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Secondary Sector Growth in Himachal Pradesh

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Abstract
This present paper focus on the measurement of long-term growth in the secondary sector of Himachal Pradesh economy. The study is based on secondary data collected from various reports of economic survey and statistical abstracts of Himachal Pradesh. Data on state gross domestic product for the secondary sector at constant prices from 1980-81 to 2015-16 at aggregated and disaggregated levels were evaluated. To justify the equation of best fit and measuring the growth rate of secondary sector and its sub sectors eleven different types of growth rate indices were used like simple linear (SLR); log-linear (LLN); hyperbolic (HYP); parabolic (PRB); cubic (CUB); logistic (LGS); gompertz (GOM); modified exponential (MEX); geometric (GEO); log-parabolic (LPB); log-cubic (LCB); were used. AIC values were used to describe the equation of best fit. From three main sector of SGDP that is primary, secondary and tertiary one main sector that is secondary and its sub sectors were taken as the variables of the study. The relative growth rate was used to assess the performance of secondary sector and its sub sectors. Findings from the study are expected to be useful in policy making for attaining balanced and sustainable growth for the secondary sector at the state level.

Keywords: *Secondary Sector, Growth and Himachal Pradesh*

I. Introduction

The Himalayan state Himachal Pradesh is known for its agricultural diversity natural beauty and clean environment. The state shares its border with Punjab, Jammu and Kashmir, Uttarakhand and Haryana with one international boarder that is Chaina. Despite its difficult geographical situations, the state has emerged as one of the socio-economically balanced state in the India. After becoming the full fledge sate in 1971, it has made wonderful growth in literacy, human development, health and connectivity. For the several years the SGDP of Himachal Pradesh remained above the national average largely owing to the balanced development of primary, secondary and tertiary sectors (GoHP, 2014).

Between these three sectors, the secondary sector comprising constructions, electricity, gas and water supply, manufacturing and other industrial activities has gained significance in structural change. Earlier in 1970 with more than 70 percent population dependence on agricultural it was a primary sector economy. However, after the reform of 1990 there was a visible change toward manufacturing and industry-based growth (Planning Commission, 2013). The secondary sector plays an important role in employment generation, self-sufficiency and rural development. This sector may be assumed as the engine of growth for Himachal Pradesh economy. BBN (Baddi, Barotiwala and Nalagarh) belt is known as the industrial hub of Himalayas has a large number of industries (GoHP, 2015).

The MSME industries has been promoted by the state especially in food industries, electronics, pharmaceuticals and textile. The special industrial package by the central government between 2003 to 2010 offer transport subsidies, tax incentive and loan assistant has led the secondary sector growth (GoHP, 2013).

II. Methodology

The present study is quantitative research and based on secondary data collected from the various reports of economic and statistical department of Himachal Pradesh. The results in the present study have been calculated by applying the following statistical tools:

2.1 Akaike Information Criterion

AIC = 2k – 2 In ($\hat{L}$)
Where:
k is the number of estimated parameters in the model.
$\hat{L}$ is the maximum value of the likelihood function for the model

2.2 Long-term Trend Analysis

For estimating long-term growth paths, traced by each of the components of a particular study variable (say, gross domestic product), an attempt was made to search out the curves of the best fit from amongst the following 11 distinct trend relationship in time variable t:

1. Simple Linear (SLR) : $Y_t = b_0 + b_1 t + u_t$
2. Parabolic (PRB) : $Y_t = b_0 + b_1 t + b_t t^2 + u_t$
3. Cubic (CUB) : $Y_t = b_0 + b_1 t + b_2 t^2 + b_3 t^3 + u_t$
4. Log-Linear (LLN) : $In\, Y_t = b_0 + b_1 t + u_t$
5. Log-Parabolic (LPB) : $In\, Y_t = b_0 + b_1 t + b_2 t^2 + u_t$
6. Log-Cubic (LCB) : $In\, Y_t = b_0 + b_1 t + b_2 t^2 + b_3 t^3 + u_t$
7. Geometric (GEO) : $Y_t = b_0 b_1^t e^{u_t}$
8. Hyperbolic (HYP) : $Y_t = \frac{t}{b_0 t + b_1 + t_u}$
9. Modified Exponential (MEX) : $Y_t = k + b_0 b_1^t$
10. Gomportz (GOM) : $Y_t = k b_0^{b_t^1}$
11. Logistics (LGS) : $Y_t = \frac{k}{1 + b_0 b_1^t}$

Where u_t stands for disturbance term at time t; b_0, b_1, b_2 and b_3 represents the unknown coefficients which were estimated through the OLS technique.

2.3 Relative Growth Rates

With the help of the best-fit functional form, relative growth rates (RGR_t) in the time-series $\{Y_t\}$ in respect of different components of gross domestic product were computed. As per Rudra (1970), $RGR_t = Y_t/Y_1$ where $Y_t = [dy/dt]$ represents the time derivation of Y_t.

For different functional forms, the derived expressions (by Sethi, 2008) for relative growth rates were:

1. SLR $= \frac{b_1}{b_0 + b_1 t}$
2. PRB $= \frac{b_1 + 2b_2 t}{b_0 + b_1 t + b_2 t^2}$
3. CUB $= \frac{b_1 + 2b_2\, t + 3b_3 t^2}{b_0 + b_1 t + b_2 t^2 + b_3 t^3}$
4. LLN $= b_1$
5. LPB $= b_1 + 2b_2 t$
6. LCB $= b_1 + 2b_2 t + 3b_3 t^2$
7. GEO $= \frac{b_1}{t}$
8. HYP $= \frac{b_1}{(b_1 + b_0\, t)\, t}$
9. MEX $= \frac{(b_0 b_1 t) In b_1}{k + b_0 b_1^t}$
10. GOM $= In b_0 . In b_1 . b_1^t$
11. LGS $= \frac{-(b_0 b_1^t) In b_1}{1 + b_0 b_1^t}$

Such growth rates were computed at different points in time so as to examine of consistency, acceleration or deceleration regarding behavioural growth paths traced by the different components. For this purpose, the temporal changes in the relative growth rates were depicted against time graphically.

III. Result and Discussion

Findings from the analysis have been discussed under the three heads: the first section is devoted to the equation of best: the second section analyses fit long-term growth in different components of domestic product from secondary sector and sub-sectors in Himachal Pradesh; the third section display the Relative Growth Rates in domestic product from secondary sector and sub-sectors of Himachal Pradesh economy, covering the period from 1980-81 to 2015-16.

3.1 Equation of Best Fit

Thirty-six years (1980-81 to 2015-16) data of Himachal Pradesh secondary sector and its sub-sectors, manufacturing (MNFG); construction (CNST); electricity, gas, water supply and other utility services (EGWS); secondary sector (SCDR) was taken at constant prices with base year 2011-12. To justify the equation of best fit eleven different types of growth rates simple linear (SLR); parabolic (PRB); cubic (CUB); log-linear (LLN); log-parabolic (LPB); log-cubic (LCB); geometric (GEO); hyperbolic (HYP); modified exponential (MEX); gompertz

(GOM); logistic (LGS) were tested for secondary sector and its sub-sectors. The choice for best-fit functional form was made based on the minimum value of Akaike's Information Criterion.
The construction sub-sector found the minimum value of Akaike's information criterion 103.7 for the cubic equation. Hence, the cubic growth rate equation was selected for this sub-sector.

Table 1.
Computed Values of Akaike's Information Criterion (AIC) for Eleven Different Functional Forms in respect of the Indexes# on Secondary Sector and Sub-Sectors of Himachal Pradesh State (1980-81 to 2015-16)

Sector/ Sub-Sector	Functional Form Estimated										
	SLR	PRB	CUB	LLN	LPB	LCB	GEO	HYP	MEX	GOM	LGS
MNFG	209.7	147.6	115.0	115.8	119.3	116.7	229.0	273.2	143.8	137.1	175.7
CNST	148.8	115.8	103.7	129.6	130.3	112.3	197.4	251.4	141.0	141.9	142.6
EGWS	182.3	102.2	100.8	150.9	98.6	111.2	204.9	254.0	150.3	147.4	127.5
SCDR	191.2	104.8	76.0	72.9	79.1	76.9	220.3	266.6	128.7	120.3	107.9

Source: Author's Computations

Values of the Indexes for Each of the Aggregates during Different Years were Computed as $100 \times \frac{\text{Value of the Aggregate at a Given Year}}{\text{Value of the Aggregate during 2011 - 12}}$

In the case of electricity, gas, water supply, and other utility services sub-sector, the minimum value of Akaike's Information Criterion was 98.6 for the log-parabolic equation. Therefore, log-parabolic growth rate equation was selected for this sub-sector. Out of eleven different types of growth rates equations selected for the line of best fit, only two kinds of growth rates selected on Akaike's information criterion in cubic and log-parabolic others were not selected at all.

IV. Equation of Best Fit for Secondary Sector

The secondary sector was also taken for long-run growth analysis. The choice for best-fit functional form was made based on the minimum value of Akaike's information criterion. For the secondary sector, the minimum value of Akaike's Information Criterion was 72.9 for the log-linear equation.

Table 2
Computed Values of Akaike's Information Criterion (AIC) for Eleven Different Functional Forms in respect of the Indexes# on Real GSDP from Secondary Sector of Himachal Pradesh (1980-81 to 2015-16)

Sector/ Sub-Sector	Functional Form Estimated										
	SLR	PRB	CUB	LLN	LPB	LCB	GEO	HYP	MEX	GOM	LGS
SCDR	191.2	104.8	76.0	72.9	79.1	76.9	220.3	266.6	128.7	120.3	107.9

Source: Author's Computations

Values of the Indexes for Each of the Aggregates during Different Years were Computed as $100 \times \frac{\text{Value of the Aggregate at a Given Year}}{\text{Value of the Aggregate during 2011 - 12}}$

4.1. Long-Term Trends in Different Components of Gross State Domestic Product

For this purpose, eleven different functional forms estimated from the time series on secondary sector and sub-sectors manufacturing (MNFG); construction (CNST); electricity, gas, water supply and other utility services (EGWS); secondary sector (SCDR) for the thirty six years study period in respect of Himachal Pradesh economy. The choice for best-fit functional form was made based on the minimum value of Akaike's Information Criterion and out of eleven functional forms, finally chosen a form of the best-fit, along with the corresponding value of t, R^2, Adjusted R^2, F-value for R^2 and AIC.

A perusal at Table 2 reveals that the long-term growth pattern of the manufacturing sub-sector has most properly modeled as cubic as it has been associated with the minimum value (=114.047) of the Akaike's information criterion (AIC) among the eleven functional forms tried. Further, the equation has a reasonably high value for the line of best-fit (R^2 =0.987); a low value for adjusted R^2 (=0.985) and F-value for R^2 was 801.500. This indicated the equation of best-fit to the income from the manufacturing sub-sector of the Himachal Pradesh economy. Among the other sub-sectors, electricity, gas, water supply, and other utility services were most properly modeled as log-parabolic as it was associated with the minimum value (=98.609) of the Akaike's information criterion (AIC) among the eleven functional forms tried. Further, the equation had a reasonably high value for the line of best-fit (R^2 =0.961); a low value for adjusted R^2 (=0.959) and F-value for R^2 was 411.100. This has indicated the equation of best-fit to the income from the electricity, gas, water supply, and other utility services sub-sector of Himachal Pradesh economy.

Table 3
Computation of the Best-Fit Functional Forms for indexed GSDP (At 2011-12 Constant Prices) in Himachal Pradesh at Disaggregated Level

Sector/ Sub-Sector	Best fit Form	Values of Coefficients	t-Values of the Coefficients	R^2	Adjusted R^2	F-value for R^2	AIC
MNFG	CUB	β_0 =-3.4973 β_1 = 2.5481 β_2 =-0.1902 β3 =0.0064	-1.004 ^{NS} 3.168** -3.795*** 7.173***	0.987	0.985	801.500	115.047
CNST	CUB	β_0 = 27.6978 β_1 =-1.7343 β_2 = 0.2267 β_3 =-0.0029	9.303*** -2.523* 5.291*** -3.918***	0.986	0.984	761.500	103.735
EGWS	LPB	β_0 =1.2582 β_1 =0.1333 β_2 =-0.0009	11.064*** 9.412*** -2.539*	0.961	0.959	411.100	98.609
SCDR	LLN	β_0 = 1.7771 β_1 =0.0866	61.220*** 63.340***	0.991	0.991	4013.000	72.855

Source: Author's Computations

NS: Non-significant;': Significant at 10% probability level; *: Significant at 5% probability level;**: Significant at 1% probability level;
***: Significant at 0.1% probability level.

The construction sub-sector has most properly modeled as cubic as it has been associated with the minimum value (=103.735) of the Akaike's information criterion (AIC) among the eleven functional forms tried. Further, the equation has a reasonably high value for the line of best-fit (R^2 =0.986); a low value for adjusted R^2 (=0.984) and F-value for R^2 was 761.500. This indicated the equation of best-fit to the income from the construction sub-sector of Himachal Pradesh economy. From secondary sector and three sub-sectors cubic growth rate equation selected for 2 sub-sectors (viz., manufacturing and construction). Log parabolic growth rate equation selected for one sub-sector (i.e. electricity, gas, water supply). The log-linear growth rate equation also selected for secondary sector.

4.2 Relative Growth Rates in Secondary Sector and Sub-Sectors of Himachal Pradesh

The relative growth rates were worked out after identifying the most appropriate functional forms in respect of secondary sector and sub-sectors of Himachal Pradesh economy with the help of the estimated values of the parameters of the equation of best-fit, to all data points for secondary sector and sub-sectors. In other words, a precisely investigation has been attempted for a thirty-six-year study period if there is any indication of acceleration, deceleration, or consistency in the growth rates of secondary sector and sub-sectors.

Relative growth rates of the secondary sector and sub-sectors shown in table 4. The relative growth rate shows the high performance of a sector or sub-sector concerning another sector or sub-sector. If a sector is showing a relatively high growth rate, again and again, we can state it as the driver of growth.

Table 4
Relative Growth Rates in Real GSDP of Service Sector and Sub-Sectors of Himachal Pradesh

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988
MNFG	-193.009	290.628	60.566	32.829	21.284	15.112	11.435	9.164	7.798
CNST	-4.925	-3.437	-1.858	-0.263	1.271	2.677	3.904	4.926	5.734
EGWS	13.150	12.961	12.773	12.584	12.395	12.207	12.018	11.829	11.640
SCDR	8.667	8.667	8.667	8.667	8.667	8.667	8.667	8.667	8.667
YEAR	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
MNFG	7.071	6.882	6.936	7.320	7.891	8.570	9.290	9.990	10.626
CNST	6.341	6.765	7.033	7,172	7.208	7.162	7.055	6.901	6.713
EGWS	11.452	11.263	11.074	10.886	10.697	10.508	10.320	10.131	9.942
SCDR	8.667	8.667	8.667	8.667	8.667	8.667	8.667	8.667	8.667

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006
MNFG	11.167	11.597	11.913	12.119	12.226	12.246	12.194	12.085	11.930
CNST	6.502	6.273	6.035	5.790	5.541	5.292	5.044	4.798	4.555
EGWS	9.754	9.565	9.376	9.187	8.999	8.810	8.621	8.433	8.244
SCDR	8.667	8.667	8.667	8.667	8.667	8.667	8.667	8.667	8.667
YEAR	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
MNFG	11.740	11.525	11.293	11.049	10.798	10.545	10.291	10.041	9.794
CNST	4.314	4.077	3.844	3.613	3.385	3.159	2.935	2.713	2.491
EGWS	8.055	7.867	7.678	7.489	7.300	7.112	6.923	6.734	6.546
SCDR	8.667	8.667	8.667	8.667	8.667	8.667	8.667	8.667	8.667

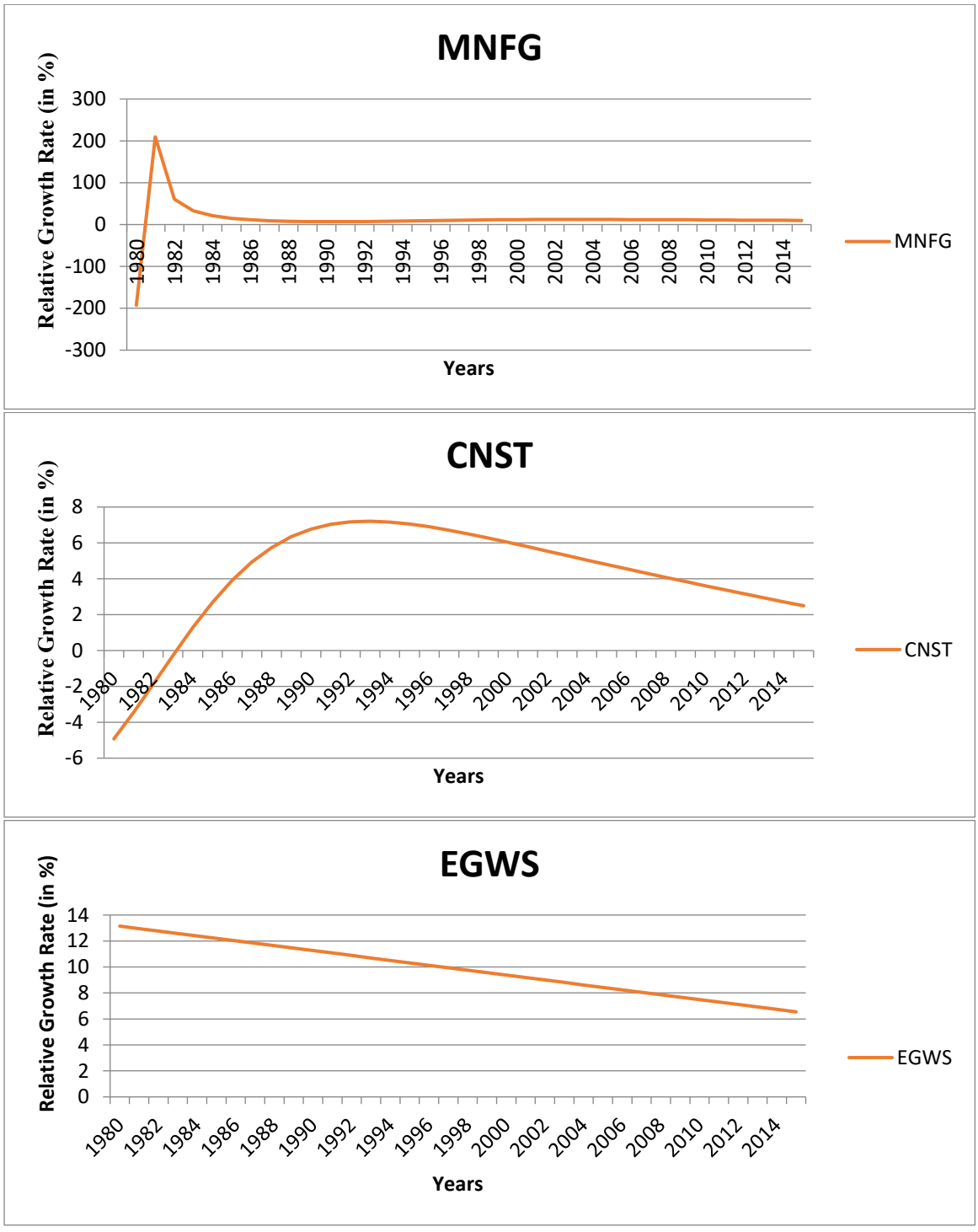
Source: Author's Computations

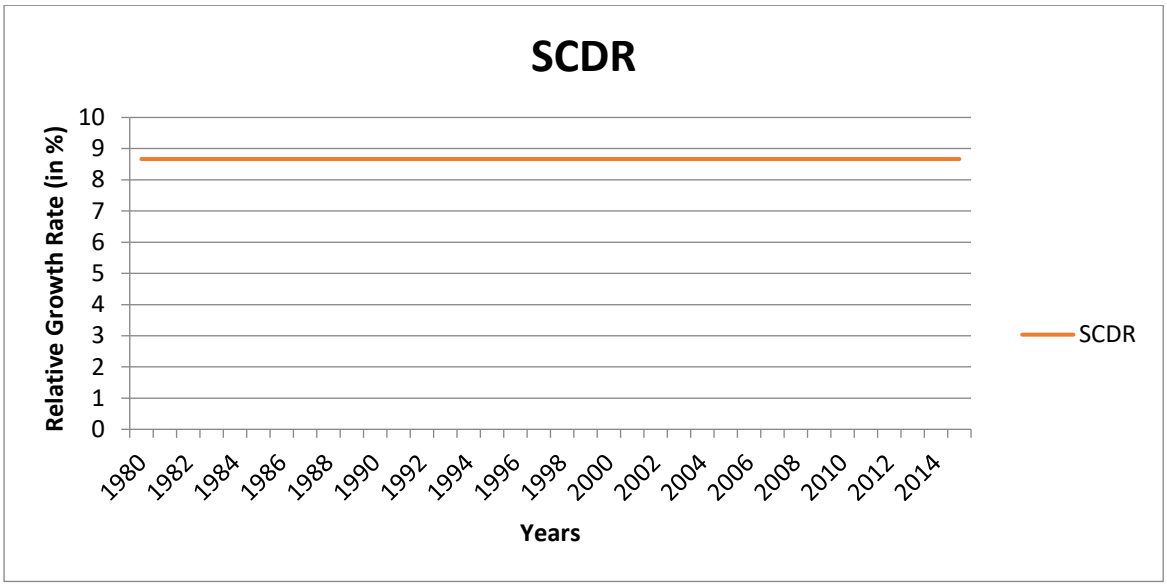
Table 4 reveals that in 1981 and 1982 the maximum growth rate was in manufacturing (i.e. 209.628 and 60.566 percent respectively). For the years 1983 and 1984 the highest growth rate was in manufacturing (i.e. 32.829 and 21.284 percent respectively) followed by electricity, gas, water supply. The manufacturing sub-sector again maintained the relatively higher growth rate (i.e. 15.112 percent) in 1985, followed by electricity, gas, water supply. The manufacturing sub-sector achieved maximum growth rate continues for five years from 1981 to 1995. Electricity, gas, water supply has found the maximum growth rate (i.e. 12.018 percent) in 1986 followed manufacturing (i.e. 11.435 percent). The electricity, gas, water supply sub-sector achieved the maximum growth rate (i.e. 11.884 percent) in the year 1987 followed by manufacturing (i.e. 9.164 percent). For upcoming two years 1988 and 1989 again the maximum growth rate has found in electricity, gas, water supply (i.e. 11.640) followed by secondary sector (i.e. 8.667 percent). Electricity, gas, water supply sub-sector achieved the maximum growth rate in continuous for three years from 1987 to 1989. Electricity, gas, water supply becomes the highest growing sub-sector (i.e. 11.263 and 11.074 percent respectively) for the years 1990 to 1991 followed by secondary (i.e. 8.667 and 8.667 respectively percent). Electricity, gas, water supply again maintained the relatively higher growth rates (i.e. 10.886, 10.697 and 10.508 percent respectively) for the years 1992 to 1994 followed by secondary sector (i.e. 8.667, 8.667 and 8.667 percent respectively). Again in 1995 the maximum growth rate in electricity, gas, water supply, and other utility services (i.e. 10.320 percent) has been followed manufacturing (i.e. 9.290 percent). Electricity, gas, water supply sub-sector achieved the maximum growth rate continues for six years from 1990 to 1995. The electricity, gas, water supply and achieved the relatively higher growth rate in the year 1996 followed by manufacturing (i.e. 9.990 percent).

From the years 1997 to 1999 the maximum growth rate found manufacturing (i.e. 10.626, 11.167 and 11.597 percent respectively) followed by electricity, gas, water supply (i.e. 9.942, 9.754 and 9.565 percent respectively). The manufacturing sub-sector achieved the maximum growth rate (i.e. 11.913, 12.119 and 12.226 percent respectively). From 2003 to 2007 the maximum growth rate was in manufacturing (i.e. 12.246, 12.194, 12.085, 11.930 and 11.740 percent respectively).

Figure I.1 also represents the relative growth rates in respect of the different components of gross state domestic product in the Himachal Pradesh economy. As discernible from the figure, growth rate of agriculture and animal husbandry sub-sector has been following an increasing pattern up till 2004, and afterward, it began to decline at a plodding pace. The maximum (i.e. 3.396 percent per annum) and minimum (i.e. 1.258 percent per annum) values of RGR_t were recorded during 2004 and 1980 respectively. As regards the forestry and logging sub-sector, has been following an increasing pattern up till 2000, and afterward, it began to decline at a languid pace. The maximum (i.e. 3.801 percent per annum) and minimum (i.e. -4.636 percent per annum) values of RGR_t were recorded during 2000 and 1980 respectively. The fishing sub-sector has been following a declining pattern up to 2000 after that shows an increasing pattern. The maximum (i.e. 13.023 percent per annum) and minimum (i.e. 1.803 percent per annum) values of RGR_t were recorded during 1980 and 2000 respectively. The mining and quarrying sub-sector showed a constant growth rate (i.e. 5.596 percent per annum) during the entire study period from 1980 to 2015. As for as the primary sector is concerned, the growth rate in this sector has witnessed an increasing pattern up to 2002, and afterward, it began to decline.

Figure I.1
Relative Growth Rates in Real GSDP of Different Sectors and Sub-Sectors of Himachal Pradesh





The manufacturing sub-sector showed an instant increase in growth rate from 1980 to 1981 then instant decrease from 1981 to 1986, and afterward, it has minor fluctuations in growth rate up to 2015 As far as the electricity, gas, water supply sub-sectors have concerned, the growth rate in this sub-sector has witnessed a linearly declining trend throughout the study period. The secondary sector also showed a constant growth rate (i.e. 8.667 percent per annum) during the entire study period from 1980 to 2015.

From the above analysis, it may be concluded that the double-digit growth rate was achieved by all the sub-sectors who occupy the highest growth rate. The manufacturing sub-sector occupies the highest growth rates for five years from 1981 to 1985.

V. Conclusion

As regards the long-run growth performance, behavioral growth paths in respect of the secondary sector and its sub sectors were observed for the Himachal Pradesh economy. Majority of the sectors followed third-degree trend path functions; that is, CUB and LCB turned out to be the best representatives in majority cases. Specifically speaking, the equations viz., PRB, LLN, and LPB were observed to be of poorer-fit. The secondary sector registered a constant rate of growth during the study period. Notably, income has exhibited inverted U-shaped growth patterns observed construction (CNST) sub sector. During the entire study period the manufacturing (MNFG); electricity, gas, water supply (EGWS) displayed an increasing trend in relative share. As regards the relative growth rates double-digit growth rate has achieved by all the sub-sectors who occupied the highest growth rate. The manufacturing sub-sector has occupied the highest growth rates for five years from 1981 to 1985. Electricity, gas, water supply, and other utility services (EGWS) sub-sector occupied the highest growth rates for six years from 1990 to 1995.

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