



# CHOW TEST FOR STRUCTURAL BREAK: A CONSIDERATION OF GOVERNMENT TRANSITION IN NIGERIA FROM MILITARY TO CIVILIAN DEMOCRATIC GOVERNMENT

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**Abstract:** In 1999 there was a transition of regime in Nigerian Government from the Military Government to the Civilian Democratic Government. Substantial changes were observed in the health sector amongst others, causes a significant effect in Gross Domestic Product (GDP). Using the Chow test and applying it to six different regression models namely Logarithm model, Inverse model, Quadratic model, Cubic model, Power model and Exponential model along with the Pooled Regression model. The results provided evidence from the Logarithm model, Inverse model, Quadratic model, Cubic model, Power model and Exponential model that there was a structural break in the GDP due to the switch in Government. Though all the models including the pooled regression showed significant effect of the health expenditure on the GDP, the pooled regression could not identify any structural break. This analysis was done using Minitab 21 statistical software.

**Keywords:** Structural Break, Pooled Regression model, Chow Test, Equality of Two Regression models.

## 1. Introduction

The 1999 transition of Nigeria from military to civilian, democratic Government is a defining moment in Nigerian history, representing the beginning of the longest, uninterrupted government since independence in 1960. Medical progress, symbolizes the level of advancement of Nigerian health sector, it is also a core driver of public health expenditure in Nigeria. Odoh V. T. and Nduka E. K. (2014), compared the health care sector of Nigerian during the military and civilian regime and they stated “the most fascinating result of this study is that given by the regime of government, the military government spent less than civilian Government by about 75.59%. This shows that civilian regime is not only more people oriented, but also more responsive to the health care needs of the people”.

The chow test is a statistical and econometric tool which is used to test if the coefficients in the linear regression on

different data sets are equal (Chow, 1960). The chow test was invented by economist Gregory Chow in 1960. In econometrics, the chow test is commonly used in time series analysis to test for the presence of a structural break. In program evaluation, the chow test is often used to determine whether the independent variable have different subgroups of the population. The single model of a chow test is written as

$$Y_t = \alpha_0 + \alpha_1 X_t + \varepsilon \quad (1.2)$$

Splitting the data of interest into two groups we obtained the expression below

$$Y_t = \beta_1 + \beta_2 X_t + \varepsilon_{1t} \quad (1.3)$$

$$Y_t = \delta_1 + \delta_2 X_t + \varepsilon_{2t} \quad (1.4)$$

where,



$Y_t$  is a random variable known as the response variable,  $\alpha_0, \alpha_1, \beta_1, \beta_2$  and  $\delta_1, \delta_2$  are constants or parameters whose exact value are not known and thus must be estimated from the experimental data.  $X_t$  represents the predictor variable whose value are controlled or at least accurately observed by the experimenter.

Model (1.3) is applied before the break at time  $t$ , while model (1.4) is applied after the structural break. The null hypothesis  $H_0$  of the chow test asserts that  $\beta_1 = \delta_1$  and  $\beta_2 = \delta_2$ , and there is the assumption that the model errors  $\varepsilon$  are independent and identically distributed from a normal distribution with unknown variance (Chow, 1960). Some authors like Muthuramu P. and Maheswari T. U. (2019) reviewed the different forms of the presence of structural break(s), Guler Z. O. and Bakir M. A. (2019) studied the effects of different methods used to determine structural breaks and they observed that their performances were different of some structural features. Thursby (1992) performed an extensive simulation study, where he compared different test, exact as well as approximate, for small samples and under heteroscedasticity. Akio N. (2014), considered double bootstrap tests for structural break when disturbance variance changes with the break. Kozumi and Hasegawa (2000) considered Bayesian approach to structural changes. Attention has also been directed to more general types of structural shift problems, Chen, B. and Hong, Y. (2001) Tested for Smooth Structural Changes in Time Series Models Via Nonparametric Regression, Bia (2010) studied the problem of structural changes in panel data.

## 2. Structural Break

A structural break takes place when a time series abruptly changes at a point in time. This change could involve a change in mean or a change in the other parameters of the process that produced the series. Structural break tests, helps to determine when and whether there is a significant change in our data. It could also be an unexpected change over time in the parameters of regression models, which can lead to huge forecasting errors and unreliability of the model in general. Structural breaks can be identified through

1. The Chow Test.
2. The Quandt Likelihood Ratio Test.
3. The CUSUM Test.
4. The Hansen and Nyblom Tests.
5. Comparing parameter stability tests.

Instances where structural break might occur include; war situations, major changes in government policy, or some equally sudden event.

### 3. Chow test

The Chow test tells us if the regression coefficients are different for split data sets. Basically, it tests whether one regression line or two separate regression lines best fit a split data. If the regression coefficients are found to be different through Chow test it indicates the presence of structural break. A data is split sometimes when there is a break point or structural point (a period of significant or violent change), causing the data set to have a clear demarcation. Such as when donations are given to an organization before and after a natural disaster, Stock market prices before and after black Friday, house prices before and after a significant interest change, asset prices before and after civil war etc.

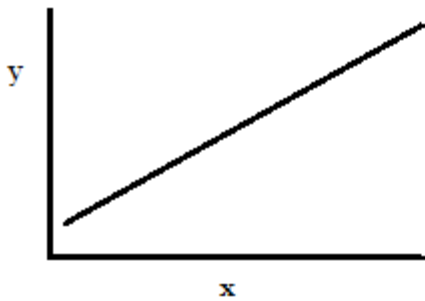


Figure 1



Figure 2

The dataset on the left has a single regression line. The data set on the right has a break point in the middle and causing two regression lines. If the two parts can be represented by one single regression line, we say that the regression can be “pooled.” Assuming the linear regression analysis of two parts of a data set shown in figure 2 resulted in the following two linear regression equations.

- First part of the data: 
$$Y_t = \alpha_1 + \beta_1 X_1 \quad (1.5)$$

- Second part of the data: 
$$Y_t = \alpha_2 + \beta_2 X_2 \quad (1.6)$$

The Chow test would tell you if the coefficients  $\beta_1 = \beta_2$  and  $\alpha_1 = \alpha_2$ . If they are equal, the data set can be represented with a single regression line. If they are not equal, it shows that there is indeed a break point and the data set cannot be represented with a single regression line. The types of regression models considered in this work include;

Linear regression; 
$$Y = \beta_0 + \beta_1 X \quad (1.7)$$

Logarithm equation; 
$$Y = \beta_0 + \beta_1 \ln X \quad (1.8)$$

Inverse regression; 
$$Y = \beta_0 + \beta_1 \frac{1}{X} \quad (1.9)$$

Quadratic regression; 
$$Y = \beta_0 + \beta_1 X + \beta_2 X^2 \quad (2.0)$$

Cubic regression; 
$$Y = \beta_0 + \beta_1 X + \beta_2 X^2 + \beta_3 X^3 \quad (2.1)$$

Power regression; 
$$Y = \beta_0 X^{\beta_1} \quad (2.2)$$

Exponential regression; 
$$Y = \beta_0 e^{X\beta_1} \quad (2.3)$$

Where Y is the Real Gross Domestic Product, x is the Health expenditure  $\beta_0, \beta_1, \beta_2$  and  $\beta_3$  are the regression coefficients.

### 3.1 Procedure for the Chow Test

The procedure for running the chow test is as follows:

1. Firstly, run the regression using all data, without any breaks. Extract the residual sum of squares for error ( $RSS_e$ ).
2. Run two separate regression on the data before and after the structural break, collecting the RSS in both cases, giving  $RSS_1$  and  $RSS_2$
3. Using the three values, calculate the test statistic using the following formula

$$F = \frac{RSS_e - (RSS_1 + RSS_2) / k}{(RSS_1 + RSS_2) / (n - 2k)} \sim F(k, n - 2k) \quad (2.6)$$

4. Find the critical values from the F-table with k, n-2k degrees of freedom, where k is the number of predictors.
5. Take decision and conclude appropriately. The null hypothesis states that there is no structural



break against the alternative hypothesis that states that there exist structural break.

**4. Model Specification**

The model for this study is assumed to have the form:

$$RGDP = \beta_0 + \beta_1 Heath + \varepsilon \tag{2.7}$$

where, the response variable represents the Real Gross Domestic Product (RGDP) that can stand as a proxy for economic growth while the independent variable is the Health expenditure in Nigeria from the year 1981 – 2014,  $\beta_0$  and  $\beta_1$  are the regression coefficients. The data for government regime in Nigeria was split into two, namely

the military regime from 1981 to 1998 and civil government model from 1999 to 2014.

Similarly, the chow test model is written as:

$$RGDP = \alpha_0 + \alpha_1 Heath_t + \varepsilon \tag{2.8}$$

where, the response variable is the Real Gross Domestic Product ( $RGDP_t$ ) while the independent variable is the health expenditure,  $\alpha_0$  and  $\alpha_1$  are the regression coefficients. The model is then fitted to the full data without split and to the split data sets for the military regime and the civilian regime.

**5. RESULTS**

**Table 1: Chow Test on Different Regression Models**

Model		N	K	Parameters (p-value)	R <sup>2</sup>	RMSE	Chow F values	Critical F value	Decision
<b>Linear</b>	Military Govt. Model	<b>18</b>	<b>2</b>	-80.0(0.600)	91.2%	3455717	<b>3.489</b>	<b>4.08</b>	<b>Not Sig. accept H<sub>0</sub></b>
		<b>21</b>	<b>2</b>	121.14(0.000**)	98.4%	578138872			
	Civil Govt. Model			-5238.0(0.024**)					
		<b>39</b>	<b>2</b>	157.91(0.000**)	<b>98.9%</b>	<b>697572842</b>			
	<b>Full Model</b>			<b>-1738.0(0.057)</b>					
				<b>151.77(0.000**)</b>					
Logarithm	<b>Military Govt. Model</b>	18	2	<b>-975.0(0.006**)</b>	<b>81.4%</b>	7334708	90.121	4.08	Sig. reject H <sub>0</sub>
		21	2	<b>1230.0(0.000**)</b>	<b>89.3%</b>	396628152			
	<b>Civil Govt. Model</b>			-		2			
		39	2	<b>229413.0(0.000**)</b>	62.9%	244368757			
	Full Model			)		52			
				<b>50210(0.000**)</b>					
				-					
				28572.0(0.002**)					
				151.98(0.000**)					
Inverse	<b>Military Govt. Model</b>	18	2	<b>2816.0(0.000**)</b>	<b>61.1%</b>	15297878	32.312	4.08	Sig. reject H <sub>0</sub>
		21	2	<b>-6082.0(0.000**)</b>	<b>52.4%</b>	177058059			
	<b>Civil Govt. Model</b>			-		92			
		39	2	<b>88858.0(0.000**)</b>	23.5%	504409211			
	Full Model			)		72			
				<b>6994705(0.000**)</b>					
				43987.0(0.000**)					



				-110334(0.002**)					
Quadratic	<b>Military Govt. Model</b>	18	3	<b>-8003.0(0.049**)</b> <b>176.5(0.000**)</b> <b>-0.0201(0.388)</b>	<b>98.5%</b>	3367171	114.789	4.08	Sig. reject H <sub>0</sub>
	<b>Civil Govt. Model</b>	21	3	<b>-149.0(0.441)</b> <b>158.9(0.000**)</b> <b>-0.492(0.539)</b>	<b>91.4%</b>	55405222			
	<b>Full Model</b>	39	3	-11156.0(0.261) 141.63(0.000**) 0.0134(0.250)	98.9%	672081054			
Cubic	<b>Military Govt. Model</b>	18	4	<b>635.0(0.020**)</b> <b>-191.2(0.047**)</b> <b>19.95(0.002**)</b> <b>-0.3106(0.002**)</b>	<b>95.9%</b>	1619110	55.302	4.08	Sig. reject H <sub>0</sub>
	<b>Civil Govt. Model</b>	21	4	- <b>18997.0(0.002**)</b> <b>296.9(0.000**)</b> <b>-0.339(0.011**)</b>	<b>98.9%</b>	384159333			
	<b>Full Model</b>	39	4	<b>0.00023(0.014**)</b> -1231.0(0.274) 144.6(0.000**) 0.0023(0.971) 9.0*10 <sup>6</sup> (0.858)	98.9%	671456908			
Power	<b>Military Govt. Model</b>	18	2	<b>4.410(0.000**)</b> <b>1.1002(0.000**)</b>	<b>96.6%</b>	0.9147	4.155	4.08	Sig. reject H <sub>0</sub>
	<b>Civil Govt. Model</b>	21	2	<b>3.468(0.000**)</b> <b>1.2431(0.000*)</b>	<b>96.7%</b>	0.7032			
	<b>Full Model</b>	39	2	4.4051(0.000**) 1.0833(0.000**)	99.1%	2.002			
Exponential	<b>Military Govt. Model</b>	18	2	<b>5.340(0.000**)</b> <b>0.0966(0.000**)</b>	<b>86.0%</b>	3.714	142.364	4.08	Sig. reject H <sub>0</sub>
	<b>Civil Govt. Model</b>	21	2	<b>9.198 (0.000**)</b> <b>0.00344(0.000**)</b>	<b>82.6%</b>	3.674			
	<b>Full Model</b>	39	2	7.095(0.000**) 0.0072(0.000**)	68.3%	67.49			

**Footnote:** \*\*= sig. at 0.05



## 6. Result Interpretation and Conclusion

The results show the best fit for all the models and checked for the significance of the health expenditure on RGDP for each model. The result is presented in the above table 3.1. The results also show that there is no significant difference in the chow test, when the linear model was the best fit which tells us that the coefficients are equal and it implies that, there is no structural break under the pooled Linear Model, while when the other models (Logarithm, Inverse, Quadratic, Cubic, Power and Exponential) were of best fit, the result shows significance of the Chow test, which implies that the regression coefficients are not equal confirming the existence of a structural break in these models.

In conclusion, the Chow test was able to ascertain and confirm that the Nigerian regime from 1981 to 2014 had a structural break between 1998 and 1999 when the civilian regime took over from the military regime. In other words that data is not suitable for a pooled linear regression model but can only fit two separate regression models.

## 7. References

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