12, the primary sector contributed 14.00 percent, the secondary sector contributed 52.12 percent, and the tertiary sector contributed 33.88 percent to the economy. However, there has been a notable shift in sectoral contributions over the decade. By 2021-22, the primary sector's contribution decreased slightly to 12.36 percent, while the secondary sector decreased to 46.21 percent. Remarkably, the tertiary sector witnessed a substantial increase in its contribution, rising to 41.43 percent. This suggests a structural transformation in the economy, with a gradual shift from primary and secondary activities towards tertiary activities, indicative of evolving economic dynamics and patterns of development.

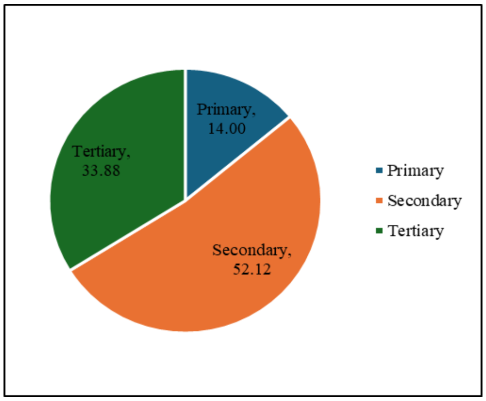

Figure 1. Contribution of the three sectors of the Economy at Current Prices (in %) for the Year 2011-12

Source: *Economic Survey 2022-23 Part-I, Government of Uttarakhand.*

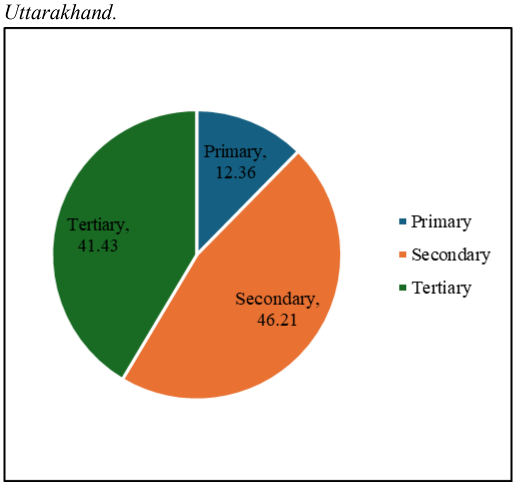

Figure 2. Contribution of the three Sectors of the Economy at Current Prices (in %) for the Year 2021-22

Source: Economic Survey 2022-23 Part-I, Government of Uttarakhand.

This study aims to assess the level of diversification within the Uttarakhand economy by employing a VAR (Vector Autoregression) approach. This method will be utilized to analyze the contributions of different sectors to the GSDP and how all these sectors influence overall economic growth. Essentially, the research will investigate how much Uttarakhand's economy relies on various sectors for its growth and development.

Literature Review

Wang et al. (2010) uncovered a consistent positive link between agriculture and economic growth, highlighting its pivotal role in sustaining overall economic development despite its declining GDP share. Andzio and Kamitewoko (2004) further supported this by examining the influence of agriculture on the GDP of China and three Sub-Saharan African countries, showcasing its essential role in their economies. Subramaniam and Reed (2009) developed a specific econometric model to examine linkages between all the sectors of the economy i.e., agriculture, manufacturing, services, and trade sectors in Poland and Romania. Chang et al. (2006) emphasized increased agricultural productivity's significant role in driving economic development and fostering long-standing economic growth in Taiwan, Korea, and Japan. Hwa (1988) and Sastry et al. (2003) supported these findings, indicating agriculture's substantial contribution to overall economic advance. Gollin et al. (2002) contended that enhanced agricultural yield fosters economic progress, while Turan Katircioglu (2006) discovered bidirectional causation between agrarian output and economic advance in North Cyprus. Awokuse (2009) found significant contributions of the primary sector to economic development across various countries, while Xuezhen et al. (2010) revealed an optimistic correlation between agricultural growth and economic progress in China. Jatuporn et al. (2011) further investigated this relationship in Thailand. Tregenna (2008) highlighted the crucial role of the manufacturing sector in stimulating demand, and Szirmai (2012) cautioned against solely relying on the secondary

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sector for economic growth. Matahir (2012) identified a unidirectional correlation between Malaysia's industrial sector to agriculture. Gemmell et al. (1998) examined interconnections among GDPs and productivity, while Block (1999) analyzed growth multipliers in Ethiopia's sectors. Gani and Clemes (2002) emphasized sectoral linkages, and Clemes et al. (2003) revealed beneficial effects between tertiary and secondary sectors in ASEAN economies. Craigwell et al. (2008) found cointegrating relationships in Barbados' sectors. Subramanian et al. (2009) demonstrated the tertiary sector's role in driving development. Eddine (2010) found co-integration among Tunisian sectors, while Rahman et al. (2011) highlighted the primary and secondary sectors' contributions to Bangladesh's GDP. Hussin and Yik (2012) affirmed sectoral roles in economic advancement in India and China. Usman and Ijaiya (2011) analyzed budgetary allocations in Nigeria, and Marwan et al. (2010) estimated real GDP growth for Lebanon. Gerhard (1993) focused on Austrian output growth, and Bouton and Erkel-Rousse (2003) investigated sectoral business surveys' role in forecasting, noting the impact of service GDP growth on agriculture.

Research Methodology

The data for this research work was gathered annually over a twenty-three-year period (2000-2023) from reports (2009, 2015, and 2023) issued by the Directorate of Economics and Statistics, Uttarakhand. The data revealed Uttarakhand's GSDP and the contributions to GSDP from the primary, secondary, and tertiary sectors in lakhs of rupees. The Vector Autoregressive (VAR) model was used in this study. The lag length of 1 was selected for the VAR model based on the Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn Criterion (HQ), which all indicated this as the optimal choice. Lag-1 minimizes information loss, ensures model stability, avoids overfitting, and provides the best fit for the data with balanced model complexity and explanatory power. According to Gujarati and Porter (2009), it is imperative to determine whether the economic variables are stationary before utilizing the VAR model.

The Unit Root Test

A test that has gained popularity in recent years for assessing stationarity or non-stationarity is the unit root test, conducted using the Augmented Dicky-Fuller (ADF) test

$$\Delta Y_t = m + dt + gY_t + \sum_{i=1}^{n} + \alpha_i \Delta Y_{t-i} + u_t \quad \textbf{(1)}$$

Where,

ΔY_t = First difference of the economic variable Y_t,

m = Intercept (drift),

g = 1 – Φ where Φ is the characteristic root,

d_t = Deterministic trend,

u_t = Error term.

The ADF and Phillips-Perron (PP) unit root tests involve intercepts and trends to examine the stationary of variables at both levels and first differences.

The Granger Causality Test

The compendium of the Granger causality test aims to find inter-sectoral linkages (feedback or bilateral causality) to build a VAR model of the Uttarakhand economy. Before we perform the causality test, we must first test for the optimal lag using the basic information selection criterion. Since the Granger causality test is employed on stationary series, the lag selection criteria is also performed on stationary series, which are the first differences of the variables under consideration denoted by DLGSDP, DLPS, DLSS, and DLTS. This is achieved by using the subsequent info criteria:

Akaike's Information Criterion (AIC)

$$AIC(m) = \text{logdet}\,(\hat{\varepsilon}_m) + \frac{2}{T} mk^2 \quad \textbf{(2)}$$

The Hanna-Quinn Criterion (HQ)

$$HQ = \text{logdet}\,(\hat{\varepsilon}_m) + \frac{2 \log \log T}{T} \quad \textbf{(3)}$$

Schwarz Criterion (SC)

$$SC\,(m) = \text{logdet}\,(\hat{\varepsilon}_m) + \frac{\log T}{T} mk^2 \quad \textbf{(4)}$$

Where,

$\hat{\varepsilon}_m = T^{-1} \Sigma_{t=1}^{T} \hat{u} + \hat{u}_t$ = Residual covariance matrix for the model,

m = Order of the model,

k = Number of variables in the model,

T = Sample size.

The Granger causality test is performed using equations 5 and 6

$$X_t = \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{j=1}^{n} \beta_j X_{t-j} + u_{1t} \quad \textbf{(5)}$$

$$Y_t = \sum_{i=1}^{n} \lambda_i Y_{t-i} + \sum_{j=1}^{n} \delta_j X_{t-j} + u_{2t} \quad \textbf{(6)}$$

Where X and Y are economic variables, α, β, λ and δ are coefficients of economic variables, and u_{1t} and u_{2t} are the uncorrelated error terms.
The VAR model is estimated using

$Y_t = V_0 + V_1 t + A_1 Y_{t-1} + - - - - + A_p Y_{t-p} + u_t$ **(7)**

Where V_0 and $V_1 t$ are deterministic terms. Equation 7 can be written in compact form

$Y_t = [V_0, V_1, A_1, - - - -, A_p] Z_{t-1} + u_t$

Where $Z_{t-1} = (1, t, Y_{t-1}^I, - - - -, Y_{t-p}^I)$

Adjustments to the deterministic terms can be made accordingly if the model contains a constant or lacks any deterministic component at all. With a sample size T and variables $Y_1, . . . ,$ Y_T along with p pre-sample vectors $Y_{-p+1}, ...,$ $Y_0,$ the parameters can be efficiently estimated using ordinary least squares (OLS) for each equation independently. The estimator is readily observed to be

$[\hat{V}_0, \hat{V}_1, \hat{A}_1, - - - -, \hat{A}_p] = (\sum_{t=1}^{T} Y_t Z_{t-1}^I)(\sum_{t=1}^{T} Z_t Z_{t-1}^I)^{-1}$ **(8)**

Result And Discussion

Table 1 exhibits the result of the ADF test acted on four variables in their levels and differences. Notably, none of the variables exhibit stationarity in their levels; however, they achieve stationarity after first differencing. An asterisk (*) in the context of critical values signifies that the null hypothesis of a unit root is rejected at significance levels of one, five, and ten percent. In this analysis, we examine variables that include solely an intercept and those that incorporate both a trend and intercept in both level and first difference formats.

Table 1. ADF Test result for both Trend and Without Trend of four variables in Level and First Difference

Result of ADF Test										
Variables	t-Statistics	Critical Value			MacKinnon (1996) one-sided p-values	t-Statistics	Critical Value			MacKinnon (1996) one-sided p-values
	With Intercept	1%	5%	10%		With Trend and Intercept	1%	5%	10%	
ADF Test - Levels										
LGSDP	0.131037	-3.752946	-2.998064	-2.638752	0.9612	-2.122345	-4.416345	-3.622033	-3.248592	0.5072
LPS	-0.631156	-3.752946	-2.998064	-2.638752	0.8449	-2.141006	-4.416345	-3.622033	-3.248592	0.4976
LSS	-0.185061	-3.752946	-2.998064	-2.638752	0.9276	-2.001097	-4.416345	-3.622033	-3.248592	0.5701
LTS	0.953047	-3.752946	-2.998064	-2.638752	0.9944	-2.569692	-4.416345	-3.622033	-3.248592	0.2956
ADF Test – 1st Difference										
D(LGSDP)	-4.354440	-3.769597*	-3.004861*	-2.642242*	0.0027	-4.313135	-4.440739	-3.632896*	-3.254671*	0.0130
D(LPS)	-4.275971	-3.769597*	-3.004861*	-2.642242*	0.0032	-4.166431	-4.440739	-3.632896*	-3.254671*	0.0175
D(LSS)	-4.336107	-3.769597*	-3.004861*	-2.642242*	0.0028	-4.257303	-4.440739	-3.632896*	-3.254671*	0.0146
D(LTS)	-4.828681	-3.769597*	-3.004861*	-2.642242*	0.0009	-5.106577	-4.440739*	-3.632896*	-3.254671*	0.0025

Source: Author's computation

Note: The Test is conducted using EViews (LGSDP= Logarithm of Gross State Domestic Product, LPS= Logarithm of Primary Sector, LSS=Logarithm of Secondary Sector, LTS=Logarithm of Tertiary Sector, and D=First Difference of the Variables)

Table 2: VAR Lag Order Selection Criterion

Sample: 2000-2023 Number of observations=23

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1004.347	NA	2.21e+34	87.59539	87.74350	87.63264
1	-939.4754	107.1791*	1.74e+32*	82.73699*	83.32943*	82.88599*

Note: The asterisk (*) denotes the lag order chosen by the criterion. The LR represents the sequential modified LR test statistic, with each test conducted at a five percent significance level. FPE stands for Final Prediction Error. The endogenous variables considered in this context are DLgsdp, DLps, DLss, and DLts.

Corresponding to the VAR lag selection criterion in table three, we use lag-1 for the Granger Causality test. The reason is because of all the criteria LR, FPE, AIC, SC, and HQ all selected lag 1. Having identified the lag of 1, we carry on operating the pair-wise Granger Causality test for all the series DLGSDP, DLPS, DLSS, and DLTS using equations (5) and (6). The outcome of the pairwise Granger Causality test is presented in Table 3.

DL Primary Sector (DLPS) and DLGross State Domestic Product (DLGSDP):

The F-statistic (0.22264) is associated with the H0, which is that DLPS yields a p-value of 0.6421, indicating insignificance. Therefore, we failed to reject the H0, suggesting that DLPS does not exhibit Granger causality on DLGSDP. Similarly, the F-statistic (2.22546) associated with the H0 that DLGSDP does not exhibit Granger causality on DLPS yields a p-value of 0.1514, which is also insignificant. Consequently, we failed to reject the H0, implying that DLGSDP does not exhibit Granger causality on DLPS. Thus, no evidence suggests that DLPS and DLGSDP have a causal relationship.

Table 3. Pairwise Granger Causality Test Result

Sample: 2000-2023 Lag:1

HO	Obs	F-Stat.	Prob.
DLPS does not exhibit Granger causality on DLGSDP	23	0.22264	0.6421
DLGSDP does not exhibit Granger causality on DLPS		2.22546	0.1514
DLSS does not exhibit Granger causality on DLGSDP	23	2.87789	0.0262
DLGSDP does not exhibit Granger causality on SS		2.76927	0.0310
DLTS does not exhibit Granger causality on DLGSDP	23	1.39751	0.2510
DLGSDP does not exhibit Granger causality on DLTS		0.00272	0.9589
DLSS does not exhibit Granger causality on DLPS	23	0.91984	0.3490
DLPS does not exhibit Granger causality on DLSS		0.00012	0.9914
DLTS does not exhibit Granger causality on DLPS	23	2.78151	0.1109
DLPS does not exhibit Granger causality on DLTS		0.26059	0.6153
DLTS does not exhibit Granger causality on DLSS	23	1.92342	0.1807
DLSS does not exhibit Granger causality on DLTS		0.00232	0.9621

Source: Author's computation

DL Secondary Sector (DLSS) and DLGross State Domestic Product (DLGSDP):

The F-statistic (2.87789) associated with the H0 that DLSS does not exhibit Granger causality on DLGSDP yields a p-value of 0.0262, indicating significance. Therefore, we reject the H0, suggesting that DLSS does exhibit Granger causality on DLGSDP. Similarly, the F-statistic (2.76927) associated with the null hypothesis that DLGSDP does Granger DLSS yields a p-value of 0.0310, which is also significant. Consequently, we reject the H0, implying that DLGSDP does exhibit Granger causality on DLSS. Thus, evidence suggests that DLSS and DLGSDP have a causal relationship.

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DL Tertiary Sector (DLTS) and DLGross State Domestic Product (DLGSDP):

The F-statistic (1.39751) associated with the H0 that DLTS does not exhibit Granger causality on DLGSDP yields a p-value of 0.2510, indicating insignificance. Therefore, we failed to reject the H0, suggesting that DLTS does not exhibit Granger causality on DLGSDP. Similarly, the F-statistic (0.00272) associated with the H0 that DLGSDP does not exhibit Granger causality on DLTS yields a p-value of 0.9589, which is also insignificant. Consequently, we failed to reject the null hypothesis, implying that DLGSDP does not exhibit Granger causality on DLTS. Thus, no evidence suggests that DLTS and DLGSDP have a causal relationship. Although the tertiary sector contributes significantly to Uttarakhand's Gross State Domestic Product (GSDP), no significant relationship was found between the tertiary sector and GSDP in the Granger causality test (high p-values of 0.2510 and 0.9589). This may be due to:

- The tertiary sector's indirect, delayed impact on GSDP.
- Data limitations (annual data may miss short-term shifts).
- The sector's focus is on non-productive services.
- External factors influencing the sector's performance. Thus, the relationship between the tertiary sector and GSDP is complex and indirect.

DLSecondary Sector (DLSS) and DLPrimary Sector (DLPS):

The F-statistic (0.91984) associated with the H0 that DLSS does not exhibit Granger causality on DLPS yields a p-value of 0.3490, indicating insignificance. Therefore, we failed to reject the H0, suggesting that DLSS does not exhibit Granger causality on DLPS. Similarly, the F-statistic (0.00012) associated with the H0 that DLPS does not exhibit Granger causality on DLSS yields a p-value of 0.9914, which is also insignificant. Consequently, we failed to reject the H0, implying that DLPS does not exhibit Granger causality on DLSS. Thus, no evidence suggests that DLSS and DLPS have a causal relationship.

DLTertiary Sector (DLTS) and Primary Sector (DLPS):

The F-statistic (2.78151) associated with the H0 that DLTS does not exhibit Granger causality on DLPS yields a p-value of 0.1109, indicating insignificance. Therefore, we failed to reject the H0, suggesting that DLTS does not exhibit Granger causality on DLPS. Similarly, the F-statistic (0.26059) associated with the H0 that DLPS does not exhibit Granger causality on DLTS yields a p-value of 0.6153, which is also insignificant. Consequently, we failed to reject the H0, implying that DLPS does not exhibit Granger causality on DLTS. Thus, no evidence suggests that DLTS and DLPS have a causal relationship.

DLTertiary Sector (DLTS) and Secondary Sector (DLSS):

The F-statistic (1.92342) associated with the H0 that TS does not exhibit Granger causality on SS yields a p-value of 0.1807, indicating insignificance. Therefore, we failed to reject the H0, suggesting that TS does not exhibit Granger causality on SS. Similarly, the F-statistic (0.00232) associated with the H0 that DLSS does not exhibit Granger causality on DLTS yields a p-value of 0.9621, which is also insignificant. Consequently, we failed to reject the H0, implying that DLSS does not exhibit Granger causality on DLTS. Thus, no evidence suggests that TS and SS have a causal relationship.

VAR Model Estimation Result

Table 4 presents the results of the unrestricted VAR. Where $Y_t = \begin{bmatrix} DLGSDP \\ DLDD \end{bmatrix}$, V_0 is a constant term, V_1t is the deterministic term, which is not included for simplicity's sake. A_i (i = 1, …..,p) is the parameter matrix, and u_t is the error term. Table 4 presents the results of the unrestricted VAR.

Table 4. VAR Estimates

Sample (adjusted): 2000-2023
Included observations: 23 after adjustments
Standard errors in () & t-statistics in []

	DLGSDP	DLSS
DLGSDP (-1)	1.714788	0.537866
	(0.54025)	(0.37030)
	[3.17408]	[1.45253]
DLSS (-1)	-1.294921	0.013911
	(0.98345)	(0.67408)
	[-1.31671]	[0.02064]
C	-130966.7	-233205.0
	(773388.)	(530096.)
	[-0.16934]	[-0.43993]
R-squared	0.966683	0.947696
Adj. R-squared	0.963351	0.942466
Sum sq. resids	3.12E+13	1.46E+13
S.E. equation	1248496.	855745.6
F-statistic	290.1435	181.1916
Log-likelihood	-353.8897	-345.2021
Akaike AIC	31.03389	30.27844
Schwarz SC	31.18199	30.42655
Mean dependent	9093387.	4304871.
S.D. dependent	6521618.	3567654.
Determinant resid covariance (dof adj.)		2.40E+22
Determinant resid covariance		1.82E+22
Log-likelihood		-654.7024
Akaike information criterion		57.45238
Schwarz criterion		57.74859
Number of coefficients		6

Source: Author's computation

Conclusion

The study employed data from reports spanning 2000 to 2023 from the Directorate of Economics and Statistics, Uttarakhand, focusing on Uttarakhand's Gross State Domestic Product (GSDP) and its contributions from the Primary, Secondary, and Tertiary sectors. The Vector Autoregressive (VAR) model, as outlined by Gujarati and Porter (2009), was utilized, with initial attention given to testing the stationarity of individual economic variables using the ADF and PP unit root tests. Results indicated that while the variables were non-stationary at their levels, they achieved stationarity upon first differencing. Subsequently, the Granger causality test was conducted to discern inter-sectoral linkages, with lag selection performed based on various information criteria. The pairwise Granger causality test revealed significant causality between the Secondary Sector (SS) and GSDP, implying a causal relationship. However, no significant causality was observed between the Primary Sector (PS) or Tertiary Sector (TS) and GSDP. Additionally, no significant causal

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relationships were found between PS and SS or TS, nor between TS and SS. The VAR model estimation further supported these findings, indicating a significant relationship between GSDP and SS. In conclusion, while the Secondary Sector influences Uttarakhand's economic growth, the Primary and Tertiary Sectors do not exhibit significant causal relationships with GSDP. These findings contribute to a nuanced understanding of Uttarakhand's economic dynamics and can inform policymaking to foster sustainable economic development in the region.

Practical Implications Of Findings.

The study highlights the significant role of the secondary sector (manufacturing, construction, processing) in Uttarakhand's economic development, driving GSDP growth and offering opportunities for job creation and infrastructure development. While the tertiary sector contributes to GSDP, its influence on short-term growth is less direct. The policy focus should be on enhancing the secondary sector's potential.

Policy Recommendations:

Infrastructure Development: Invest in industrial hubs, roads, and utilities to attract investment and boost manufacturing. Example: Develop industrial corridors between Dehradun, Haridwar, and Rudrapur.

Skill Development: Launch vocational training programs for sectors like manufacturing and agro-processing to improve workforce productivity. Example: Partner with training centers to provide sector-specific skills.

Agro-Processing Investment: Offer incentives like subsidies and loans to promote agro-processing industries. Example: Establish food processing units for fruits, vegetables, and herbal products.

Public-Private Partnerships (PPPs): Encourage PPPs for infrastructure projects to attract private investment. Example: Develop industrial parks and logistic hubs through PPPs.

Support for SMEs: Provide access to finance, technology, and markets for small and medium enterprises. Example: Create an SME credit guarantee fund and offer tax incentives.

R&D Investment: Increase funding for R&D in key industrial sectors. Example: Collaborate with universities to develop R&D centers in renewable energy and sustainable manufacturing.

Export Strategy: Develop policies to help local manufacturers access global markets. Example: Offer export incentives and improve trade facilitation for targeted industries.

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