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Comparison of Global GDP Analytics– A Statistical Perspective

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Abstract **-** Gross domestic product (GDP) is an indicator of the economic health of a country. The objective of the present paper is to make a comparative study of GDP of India, USA and Japan with various components viz., Agriculture, Mining Quarrying, Manufacturing, Electricity Gas Water Supply, Construction, Trade Hotels Transport, Finance Insurance Real Estate. For the study we evaluate the analytics by considering the yearly aggregate GDP data (Market Price) at constant prices for the period 1996-97 to 2015-16. For the study Multiple and Stepwise Regressions are applied and it is observed that, in India, Finance Insurance Real Estate, Manufacturing and Construction influences the GDP at constant prices while in USA, the independent variable, Trade Hotels Transport influences the GDP and in Japan, the independent variables, viz., Construction, Manufacturing, and Trade Hotels Transport influences the GDP. Also it is observed that there is a substantial amount of variation in GDP of Japan and USA than in India. Also, from this study we can claim that over the years India fares well in GDP as compared to the other two countries. Hence, the economy of India is very sound and consistent.

Keywords- GDP, Multiple Regression, Stepwise Regression

I. INTRODUCTION

Gross domestic product (GDP) is the monetary value of all the finished goods and services produced within a country's borders in a specific time period [2] [5]. GDP is commonly used as an indicator of the economic health of a country, as well as a gauge of a country's standard of living. Since the mode of measuring GDP is uniform from country to country, GDP can be used to compare the productivity of various countries with a high degree of accuracy[3][8]. Gross Domestic Product can be calculated using the following formula:

GDP = Consumption(C) +Country's Investment (I) + Government Expenditure (G) + Balance of trade (NX = Exports - Imports)

There are three primary methods by which GDP can be determined. First one is the expenditure approach which measures the total sum of all products used in developing a finished product for sale. It consists of household, business and government purchases of goods and services and net exports. The second one is Production Approach, which estimates the total value of economic output and deducts costs of intermediate goods that are consumed in the process, like those of materials and services. The third approach is Income approach which is something of an intermediary between the two approaches. It measures GDP by way of totaling domestic incomes earned at all levels and by using gross income both as an indicator of implied productivity and of implied expenditure.

In this paper an attempt is made to make a comparative study of GDP of India, USA and Japan with various components using Multiple and Stepwise regressions which shows the most influence component of the GDP.

The introduction is followed by Brief Review which is discussed in Section 2, Section 3 discusses the Data and Methodology of the study, Section 4 gives the Results and the Conclusions are made in Section 5.

II. BRIEF REVIEW

The GDP process and its comparison are organized into four sections. Section 2.1 is on theoretical review, section 2.2 is on GDP of USA, India and Japan, section 2.3 is on Multiple Regression and section 2.4 is on Stepwise Regression:

2.1) GDP

GDP is a macroeconomic assessment that measures the value of the goods and services produced by an economic entity in a specific period, adjusted for inflation[4][7][9]. In

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India, contributions to GDP are mainly divided into 3 broad sectors - agriculture and allied services, industry and service sector.

GDP at market prices = GDP at factor cost + Indirect Taxes – Subsidies

Quite simply, if the GDP measure is up on the previous three months, the economy is growing. If it is negative it is contracting. When GDP declines for two consecutive quarters or more, by definition the economy is in a recession [8][11][2].

GDP in a country is usually calculated by the national statistical agency, which compiles the information from a large number of sources. In making the calculations, however, most countries follow established international standards.

2.2) GDP of United States, India and Japan

The **United States** is the world's largest national economy in nominal terms and second largest according to purchasing power parity (PPP), representing 22% of nominal global GDP and 17% of gross world product (GWP) [9][11]. The United States' GDP was estimated to be $18.56 trillion in 2016. The U.S. dollar is the currency most used in international transactions and is the world's foremost reserve currency. GDP in the United States averaged 6560.26 USD Billion from 1960 until 2015, reaching an all-time high of 18036.65 USD Billion in 2015 and a record low of 543.30 USD Billion in 1960. The U.S. is one of the largest trading nations in the world as well as the world's second largest manufacturer, representing a fifth of the global manufacturing output [3][12].

The **economy of India** is the seventh-largest in the world measured by nominal GDP and the third-largest by purchasing power parity (PPP) [5][12]. The country is classified as a newly industrialized country, and one of the G-20 major economies, with an average growth rate of approximately 7% over the last two decades. The long-term growth prospective of the Indian economy is positive due to its young population, corresponding low dependency ratio, healthy savings and investment rates, and increasing integration into the global economy.

The **economy of Japan** is the third-largest in the world by nominal GDP and the fourth-largest by purchasing power parity (PPP) and is the world's second largest developed economy[8][10]. According to the International Monetary Fund, the country's per capita GDP (PPP) was at $37,519.

2.3) Multiple Regression:

The data is treated with multiple regression technique to see how Y is dependent on the independent variables X_1, X_2, … X_n and along with the coefficient of determination R^2 and predict the future Y value.

In linear multiple regression, the model specification is that the dependent variable, Y_i is a linear combination of the parameters [1][6]. For example, in linear multiple regression for modeling data points there are n independent variables and n parameters, β_0, β_1... β_n, then the multiple regression equation of Y on β_0, $\beta 1$..... β_n is given by:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ...+ \beta n Xn + \varepsilon$$

Here β_0 is the intercept and β_1, β_2, β_3..... β_n are analogous to the slope in linear regression equation and are also called regression coefficients and can be interpreted the same way as slope and X_1, X_2, …, X_n are the exploratory variables and ε is the error and follows Normal distribution. For empirical evaluation the GDP data is converted into log GDP for comparisons and predictions .The appropriateness of the multiple regression models as a whole can be tested by the F-test in the ANOVA table. A significant F indicates a linear relationship between Y and at least one of the X's. Once a multiple regression equation has been constructed, one can check how good it is (in terms of predictive ability) by examining the coefficient of determination (R^2). The closer R^2 is to 1, the better is the model and its prediction. Also for the data we computed the Stepwise Regression to drop the independent variable which does not influence the dependent variable Y by fitting a number of Regression models.

2.4) Stepwise Regression:

Stepwise regression is a method of fitting regression models in which the choice of predictive variables is carried out by an automatic procedure. In each step, a variable is considered for addition to or subtraction from the set of explanatory variables based on some prespecified criterion. Usually, this takes the form of a sequence of *F*-tests or *t*-tests, but other techniques are possible, such as adjusted R^2, Akaike information criterion, Bayesian information criterion. Properly used, the stepwise regression option puts more power and information than does the ordinary multiple regression option, and it is especially useful for sifting through large numbers of potential independent variables and/or fine-tuning a model by poking variables in or out [1][6].

III. DATA &METHODOLOGY

The objective of this paper is to examine the relationship among GDP and various sectors like Agriculture, Mining Quarrying, Manufacturing, Electricity Gas Water Supply, Construction, Trade Hotels Transport, Finance Insurance Real Estate in India, US and Japan using time series data from 1996 to 2016.In this study, the GDP data analyzed, are collected from the following official websites: India GDP from http://www.rbi.org.in of Reserve Bank of India (RBI), US GDP from http://www.bea.gov/national and Japan GDP from http://www.esri.cao.go.jp

The yearly aggregate GDP data (Market Price) at constant prices is taken for the study from 1996-97 to 2015-16.For comparing the GDP of the three countries viz., India USA

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and Japan, the Multiple Regression and Step wise Regression procedures are implemented for the data.

IV. RESULT

From the analysis, the three countries results are listed below for both Multiple and Step wise Regression procedures, separately:

I.1) India GDP

With Multiple Regression

Table 1: Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	1.000[a]	1.000	1.000	.00430	1.000	5.990	7	12	.000

a. Predictors: (Constant), FinanceInsuranceRealEstate, Agriculture, Mining Quarrying, TradeHotelsTransport, Manufacturing, Construction, ElectricityGasWaterSupply

b. Dependent Variable: GDP at Factor Cost

Table 2:ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.740	7	1.106	5.990	.000[a]
	Residual	.000	12	.000		
	Total	7.740	19			

a. Predictors: (Constant), FinanceInsuranceRealEstate, Agriculture, Mining Quarrying, TradeHotelsTransport, Manufacturing, Construction, ElectricityGasWaterSupply

Table 3: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.474	.210		7.014	.000*	1.016	1.932
	Agriculture	.278	.038	.197	7.266	.000*	.195	.361
	Mining Quarrying	.109	.032	.120	3.449	.005*	.040	.178
	Manufacturing	.237	.032	.251	7.514	.000*	.168	.306
	ElectricityGasWaterSupply	-.121	.059	-.110	-2.037	.064	-.250	.008
	Construction	-.013	.029	-.016	-.440	.667	-.077	.051
	TradeHotelsTransport	.277	.034	.267	8.088	.000*	.202	.351
	FinanceInsuranceRealEstate	.236	.046	.301	5.116	.000	.135	.336

a. Dependent Variable: GDP at Factor Cost

*Significant

From table 1 and 3 it is observed that there is a perfect correlation between the independent variables viz., Agriculture, Mining Quarrying, Manufacturing, Electricity Gas Water Supply, Construction, Trade Hotels Transport, Finance Insurance Real Estate, and the dependent variable, GDP at Factor cost.

It is also observed from table 2 that the independent variables Agriculture, Mining Quarrying, Manufacturing, Trade Hotels Transport and Finance Insurance Real Estate are significant and has good relationship with the GDP.

With Stepwise Regression

Table 4: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	1.000[a]	.999	.999	.02008	.999	1.918	1	18	.000
2	1.000[b]	.999	.999	.01539	.000	13.652	1	17	.002
3	1.000[c]	1.000	1.000	.01028	.000	22.096	1	16	.000

a. Predictors: (Constant), FinanceInsuranceRealEstate

b. Predictors: (Constant), FinanceInsuranceRealEstate, Manufacturing

c. Predictors: (Constant), FinanceInsuranceRealEstate, Manufacturing, Construction

Table 5: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.733	1	7.733	1.918	.000[a]
	Residual	.007	18	.000		
	Total	7.740	19			
2	Regression	7.736	2	3.868	1.634	.000[b]
	Residual	.004	17	.000		
	Total	7.740	19			
3	Regression	7.738	3	2.579	2.441	.000[c]
	Residual	.002	16	.000		
	Total	7.740	19			

a. Predictors: (Constant), FinanceInsuranceRealEstate

b. Predictors: (Constant), FinanceInsuranceRealEstate, Manufacturing

c. Predictors: (Constant), FinanceInsuranceRealEstate, Manufacturing, Construction

d. Dependent Variable: GDP at Factor Cost

Table 6: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.589	.048		74.033	.000*
	FinanceInsuranceRealEstate	.782	.006	1.000	138.490	.000*
2	(Constant)	3.121	.132		23.680	.000*
	FinanceInsuranceRealEstate	.529	.068	.677	7.737	.000*
	Manufacturing	.306	.083	.323	3.695	.002*

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3	(Constant)	3.224	.091		35.533	.000*
	FinanceInsuranceRealEstate	.384	.055	.491	6.948	.000*
	Manufacturing	.295	.055	.312	5.336	.000*
	Construction	.159	.034	.198	4.701	.000*

a. Dependent Variable: GDP at Factor Cost
b. *Significant

From the tables 4 and 6 it is observed that there is perfect correlation between the three independent variables viz., Finance Insurance Real Estate, Manufacturing, Construction and the dependent variable, GDP at Factor cost. These variables are significant and have a good relationship with the GDP as shown in table 5.The excluded variables are Agriculture, Mining Quarrying, Electricity Gas Water Supply and Trade Hotels Transport, which are insignificant and their influence on GDP has no impact, hence, are dropped from analysis. From this technique it is observed that the data fits into 3 significant models with respect to the Independent Variables and Finance, Insurance and Real Estate in all the 3 models with their significance in the models.

I.2) USA GDP

With Multiple Regression

Table 7: Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.959[a]	.919	.867	.03054	.919	17.775	7	11	.000

a. Predictors: (Constant), Finance Insurance Real Estate, Construction, Electricity Gas Water Supply, Agriculture, Manufacturing, Mining Quarrying, Trade Hotels Transport
b. Dependent Variable: GDP at Factor Cost

Table 8: ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.116	7	.017	17.775	.000[a]
	Residual	.010	11	.001		
	Total	.126	18			

a. Predictors: (Constant), Finance Insurance Real Estate, Construction, Electricity Gas Water Supply, Agriculture, Manufacturing, Mining Quarrying, Trade Hotels Transport
b. Dependent Variable: GDP at Factor Cost

Table 9: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.079	1.345		1.545	.151	-.882	5.040
	Agriculture	.265	.364	.166	.729	.481	-.536	1.066
	Mining Quarrying	.025	.141	.038	.174	.865	-.286	.336
	Manufacturing	.279	.243	.201	1.149	.275	-.256	.814
	ElectricityGasWaterSupply	.009	.098	.014	.094	.927	-.206	.224
	Construction	.002	.098	.004	.026	.980	-.213	.218
	TradeHotelsTransport	.205	.246	.305	.832	.423	-.337	.746
	FinanceInsuranceRealEstate	.215	.145	.372	1.486	.165	-.104	.534

a . Dependent Variable: GDP at Factor Cost
No coefficient is significant.

From this analysis it is evident that though the model fits well with all the variables as shown in table 7 ($R^2 = 0.919$), but no independent variable has a role to play with the dependent variable GDP and this could be due to the fact that the data may be non linear though it fits without any independent variable having any role to play. From tables 8 and 9 it is evident that there is a correlation between the independent variables viz., Agriculture, Mining Quarrying, Manufacturing, Electricity Gas Water Supply, Construction, Trade Hotels Transport, Finance Insurance Real Estate, and the dependent variable, GDP at Factor cost but with some error.

With Stepwise Regression:

Table 10: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.930[a]	.865	.857	.03164	.865	109.149	1	17	.000

a. Predictors: (Constant), TradeHotelsTransport

Table 11: ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.109	1	.109	109.149	.000[a]
	Residual	.017	17	.001		
	Total	.126	18			

a. Predictors: (Constant), TradeHotelsTransport
b.Dependent Variable: GDP at Factor Cost

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Table 12: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	4.538	.509		8.910	.000	4.538	.509
	TradeHotelsTransport	.624	.060	.930	10.447	.000	.624	.060

a. Dependent Variable: GDP at Factor Cost

From this analysis it is clear that the multiple regression fails to represent the relation between the dependent and independent variables and the stepwise procedure fits well with one independent variable "Trade Hotels Transport".

From the tables 10 and 11 it is observed that there is perfect correlation between the independent variable Trade Hotels Transport and the dependent variable, GDP at Factor cost. And from table 12 it is observed that this variable is significant and influences the GDP more. The excluded variables are Agriculture, Mining Quarrying, Manufacturing, Electricity Gas Water Supply, Construction and Finance Insurance Real Estate, which are insignificant and their influence on GDP has a very less impact hence are dropped from the analysis.

I.3) JAPAN GDP

With Multiple Regression

Table 13: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.960[a]	.923	.877	.02404	.923	20.408	7	12	.000

a. Predictors: (Constant), FinanceInsuranceRealEstate, ElectricityGasWaterSupply, Construction, Manufacturing, TradeHotelsTransport, Agriculture, Mining Quarrying
b. Dependent Variable: GDP at Factor Cost

Table 14: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.083	7	.012	20.408	
	Residual	.007	12	.001		
	Total	.090	19			

a. Predictors: (Constant), FinanceInsuranceRealEstate, ElectricityGasWaterSupply, Construction, Manufacturing, TradeHotelsTransport, Agriculture, Mining Quarrying

Table 15: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-1.184	2.119		-.559	.587	-5.801	3.433
	Agriculture	.211	.111	.329	1.904	.081	-.030	.452
	Mining Quarrying	-.060	.046	-.436	-1.287	.222	-.160	.041
	Manufacturing	.338	.128	.322	2.633	.022*	.058	.617
	ElectricityGasWaterSupply	.004	.087	.008	.042	.967	-.185	.193
	Construction	.307	.078	.800	3.919	.002*	.136	.477
	TradeHotelsTransport	.552	.238	.393	2.323	.039*	.034	1.069
	FinanceInsuranceRealEstate	.192	.149	.137	1.292	.221	-.132	.517

*Significant

From the tables 13 and 14 it is observed that there is a correlation between the independent variables viz., Agriculture, Mining Quarrying, Manufacturing, Electricity Gas Water Supply, Construction, Trade Hotels Transport, Finance Insurance Real Estate, and the dependent variable, GDP at Factor cost.

It is also observed from table 15 that the independent variables Manufacturing, Construction and Trade Hotels Transport are significant which influence the GDP.

With Stepwise Regression:

Table 16: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.876[a]	.767	.754	.03406	.767	59.133	1	18	.000
2	.924[b]	.853	.836	.02779	.087	10.037	1	17	.006
3	.942[c]	.888	.867	.02502	.035	4.985	1	16	.040

a. Predictors: (Constant), Construction
b. Predictors: (Constant), Construction, Manufacturing
c. Predictors: (Constant), Construction, Manufacturing, TradeHotelsTransport

Table 17: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.069	1	.069	59.133	.000[a]
	Residual	.021	18	.001		
	Total	.090	19			
2	Regression	.076	2	.038	49.429	.000[b]
	Residual	.013	17	.001		
	Total	.090	19			
3	Regression	.079	3	.026	42.339	.000[c]
	Residual	.010	16	.001		

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	Total	.090	19			

a. Predictors: (Constant), Construction
b. Predictors: (Constant), Construction, Manufacturing
c. Predictors: (Constant), Construction, Manufacturing, TradeHotelsTransport
d. Dependent Variable: GDP at Factor Cost

Table 18: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.269	.212		29.638	.000*
	Construction	.336	.044	.876	7.690	.000*
2	(Constant)	3.948	.753		5.246	.000*
	Construction	.263	.042	.686	6.211	.000*
	Manufacturing	.367	.116	.350	3.168	.006*
3	(Constant)	2.221	1.028		2.160	.046*
	Construction	.270	.038	.704	7.053	.000*
	Manufacturing	.380	.104	.363	3.644	.002*
	TradeHotelsTransport	.265	.118	.189	2.233	.040*

a. Dependent Variable: GDP at Factor Cost
b. * Significant

From table 16 it is observed that by stepwise regression the data fits into 3 models with common independent variable as "Construction", while the 2nd model has another independent variable "Manufacturing" and the 3rd model along with Manufacturing has another independent variable "Trade Hotels Transport" which has influence on the dependent variable.

From the tables 17 and 18 it is observed that there is correlation between the independent variables Construction, Manufacturing, Trade Hotels Transport and the dependent variable, GDP at Factor cost. These variables are significant and influence the GDP more.

The excluded variables are Agriculture, Mining Quarrying, Electricity Gas Water Supply, and Finance Insurance Real Estate, which are insignificant and their influence on GDP has a very less impact, hence, are dropped from the analysis.

I.4) Comparison :

With Multiple Regression

Country	R^2	SE	F-Test
US	0.919	0.03054	Significant
Japan	0.923	0.02404	Significant
India	1.000	0.00430	Significant

With Stepwise Regression

Country	R^2	SE	F-Test
US	0.865	0.03164	Significant
Japan	0.888	0.02502	Significant
India	1.000	0.01028	Significant

V. CONCLUSIONS

From the analysis it is observed that, the three components, viz., Finance Insurance Real Estate, Manufacturing and Construction of the Indian GDP influences the GDP at constant prices. While in USA, the independent variable, Trade Hotels Transport influences the GDP. Similarly, in Japan, the three, the independent variables, viz., Construction, Manufacturing, Trade Hotels Transport influences the GDP. Also it is observed that there is a substantial amount of variation in GDP of Japan and USA while in India the variation is not much as compared to the other two countries.

From this study we can claim that over the years India fares well in GDP as compared to the well established countries like US and Japan. Hence, the economy of India is very sound and consistent. Also there is no comparison of these 3 countries independent variables influence.

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