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FORECASTING OF SECTOR-WISE CONTRIBUTIONS OF GVA IN ODISHA: A LINEAR REGRESSION ANALYSIS APPROACH

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ABSTRACT

Gross Value Added (GVA), a crucial GDP-derived metric, reflects a nation's financial health and captivates researchers in business and economics. GVA's significance in macroeconomics makes it a prime concern, serving as a key index for national development assessment and macroeconomic evaluation. Moreover, it underpins government economic strategies. Precisely predicting GVA is vital for insightful future economic health understanding. GVA's summarized past data inadequately informs effective economic strategies, policies, and resource allocation. Reliable GVA estimates through forecasting, like Linear regression used here for Odisha, enable sector-wise insights, growth analysis, and projection for informed decision-making.

Keywords: Gross Value Added (GVA), GDP-derived metric, financial health

1. INTRODUCTION

Gross Value Added (GVA) stands as a comprehensive metric encompassing all economic activities, offering a more comprehensive view of the economy compared to other macroeconomic indicators. Representing the market value of final goods and services produced within a nation's borders in a given year, GVA serves as a paramount indicator of economic performance. Its computation involves three distinct approaches: the Expenditure approach, which includes household, business, and government expenditures along with net exports; the Production approach, summing value added at each production stage by all domestic industries, including taxes and subsidies on products; and the Income approach, combining all factor income generated by production, encompassing remuneration of employees, capital income, gross operating surplus, profit, taxes, and subsidies.

Moreover, GVA holds a pivotal role in shaping governmental economic strategies and policies. The precision of GVA prediction becomes imperative for informed insights into future economic health. Past GVA data offers a summary of previous activities but lacks the granularity required for effective economic development strategies, policies, and resource allocation. A reliable estimation of future GVA is essential, achievable through meticulous forecasting using sophisticated time series models to account for the complex variables influencing GVA.

Macroeconomic projections are a staple of various national and supra-national institutions, guiding expectations if reasonably accurate. Among these, GVA growth rates and inflation exert significant influence. Accurate forecasting of macroeconomic variables, particularly GVA growth, carries substantial weight in policy formulation. Its effects reverberate through the economy, influenced by monetary policy decisions with variable time lags. Recognizing these lags, it is acknowledged that effective monetary policy necessitates a medium- to long-term perspective.

This research centers on forecasting the sector-wise GVA contribution in Odisha using linear regression analysis. Analyzing the percentage contributions, sector growth, and growth rates provides insights into growth trends. The forecasting process employs linear regression analysis, utilizing actual GVA data spanning 2011-12 to 2020-21 to predict GVA up to 2021-22 to 2030-31

2. LITERATURE REVIEW

Creating a suitable econometric model utilizing multiple data series to generate forecasts that are both timely and reasonably accurate has consistently posed a challenge for econometricians. As noted by Mongardini and Saadi-Sedik (2003), the pertinent data needed to assess the direction of economic activity often experiences significant delays, hindering appropriate policy responses. This holds particularly true in the context of emerging economies like India, where obtaining precise GDP growth forecasts presents additional hurdles due to factors such as incomplete and noisy data, limited sample periods for available indicators, and a higher likelihood of structural shifts in economic time series – a consequence of the rapid structural transformations and shifting policy regimes common to such economies (Liu et al., 2012; Maier, 2011).

To tackle these complexities, this study employs the Factor-Augmented Time Varying Parameter Regression (FA-TVPR) approach, akin to methodologies used by Eickmeier and Lemke (2015), Inoue et al. (2017), and Karakatsani and Bunn (2008), for estimating India's aggregate and sectoral real GDP growth. Notably, this approach integrates a coincident indicator index, capturing present economic activities, and a leading economic indicator index, focused on future economic activities, building upon the pioneering work of Burns and Mitchell (Mitchell and Burns, 1938; Burns & Mitchell, 1946). Stock and Watson (1989) advanced the concept by proposing an unobserved variable model representing the current state of the economy, an element common to fluctuations in key aggregate time series variables. The estimation of such unobserved variables employs Dynamic Factor Models (DFMs), stemming from work by Engle and Watson (1981), Geweke (1977), and Sargent and Sims (1977), and has recently been extended to emerging economies by researchers including Corona et al. (2017), Forni et al. (2001), Jiang et al. (2017), and Liu et al. (2012).

Drawing inspiration from Camba-Mendez et al. (2001), this research employs a dynamic factor model to forecast GDP growth for European countries. Unlike pre-selecting leading indicators from a pool of macroeconomic indicators, this model summarizes the information content of potential leading indicators. This mirrors the approach of Stock and Watson (1989).

In a different vein, Tsay and Tiao (1984, 1985) employed ARIMA models, fitting them to non-seasonal data by identifying autoregressive and moving average terms through partial autocorrelation and autocorrelation functions. While this approach suits seasonal data, studies such as those by Liu (1989), Liu and Hudak (1992), and Liu (1999) have employed filtering methods to forecast macro variables across different time intervals.

Reynolds et al. (1995) developed automated techniques for identifying and parameterizing ARIMA models using time-series data for a single variable, while Reilly (1980) applied a similar methodology to model macroeconomic variables like GDP. These studies, however, primarily focused on non-seasonal time series data and restricted themselves to short-term predictions. To address this limitation, several studies have incorporated analytical neural network techniques, particularly effective for seasonal data (Chiu et al. 1995; Cook and Chiu 1997; Geo et al. 1997; Saad et al. 1998), building upon the foundational works of Granger and Joyeux (1980) and Hosking (1981). Nevertheless, the practical application of these neural network models in real-life policy-

making scenarios poses challenges due to the intricacies of network design, training, testing, and parameter estimation.

2.1 Objectives

The major objectives of the research paper are given s following

1) To study the Vital Few Sectors contribution to the Gross Value added (GVA) of Odisha at current prices.
2) To examine the growth and growth rate of the VFS sectors of Odisha
3) To analyse the forecasting process to know the actual and forecasted value of GVA of VFS sectors of Odisha
4) To measure the growth rate by the forecasting of GVA of VFS sectors of Odisha

3. MATERIALS AND METHODS

Data: This research paper delves into the Gross Value Added (GVA) data concerning the state of Odisha. The dataset is collected from two primary sources: the Economic Survey of 2020-2021 and the Directorate of Economics and Statistics of Odisha. The study encompasses the period from 2011-12 to 2021-22, comprising a total of 70 observations. Within this dataset, there are seven distinct sectors known as the Vital Few Sectors (VFS) that collectively contribute around 80% of the total GVA in Odisha. This insight is derived from Pareto curve analysis conducted on the entire spectrum of Odisha's GVA sectors (Sahu Pritipadma, Gartia Rajendra 2022).

Methodology: The objective of this paper is to scrutinize the sector-wise contributions to Odisha's total GVA. Specifically, it examines the proportional distribution of GVA across the seven sectors: Agriculture, Manufacturing, Mining and Quarrying, Construction, Trade & Repair Services, Public Administration Services, and Other Services. Additionally, the paper delves into the intellectual growth and growth rates of these sectors within Odisha. Time-series data is employed to assess the GVA contribution, growth, and growth rates of the seven VFS sectors at both basic current and basic constant prices (Sahu P. & Gartia R. 2022). Given that the ARIMA model necessitates a substantial dataset, this paper resorts to regression analysis for forecasting GVA data. The primary focus is to predict the GVA of the VFS sectors using linear regression analysis.

Before executing the regression analysis, a One-sample Kolmogorov-Smirnov Test is conducted to assess the normality of the GVA data. This step is essential, as linear regression analysis requires a normally distributed dataset. The prediction of GVA for the seven VFS sectors involves generating forecasted values based on the actual GVA data, thereby determining the growth rate of each sector in Odisha. This prediction process underscores the variance between actual and forecasted GVA values, offering insights into the forthcoming GVA trends in Odisha. The paper's GVA forecasting for the seven VFS sectors extends over a five-year span, encompassing the period from 2021-22 to 2030-31. The data analysis is executed using Microsoft Excel and SPSS under a DOS environment.

3.1 Statistical Analysis

Growth Rate:

The GVA growth rates of the seven designated VFS sectors are computed using both current basic prices from 2020-21 and basic constant prices from 2011-12. The projected values are established through linear regression analysis, utilizing the actual GVA data of these VFS sectors. This process is pivotal in determining the growth rates for these sectors and their subsequent growth rates.

One- sample Kolmoronov Smirnov Test:

The Kolmogorov-Smirnov test is highly effective in assessing normality. It can be adapted to function as a goodness of fit test. Particularly, when examining the distribution's normality, the samples are normalized and juxtaposed against the standard normal distribution. This process entails aligning the reference distribution's mean and variance with the samples' estimates. It's important to note that this alteration in the reference distribution's characteristics impacts the null distribution of the statistic.

Regression analysis:

Regression analysis comprises a set of statistical techniques employed to estimate connections between a dependent variable and one or more independent variables. It serves to measure the intensity of associations between variables and to formulate predictive models for their future interrelations.

Linear regression analysis is based on six fundamental assumptions:

1) The dependent and independent variables show a linear relationship between the slope and the intercept.
2) The independent variable is not random.
3) The value of the residual (error) is zero.
4) The value of the residual (error) is constant across all observations.
5) The value of the residual (error) is not correlated across all observations.
6) The residual (error) values follow the normal distribution.

Simple Linear Regression:

Simple Linear Regression is a model that assesses the relationship between a dependent variable and an independent variable. The simple linear model is expressed using the following equation:

$$\mathbf{Y = a + bX + \epsilon}$$

Where: **Y –** Dependent variable, **X –** Independent (explanatory) variable, **a –** Intercept, **b –** Slope, **ϵ –** Residual (error)

Table 1: Gross Value Added (GVA) of Odisha at Current Prices 2020-21

Economic Activities	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**
Manufacturing	4116404	4212453	5168498	4724215	4654610	6741508	8000596	8601940	8703040	7825778
Agriculture	3090950	4387858	4531863	5239762	4645552	5617276	5615950	6534734	7757400	7196359
Trade & repair services	1838866	2218946	2533465	2782577	3082291	3240394	3665665	4106654	4386805	4004275
Public Administration services	863077	980808	1390657	1517496	1573618	1609037	1751531	1993959	2348486	2854941

Mining and Quarrying	2648738	2666989	2868392	2703161	2862080	3292604	3467115	4126450	4209939	4002881
Construction	2059629	2074164	2314669	2393041	2370792	2609537	2973274	3298939	3326640	2969443
Other services	1738239	1892760	1932774	2150766	2373548	2640051	3176499	3609298	4228354	4493111

Source: Odisha Economic Survey 2020-21

Table-1 illustrates the sector-wise contributions to Odisha's Gross Value Added at current prices in 2020-21. Notably, the Manufacturing sector takes the lead with the highest GVA contribution, while the Other Services sector exhibits the lowest contribution to Odisha's GVA. Additionally, the Agriculture sector boasts a substantial GVA contribution. Upon scrutinizing the table, it becomes evident that the growth and growth rates of each sector have exhibited a consistent upward trend spanning from 2011-12 to 2020-21.

Table 2: Percentage Share of Value Added by Sub-sectors in industry at Current Basic Prices

Sectoral Activities	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Manufacturing	18.69	16.91	18.43	16	15.29	18.99	20.45	19.82	18.64	17.55
Agriculture	17.87	21.44	20.24	22.21	20.24	20.92	19.15	19.78	21.38	21.27
Trade & repair services	8.35	8.91	9.03	9.43	10.12	9.13	9.37	9.46	9.39	8.98
Public Administration	3.92	3.94	4.96	5.14	5.17	4.53	4.48	4.59	5.03	6.4
Mining and Quarrying	12.03	10.7	10.23	9.16	9.4	9.28	8.86	9.51	9.02	8.98
Other services	7.89	7.6	6.89	7.29	7.79	7.44	8.12	8.31	9.05	10.08
Construction	9.35	8.32	8.25	8.11	7.79	7.35	7.6	7.6	7.12	6.66

Table-2 provides insights into the distribution of sectoral contributions to Odisha's total Gross Domestic Product (GDP). Notably, the Manufacturing sector takes the lead with the highest percentage share of total GVA at 18.69%, exhibiting a gradual increase from the years 2011-12 to 2020-21. In contrast, the Public Administration sector demonstrates the lowest percentage share of GVA when compared to other sectors. Furthermore, the Agriculture sector also commands a significant percentage share in Odisha's GVA composition.

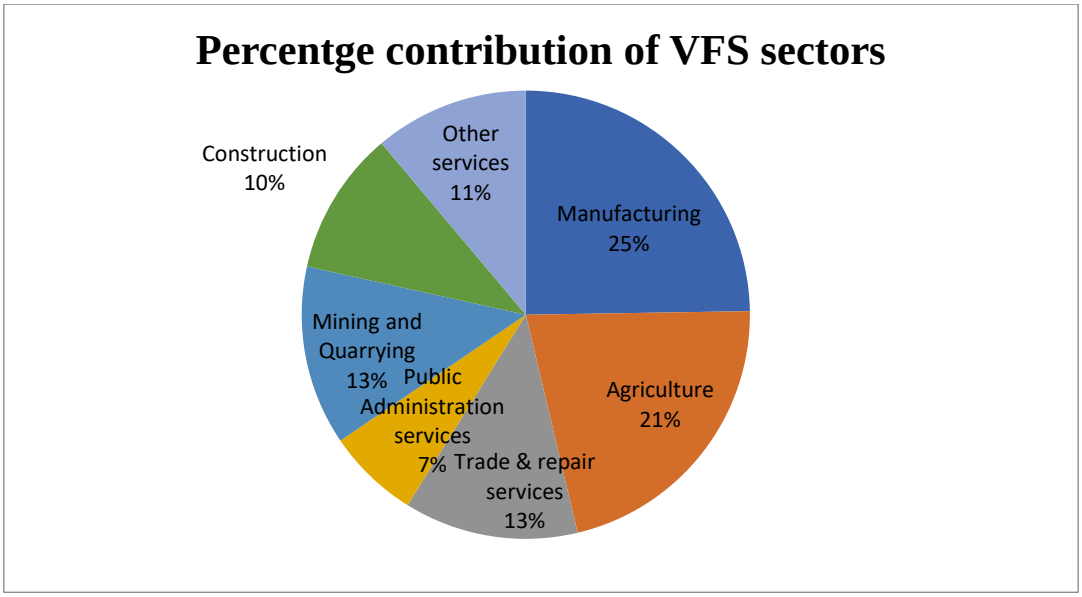


Figure 2: Percentage Share of VFS sector

The depicted chart delineates the percentage contributions of various sectors to Odisha's overall Gross Value Added (GVA). Notably, the Manufacturing sector and Agriculture sector stand out as the primary contributors to Odisha's total GVA, accounting for substantial proportions of 25% and 21% respectively. In contrast, the Public Administration sector contributes a relatively lower share of 7% to Odisha's total GVA. However, it's important to highlight that the remaining sectors also play significant and indispensable roles in contributing to the state's overall GVA.

Table 3: Growth Rates of Value Added by Sub-sectors in Industry at Constant (2011-12) Basic Prices

Sectoral Activities	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Manufacturing	-3.19	21.21	-9.43	10.66	33.23	7.94	9.43	3.61	-7.88
Agriculture	15.85	-4.16	7.84	-12.73	19.92	-10.99	7.67	11.92	-6.54
Trade & repair services	12.65	8.38	8.49	15.2	3.33	9.96	7.59	5.02	-9.01
Public Administration	6.95	35.35	7.31	6.97	0.8	5.71	9.29	16.09	21.09
Mining and Quarrying	-1.96	19.29	-7.94	28.83	13.76	-8.96	9.43	3.38	-7.88
Construction	-2.43	6.73	-0.29	0.36	7.19	8.26	5.21	0.83	-10.79
Other services	0.2	-4.37	4.07	4.44	4.5	14.48	9.52	11.21	1.33

The table indicates the growth and growth rates of all sectors contributing to GVA of Odisha. The highest and positive growth rate occurs in manufacturing sector i.e. 33.23 in the year 2016-17 whereas the lowest growth rate or the most negative growth rte is seen in construction sector in 2012-13. The agriculture sector has also high growth rate i.e. 19.92 in 2016-17. The other sectors have also measurable growth rates from 2011-12 to 2020-21.

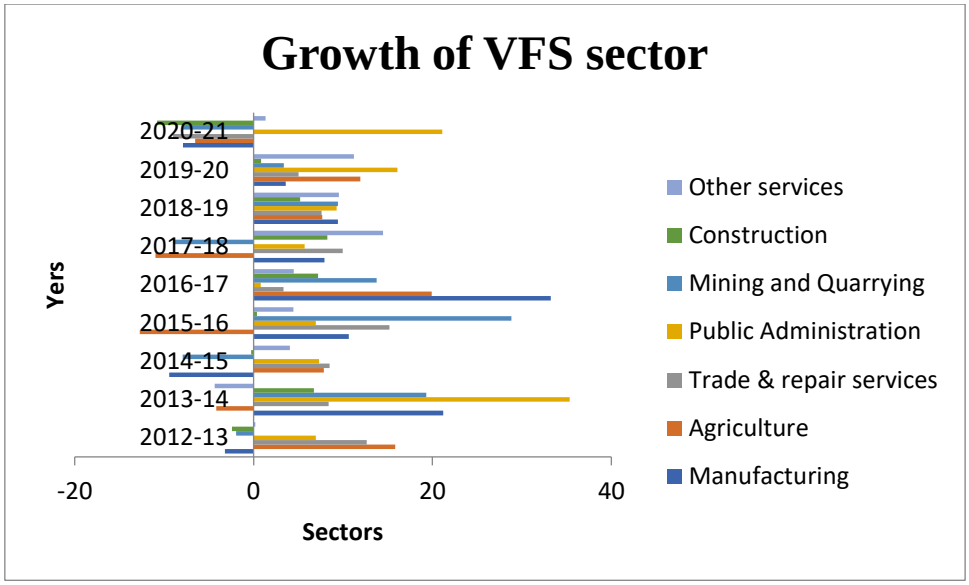


Figure 3: Growth of VFS sectors

The figure shows that the manufacturing and agriculture sectors have highest and positive growth rates as compared to other sectors of GVA of Odisha. The lowest and negative growth rate is seen in construction and other services sector of GVA of Odisha. The growth of all sectors gradually increases from the period 2011-12 to 2020-21 and show upward trend from the given period.

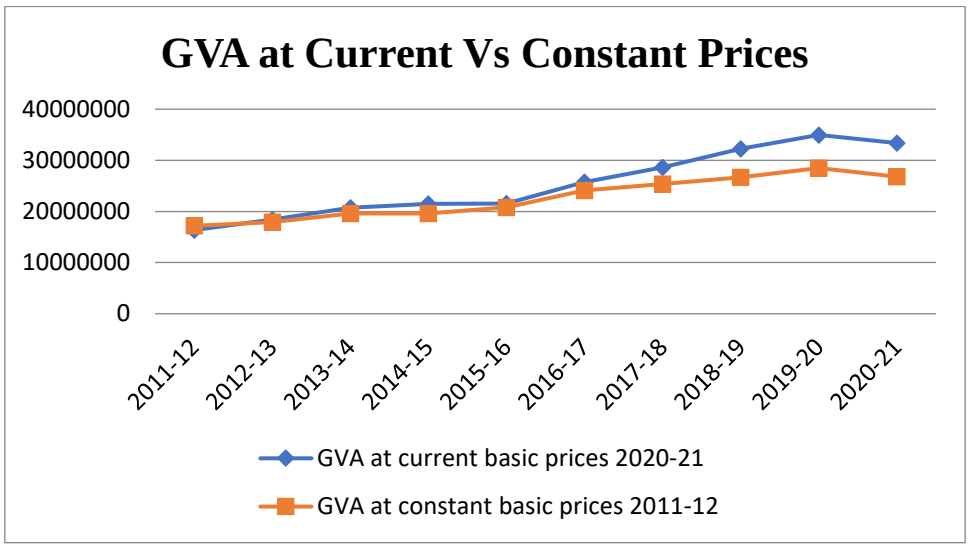


Figure 5: GVA at Current Vs Constant Prices from 2011-12 to 2020-21

The graph shows that the growth of GVA at current and constant prices from the period 2011-12 to 2020-21. The GVA at Current prices is gradually increased from the study period and show upward trend whereas the GVA at constant prices is also increased from the study period but it rises slowly than that of GVA at current prices. From the above graph, it shows that GVA at current prices increases rapidly as compared to GVA at constant prices.

Table 4: Descriptive Statistics of Gross Value Added (GVA) of Odisha:

Economic Activities	Minimum Statistic	Maximum Statistic	Sum Statistic	Mean	Std. Error	Std. Deviation Statistic	Variance Statistic
Manufacturing	4116404	8703040	62749042	6274904.20	597018.825	1887939.293	3564314772304.62
Agriculture	3090950.00	7757400.00	54617704.0	5461770.400	445124.480	1407607.200	1981358032214.71
Trade Repair Services	1838866.00	4386805.00	31859938.0	3185993.800	269596.791	852539.909	726824298127.73
Public Administration	863077.00	2854941.00	16883610.0	1688361.000	188946.206	597500.367	357006688873.33
Mining Quarrying	2648738.00	4209939.00	32848349.0	3284834.900	199717.965	631563.660	398872656732.54
Other Services	1738239.00	4493111.00	28235400.0	2823540.000	316744.639	1001634.497	1003271665877.77
Construction	2059629.00	3326640.00	26390128.0	2639012.800	149907.394	474048.804	224722269379.95

The Descriptive Statistics of sector wise contribution of all sectors of GVA of Odisha is shown in table-2 which figures out the statistical measures like mean, sum, variance, standard deviation of all Vital Few sectors contributing to GVA of Odisha.

For the process of Regression analysis, the selected sample data should be normal i.e. the test distribution must be normal. For the checking of normality of the data, the one sample Kolmogorov Smirnov test is analyzed. This hypothesis test result shows that the null hypothesis rejected because the asymptotic significance level of all sectors is 0.05. This result confirms that the test distribution is normal and suitable for regression analysis for forecasting process.

Table 5: Forecasting of Vital Few Sector (VFS) from 2011-12 to 2025-26

Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31
Manufacturing	4116404	4212453	5168498	4724215	4654610	6741508	8000596	8601940	8703040	7825778	9401730	10410384	10914711	11419037	11923364	12427690.97	12932017.75	13436344.53	13940671.32	14444998.1
Agriculture	3090950	4387858	4531863	5239762	4645552	5617276	5615950	6534734	7757400	7196359	7894110.295	8678736.068	9071048.955	9463361.841	9855674.727	10247987.61	10640300.5	11032613.39	11424926.27	11817239.16
Trade & repair services	1838866	2218946	2533465	2782577	3082291	3240394	3665665	4106654	4386805	4004275	4689509	5174514	5417016	5659518	5902021	6144523	6387026	6629528	6872031	7114533
Public Administration	863077	980808	1390657	1517496	1573618	1609037	1751531	1993959	2348486	2854941	2731064	3067419	3235597	3403775	3571953	3740131	3908309	4076486	4244664	4412842
Mining and Quarrying	2648738	2666989	2868392	2703161	2862080	3292604	3467115	4126450	4209939	4002881	4370133	4720229	4895277	5070325	5245373	5420421	5595469	5770517	5945565	6120613
Construction	2059629	2074164	2314669	2393041	2370792	2609537	2973274	3298939	3326640	2969443	3437862	3695556	3824402	3953249	4082096	4210942	4339789	4468636	4597482	4726329
Other Services	1738239	1892760	1932774	2150766	2373548	2640051	3176499	3609298	4228354	4493111	4602212	5175978	5462860	5749743	6036626	6323508	6610391	6897274	7184156	7471039

The provided table presents a comprehensive forecast derived through linear regression analysis for all sectors' Gross Value Added (GVA) data in Odisha, spanning the period from 2021-22 to 2030-31. This ten-year projection is based on a meticulous analysis of historical data and future trends. The forecasting entails seven significant Vital Few Sectors (VFS): Manufacturing, Agriculture, Trade & Repair Services, Public Administration, Mining and Quarrying, Other Services, and Construction. These sectors' forecasting is meticulously executed using linear regression analysis. The methodology involves leveraging actual GVA values spanning the period from 2011-12 to 2020-21 as the foundation for prediction. This predictive model extends the analysis further into the future, offering forecasts for the years 2021-22 to 2030-31.

The linear regression equation and R Squared value of all the seven VFS Sectors from 2011-12 to 2020-21 and forecasted from 2021-22 to 2030-31 are shown in the graph. The regression trend line of all VFS sectors from the given period is also represented in the following graph.

(i) The linear equation and R squared of agriculture sector is given s follows
$y = 57849x + 1E+06$
$R^2 = 0.818$

(ii) The linear equation and R squared value of Manufacturing sector is given s follows
$y = 71204x + 1E+06$
$R^2 = 0.821$

(iii) The linear equation and R squared value of Mining and Quarrying is given by
$y = 29476x + 1E+06$
$R^2 = 0.713$

(iv) The linear equation and R squared value of Construction is given by
$y = 22839x + 1E+06$
$R^2 = 0.686$

(v) The linear equation and R squared value of Trade & Repair is given by
$y = 35089x + 79098$
$R^2 = 0.858$

(vi) The linear equation and R squared value of public administration is given by
$y = 21881x + 22201$
$R^2 = 0.907$

(vii) The linear equation and R squared value of Other Services is given by
$y = 36865x + 35490$
$R^2 = 0.918$

The linear equation and R squared value of all the VFS sectors are represented in the following graphs

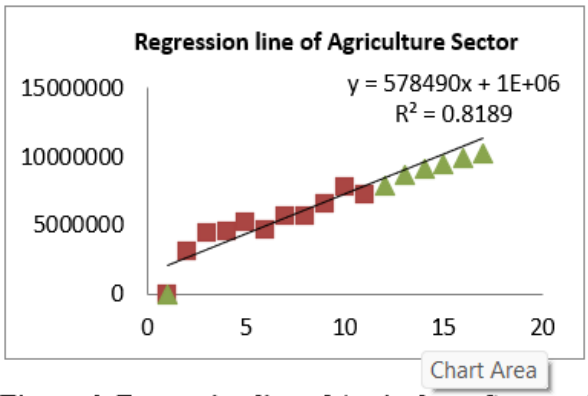


Figure 6: Regression line of Agriculture Sector

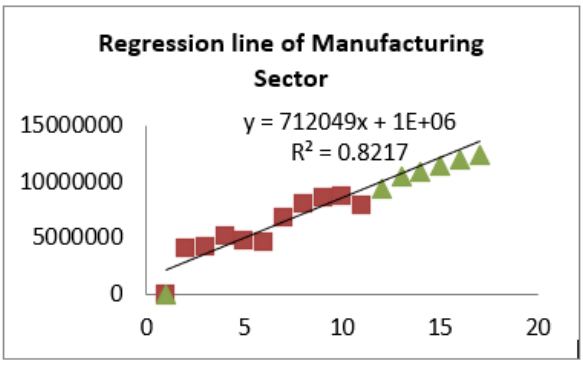


Figure 7: Regression line of Manufacturing Sector

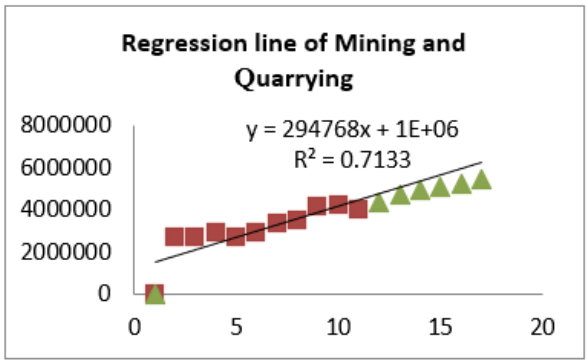


Figure 8: Regression line of Mining and Quarrying Sector

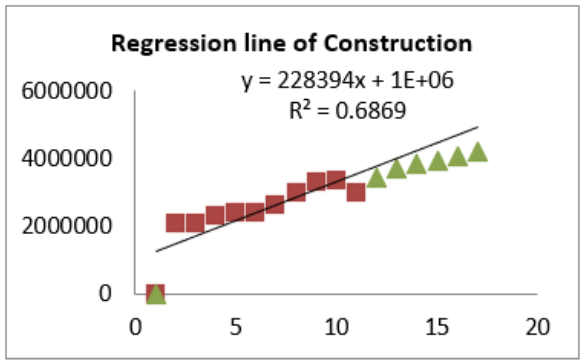
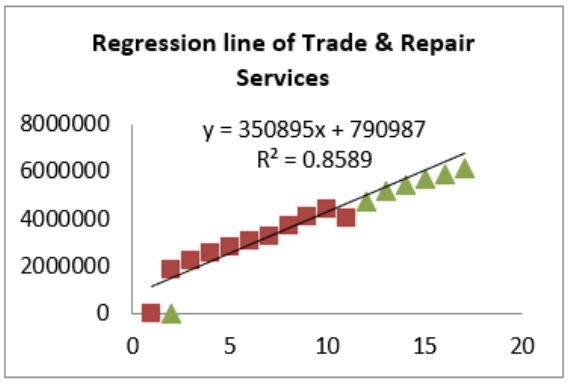


Figure 9: Regression line of Construction Sector



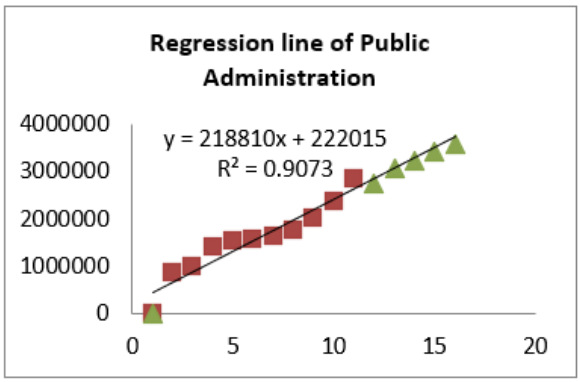


Figure 10: Regression line of Trade & Repair Services

Figure 11: Regression line of public administration

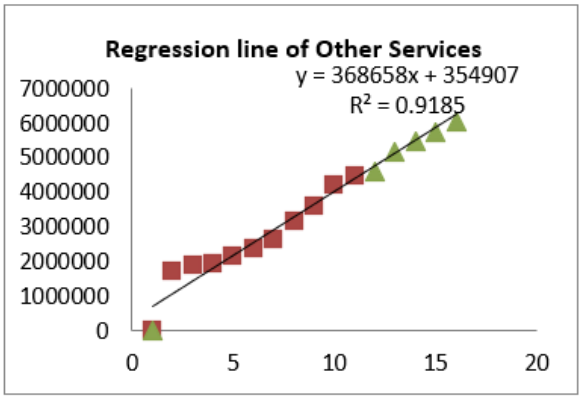


Figure 12: Regression line of Other Services

4. CONCLUSION & DISCUSSION

The analysis covers the growth and growth rate of the Vital Few sectors (VFS) within the timeframe of 2011-12 to 2020-21, revealing a consistent and positive upward trajectory. Notably, the Manufacturing and Agriculture sectors emerge as frontrunners with the highest growth rates among all sectors. Concurrently, the remaining sectors also exhibit an augmentation in their growth over the specified study period. To extend this analysis, a Linear Regression model is employed to predict the Gross Value Added (GVA) of all VFS sectors. Leveraging the actual GVA data spanning from 2011-12 to 2020-21, this model extrapolates projections from 2021-2022 to 2025-26. In particular, the Agriculture and Manufacturing sectors demonstrate forecasted GVA values surpassing those of other sectors. This underscores their dominant role in contributing to the total GVA within Odisha's economic landscape.

The implications of this Linear Regression analysis are far-reaching. It conclusively establishes the Agriculture and Manufacturing sectors as primary drivers of the state's overall GVA. Given their status as key indicators of the state's economic vitality, predicting GVA becomes paramount for understanding future trends and framing effective developmental policies. Ultimately, the core objective of forecasting GVA across all sectors is to furnish actionable insights for devising well-informed policies that will propel the state towards holistic and sustainable economic advancement.

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