Analyzing Global Competitiveness Index: Using Binary Logistics Regression

*** M.M. Shankar**

Abstract

In the global competitive era, it is not easy to say the driving factors which make nations to be globally competitive in comparisons with their counterpart, The World Economic Forum, constructed The Global Competitiveness Index, which identifying the key elements of sustainable growth. Since 2001, the forum has been using the Growth Competitiveness Index (Growth CI) developed by Jeffrey Sachs and John McArthur to assess the competitiveness of nations in order to assess the Nation's level of Competitiveness on global platform. The factors are driving the competitiveness is 1. Basic Requirements 2. Efficiency Enhancers and 3. Innovation and Sophistication factors. The objective of this research work, to analysis the factors that are determining the GCI Score between developing and developed nations. In order to prove statistically, the research-developed model based on Binary Logistical Regression tools, which has got feature of outcome variable, has dichotomous scale. The article contributes how to use of Binary Logistical Regression where situations demanding. In addition, comparison made between regression and binary logistic regression. The article dealt what is the position of India in the Global Competitive World. However, this research work has got some limitations in arbitrary fixing the certain variables as categorical variables for model building purposes.

Introduction

To measure the concept or construct the researcher used to develop Index or Scale there are Index which is used widely such as Human Development Index, Global Competitiveness Index etc. In similar, there are developed scales such as SERVQUAL to measure the Service Quality of Service Organizations and CETSCALE for measuring consumer Ethnocentrism. As a researcher, we have to understand the difference between Index and Scale. The former is a composite measure that summarizes and ranks orders several specific observations and represents a general dimension the latter is a composite measure composed of several items that have a logical or empirical structure among them. For Index, Scores assigned to individual attributes and cumulated For Scale, Scores assigned to patterns of responses (assumption: some items reflect a relatively weak degree of the variable, others stronger).

* Faculty, Dept of MBA, Dayananda Sagar College of Management Studies & IT Kumarasamy Layout, Bangalore - 78.

About Global Competitiveness Index

Since 2001, the World Economic Forum has been using the Growth Competitiveness Index (Growth CI) developed by Jeffrey Sachs and John McArthur to assess the competitiveness of nations. Though it was cutting edge at the time it was developed but it has own limitations. Prof. Xavier Sala-i-Martin, a leading expert on growth and economic development, has developed a new comprehensive model for the world Economic Forum, that is, Global Competitiveness Report 2004-05.

Apart from Global Competitiveness Index, there are some other Index is available such as Business Competitiveness Index (BCI) developed by Michael E.Porter, Christian Ketels and Mercedes Delgado which is more focused on Microeconomic Foundations of the nations. Back to GCI, it is a holistic overview of factors that are critical to driving productivity and competitiveness and groups them into nine parameters under three main sub indexes: Given in Appendix 1. GCI took 125 countries from various regions like Asia, Africa, Europe and US etc., the countries are classified according to the economy stage of development into 5. For instance, given in Appendix 2.

Objective of the study

This study has objective of illustrating binary logistics regression with help of GCI data set which around 125 nation's data and its showed difference between Regression and Binary logistic Regression. The data is based on both hard and soft data such as economic indicators and perception of managers against different nations respectively. Apart from this, the study highlights the India's position in GCI rankings against China and Pakistan which are all predominant countries in the region in terms of political and economical.(see appendix table 3) and see Appendix table 4 for the data set of GCI which showed the variables such as GCI Score, Basic requirements, Efficiency enhancers and Innovative factors

Difference between Simple Regression and Binary Logistic Regression:

To form a simple or multiple regression equation from the GCI data set. The study assumed variables such as Global Index Score is dependent variable and other variable such as Basic requirements, Efficiency enhancers and Innovative factors as a independent variables.

$$Y = b_0 + b_1x_1+b_2x_2+b_3x_3 \quad \text{Equation} - 1$$

In equation 1, Y and x1, x2 and x3 are continuous variable. To run regression analysis it is mandatory to have Y as a continuous variable. This is basics rule to follow simple regression. In the case of Binary Logistic Regression, the researcher followed same equation 1 but the nature of data or scale may be different. Here, Y should be categorical variable especially not more than two outcome such as Yes or No. In this study, researcher made five stages of economic conditions as per GDP

converted into two one as a Developed economy and other as Developing economy based on stage 1 through 3 and stage 4 to 5 respectively. As part of the analysis, the purpose of regression is estimating the GCI Score based on other independent variables. In the case of Binary Logistic Regression estimating the Dichotomous variable as a outcome variable as Developing economy or Developed economy based on given set of independent variable of the nation. Developing economy coded as 0 and Developed economy coded as 1. see Appendix table 5 (for difference between simple regression and Binary Logistic regression)

Result of Binary Logistic Regression

Table 1

Table 1 showed, the internal value (coded value) for the given dependent variable

Dependent Variable Encoding

Original Value	Internal Value
developing economy	0
developed economy	1

Table 1.1 Classification Table onlv Constant included not Predictors

Classification Table a,b

Observed		Predicted		
		economy		
		developing economy	developed economy	Percentage Correct
Step 0 economy	developing economy	85	0	100.0
	developed economy	39	0	.0
Overall Percentage				68.5

a. Constant is included in the model.
b. The cut value is .500

Table 1.2 Classification Table after Including Predictors

Classification Table

Observed		Predicted		
		economy		
		developing economy	developed economy	% Correct
economy	developing economy	80	5	94.1
	developed economy	4	35	89.7
Overall Percentage				92.7

a. The cut value is .500

We can compare both classification only constant and included predictor with constant showed better. The former was 68.5% and latter model was correctly classified 92.7% after inclusion of predictor variables

Table 2

Omnibus Tests of Model Coefficients

		Chi-square	Df	Sig.
Step 1	Step	115.207	3	.000
	Block	115.207	3	.000
	Model	115.207	3	.000

Table 2 showed the omnibus test to know the fit of the model. The value of the model chi square (table – 3) statistic works on this principle and is, therefore, equal to –2LL with variables included minus the value of –2LL when only the constant was in the model (154.42-115.20= 39.22). Apart from this, the value is significant at a .05 level and so we can say that overall the model is predicting display rule understanding significantly better than it was with only the constant included.

Table 3

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	39.215	.605	.850

From the table 3, The Log-likelihood is based on summing the probabilities associated with the predicted and actual outcomes It is similar to the residual sum of squares in multiple regressions. In simple terms, it is an indicator of how much unexplained information there is after the model has been fitter. It is understood, that larger values of log likelihood, poorly fitting statistical models.

At this stage of the analysis the value of –2*log-likelihood should be less than the value when only the constant was included in the model, because lower values of –2LL indicate that the model is predicting the outcome variable more accurately. When only the constant was included, -2LL = 154.42, but now Variables such as Basic requirements, Efficiency enhancers and Innovative factors included this value has been reduced to 39.215. This reduction tells us that the model is better at predicting display rule understanding than it was variables were added. The value of the model chi square (table – 5) statistic works on this principle and is, therefore, equal to –2LL with variables included minus the value of –2LL when only the constant was in the model (154.42-115.20= 39.22). Similarly like R Square in simple regression, there is Cox and Snell and Nagarkelke which show the better value for binary logistic regression.

Table 4

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	.983	8	.998

From the table 4, Hosmer and Lemeshow Test is to understand how far the data fit to the model. Greater the P value the data is good fit for the model. P value is .998 it is highly fit for the model.

Table 5
Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp (B)	95.0% C.I.for EXP(B)	
							Lower	Upper
Basic Requirement	3.093	1.562	3.922	1	.048	22.0	1.033	470.9
Efficiency Enhancers	4.651	2.066	5.069	1	.024	105	1.826	6005
Innovative Factors	-2.055	1.431	2.062	1	.151	.128	.008	2.116
Constant	-27.331	5.838	21.92	1	.000	.000		

This (table 5) variables in the Equation, is important because it tells us the estimates for the coefficients for the predictors included in the model. It showed coefficient and statistics for the variables that have b6een included in the model at this point (namely, Basic requirements, Efficiency enhancers and Innovative factors and constant). The b-value interpretation is the change in the logit of the outcome variable associated with a one-unit change in the predictor variable. The logit of the outcome is simply the natural logarithm of the odds of Y occurring (developing economy or developed economy). But except, Innovative Factors other two variables have got p value of significance value is less than .05, that alpha value, which is statistically significance.

Appendix table 1: Three Sub Index and Nine Pillars of GCI

Basic Requirements	Efficiency Enhancers	Innovation and Sophistication Factors
1.Institutions	5. Higher education and training	8.Business sophistication
2.Infrastructure	6. Market efficiency	9.Innovation
3.Macroeconomy	7. Technological readiness	
4. Health and Primary education		

Appendix table 2: List of few countries/economies out of 125 in each stage of development

Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
GDPp.c. < US$2000	**GDP p.c. US$ 2000-3000**	**GDP p.c. US$ 3000-9000**	**GDP p.c. US$ 9000-17000**	**GDP p.c. > US$17000-**
Angola	Albania	Algeria	Bahrain	Australia
Bangladesh	Bosnia	Brazil	Barbados	Belgium
China	Colombia	Chile	Czech Republic	Canada
Egypt	Ecuador	Jamaica	Estonia	Denmark
India	Thailand	South Africa	Taiwan, China	Singapore

Appendix 3: Comparison of India against China and Pakistan in GCI

Key Indicators	**INDIA**	**CHINA**	**PAKISTAN**
Total population (millions),2005	1,103.4	1,315.8	157.9
GDP (US$ billion),2005	775.4	2,224.8	118.5
GDP(PPP) as share of world total, 2005	5.95	15.41	.66
GDP (PPP) per capita (US $), 2005	3,344	7,204	2,628
Global Competitive Index (2006-07)	**Rank**	**Rank**	**Rank**
2006-07(out of 125)	43	54	91
2005-06(out of 117)	45	48	94
Business Competitiveness Index 2006-07	27	64	67
Institutions	34	80	79
Infrastructure	62	60	67
Macro economy	88	6	86
Health & primary education	93	55	108
Higher Education & Training	49	77	104
Market efficiency	21	56	54
Technological readiness	55	75	89
Business Sophistication	25	65	66
Innovation	26	46	60

*** Switzerland stands for 1st rank highly competitive and Angola stands 125th rank, least competitive**

Appendix table 4: Global Competitiveness Index 2006-07

Rank	Country	GCI Score	Stage of Development	Basic Requirement	Efficiency Enhancers	Innovative Factors
1	Switzerland	5.81	1	6.02	5.59	5.89
2	Finland	5.76	1	6.1	5.6	5.65
3	Sweden	5.74	1	5.95	5.65	5.66
4	Denmark	5.7	1	6.15	5.59	5.4
5	Singapore	5.63	1	6.13	5.63	5.11
6	United States	5.61	1	5.41	5.66	5.75
7	Japan	5.6	1	5.53	5.33	6.02
8	Germany	5.58	1	5.75	5.22	5.89
9	Netherlands	5.56	1	5.94	5.45	5.35
10	United Kingdom	5.54	1	5.67	5.59	5.36
11	HongKong SAR	5.46	1	6.04	5.4	4.97
12	Norway	5.42	1	5.96	5.38	4.95
13	Taiwan, China	5.41	1	5.5	5.36	5.38
14	Iceland	5.4	1	5.7	5.47	5
15	Israel	5.38	1	5.34	5.4	5.4
16	Canada	5.37	1	5.68	5.35	5.08
17	Austria	5.32	1	5.58	5.16	5.28
18	France	5.31	1	5.66	5.07	5.28
19	Australia	5.29	1	5.72	5.43	4.66
20	Belgium	5.27	1	5.59	5.07	5.21
21	Ireland	5.21	1	5.46	5.21	4.96
22	Luxemberg	5.16	1	5.73	5	4.81
23	Newzealand	5.15	1	5.65	5.15	4.65
24	Korea, Rep	5.13	1	5.47	5	4.96
25	Estonia	5.12	1	5.31	5.18	4.24
26	Malaysia	5.11	0	5.44	4.89	4.91
27	Chile	4.85	0	5.35	4.58	4.22

28	Spain	4.77	1	5.42	4.62	4.34
29	Czeh Republic	4.74	1	4.89	4.73	4.47
30	Tunisia	4.71	0	5.27	4.31	4.42
31	Barbados	4.7	1	5.24	4.6	3.78
32	United Arab Emirates	4.66	1	5.41	4.55	4.08
33	Slovenia	4.64	1	5.17	4.58	4.18
34	Portugal	4.6	1	5.22	4.47	4.14
35	Thailand	4.58	0	4.98	4.29	4.15
36	Latvia	4.57	0	4.9	4.48	3.74
37	Slovak Republic	4.55	0	4.7	4.56	3.96
38	Qatar	4.55	1	5.51	4.41	3.78
39	Malta	4.54	1	4.98	4.57	3.79
40	Lithuania	4.53	0	4.8	4.44	3.96
41	Hungary	4.52	1	4.64	4.57	4.08
42	Italy	4.46	1	4.7	4.41	4.29
43	India	4.44	0	4.51	4.32	4.6
44	Kuwait	4.41	1	5.24	4.2	3.85
45	South Africa	4.36	0	4.58	4.19	4.35
46	Cyprus	4.36	1	5.03	4.27	3.81
47	Greece	4.33	1	4.96	4.18	3.89
48	Poland	4.3	0	4.59	4.17	3.8
49	Bahrain	4.28	1	5.18	4.15	3.47
50	Indonesia	4.26	0	4.41	4.12	4.07
51	Croatia	4.26	0	4.6	1.07	3.81
52	Jordan	4.25	0	4.66	3.92	3.65
53	Costa Rica	4.25	0	4.48	1.08	4.16
54	China	4.24	0	4.8	3.66	3.75
55	Mauritius	4.2	0	4.7	3.86	3.84
56	Kazakhstan	4.19	0	4.64	3.97	3.51
57	Pananma	4.18	0	4.72	3.86	3.64

58	Mexico	4.18	0	4.61	3.91	3.8
59	Turkey	4.14	0	4.34	4.02	3.96
60	Jamaica	4.1	0	4.24	4.06	3.77
61	El Salvador	4.09	0	4.6	3.7	3.51
62	Russian Federation	4.08	0	4.43	3.91	3.55
63	Egypt	4.07	0	4.52	3.61	3.63
64	Azerbaijan	4.06	0	4.59	3.52	3.59
65	Colombia	4.04	0	4.34	3.82	3.82
66	Brazil	4.03	0	4.14	3.94	4.09
67	Trinidad and Tobago	4.03	1	4.49	3.82	3.63
68	Romania	4.02	0	4.19	3.99	3.52
69	Argentina	4.01	0	4.42	3.79	3.44
70	Morocco	4.01	0	4.44	3.58	3.54
71	Philippines	4	0	4.19	3.85	3.63
72	Bulgaria	3.96	0	4.5	3.67	3.26
73	Uruguay	3.96	0	4.51	3.63	3.41
74	Peru	3.94	0	4.28	3.7	3.61
75	Guatemala	3.91	0	4.32	3.46	3.63
76	Algeria	3.9	0	4.88	3.24	3.22
77	Vietnam	3.89	0	4.37	3.45	3.32
78	Ukraine	3.89	0	4.15	3.68	3.47
79	Sri Lanka	3.87	0	4.22	3.51	3.61
80	Macedonia, FYR	3.86	0	4.37	3.47	3.24
81	Botswana	3.79	0	4.27	3.52	3.15
82	Armenia	3.75	0	4.21	3.33	3.17
83	Dominican Republic	3.75	0	4.09	3.58	3.22
84	Namibia	3.74	0	4.4	3.28	3.25
85	Georgia	3.73	0	4.2	3.36	2.86
86	Moldova	3.71	0	4.09	3.38	3.09

87	Serbia and Montenegro	3.69	0	3.87	3.63	3.27
88	Venezuela	3.69	0	4.19	3.4	3.14
89	Bosnia and Herzegovina	3.67	0	4.24	3.22	3.08
91	Pakistan	3.66	0	3.96	3.27	3.66
92	Mongolia	3.6	0	3.91	3.37	2.92
93	Honduras	3.58	0	4.07	3.1	3.07
94	Kenya	3.57	0	3.62	3.47	3.73
95	Nicaragua	3.52	0	3.93	3.15	2.94
96	Tajikistan	3.5	0	3.94	3.07	3.02
97	Bolivia	3.46	0	3.89	3.13	2.64
98	Albania	3.46	0	3.98	3.12	2.57
99	Bangladesh	3.46	0	3.92	3.01	3.01
100	Suriname	3.45	0	4.06	3.01	2.86
101	Nigeria	3.45	0	3.53	3.31	3.6
102	Gambia	3.43	0	3.82	3.09	2.89
103	Cambodia	3.39	0	3.83	2.94	3.05
104	Tanzania	3.39	0	3.54	3.16	3.49
105	Benin	3.37	0	3.68	3.02	3.23
106	Paraguay	3.33	0	3.81	2.89	2.68
107	Kyrgyz Republic	3.31	0	3.56	3.08	2.93
108	Cameroon	3.3	0	3.66	2.9	3.05
109	Madagascar	3.27	0	3.56	2.92	3.23
110	Nepal	3.26	0	3.65	2.87	2.9
111	Guyana	3.24	0	3.58	2.89	2.95
112	Lesotho	3.22	0	3.68	2.8	2.59
113	Uganda	3.19	0	3.22	3.12	3.3
114	Mauritania	3.17	0	3.4	2.94	2.98
115	Zambia	3.16	0	3.43	3.01	2.43
116	Burkina Faso	3.07	0	3.13	2.95	3.27
117	Malawi	3.07	0	3.26	2.87	2.93
118	Mali	3.02	0	3.14	2.83	3.17

119	Zimbabwe	3.01	0	2.96	3.02	3.18
120	Ethiopia	2.99	0	3.29	2.68	2.72
121	Mozambique	2.94	0	3.21	2.62	2.86
122	Timor - Leste	2.9	0	3.27	2.57	2.36
123	Chade	2.61	0	2.84	2.35	2.53
124	Burundi	2.59	0	2.68	2.46	2.66
125	Angola	2.5	0	2.48	2.51	2.52

Appendix table 5 :
Basic Difference between Simple Regression and Binary Logistic Regression

Feature	**Simple Regression**	**Binary Logistic Regression**
Nature of Dependent Variable	Continuous or Ratio or Interval Scale	Categorical Data (only two outcome) or Dichotomous variable
Basic Equation	$Y = b_0 + b_1x_1+\varepsilon_i$	Probability of Y occurring P (Y)= $1/1 + e^{-(b0 + b1x1+\varepsilon i)}$
Relationship between variables is linear.	The relationship between variables	Regression equation in Logarithmic terms
Indicator of Influencing relationship in Model	R Square, more the value good the model	Log-Likelihood, larger values, indicates unexplained relationship.
Individual contribution of Predictors	Regression coefficient and their standard errors to compute t-statistic	Wald statistics, Most useful is exp b (Exp(B) change in odds resulting from a unit change in predictor.

Reference

- World Economic Forum, (2006), "The Global Competitiveness Index 2006-07", Hampshire Palgrave Macmillan, page no. 3-17.
- Andy Field, (2005), "Logistic Regression", Discovering Statistics Using SPSS, Sage Publication, 2nd edition, page no.219-240