

ECN 3972

Research Project

Global Warming: A Regression analysis

Introduction

Today we all are familiar with the term Global warming, which is a long term rise in the average temperature of the Earth's climate system, an aspect of climate change shown by temperature measurements, due to multiple factors like carbon emissions ,CFCs, deforestation and many more.

My research question is by how much degrees does the carbon emissions and agricultural growth contribute to the rise in global temperature? The new term I would like to add is the biofuel consumption which is a kind of fuel produced mainly from plants and animals, for example ethanol(made from corn and sugarcane),biodiesel(vegetable and liquid animal fats),green diesel(derived from algae) and biogas(methane derived from animals).

Biofuels are in theory carbon-neutral because the carbon dioxide that is absorbed by the plants is equal to the carbon dioxide that is released when the fuel is burned. My question is does biofuel consumption really helps to mitigate the effect of fossil fuel and reduce the global temperature as it has claimed?

Description of Data

Observations	50 from year(1965-2014)	Measurement	sources
Dependent variable	Global temperature	°Celsius	NASA's Goddard Institute of Space Studies(GISS)
Independent Variable 1	Total Carbon emissions from fossil fuels (gas,liquids,solids,cement production,gas flaring and per capita carbon emissions)	Million metric tons of carbon	Carbon Dioxide Information Analysis Center(CDIAC)-Oak Ridge National Laboratory

Independent Variable 2	Agricultural Growth	percentage	The World Bank, IBRD.IDA
Independent Variable 3	Biofuel Consumption	Terawatt Hours	Global & National Perspective & BP Statistical Review of World Energy, Ourworldindata.org

Descriptive statistics

Variable Name	Mean	Standard Deviation	Minimum	Maximum
Global Temperature	0.31	0.25	-0.11	0.73
Carbon Emission	6150.80	1802.51	3130.00	9855.00
Agricultural Growth	37.79	0.68	36.44	39.47
Biofuel Consumption	10884.14	1081.12	9162.46	12500.00

Model estimated

$$GW_i = \beta_0 + \beta_1 CE_i + \beta_2 AG_i + \beta_3 BC_i + \varepsilon_i$$

$$GW_i = -2.031 + 8.774CE_i + 2.436AG_i + 8.107BC_i$$

(1.159) (2.234) (2.143)
 7.571 1.090 3.783

$$\overline{R}^2 = 0.876$$

Where:

GW_i= the temperature in ith year (in degree Celsius)

CE_i= carbon emission in ith year(100,000 of million metric tons)

AG_i=agricultural land growth in ith year(in percent)

BC_i=biofuel consumption in the ith year (100,000 of terawatt hours)

Standard Errors are in parenthesis.

Hypotheses

Signs for the coefficients

The signs of the carbon emission and agricultural land use is positive. Burning of fossil fuels release carbon dioxide that has the ability to trap heat and thus increase the earth's temperature. Increasing use of land for agricultural release nitrous oxides and methane (from manure usage, livestock and poor soil management) that adds up to the greenhouse gases.

Theoretically the sign of biofuel consumption should be negative as the burning of biofuel does not add up to the carbon content in the atmosphere. I think there is uncertainty about the sign of the biofuel consumption because to produce plant and animal-based fuel one might need to clear trees, use fertilizers and chemicals for crops which further contributes towards the rising temperature of the Earth.

Results from regression

Variable	Coefficient (standard error)	
Constant	-2.031	(7.654)
Carbon emission (CE)	8.774	(1.159)
Agricultural Growth (AG)	2.436	(2.234)
Biofuel consumption(BC)	8.107	(2.143)
N	50	
Adjusted R ²	0.876	

Econometrics tests

Overall significance of the regression (F-test)

$$H_0 : \beta_1 = \beta_2 = \beta_3 = 0$$

$H_1 : H_0$ is not true.

Degrees of freedom for Numerator= 3

degrees of Freedom for Denominator=46

$$\alpha=0.05$$

Reject H_0 if F-statistics > F

F=2.84 with 3 and 46 at 5% level of significance

F-statistics=116.4

Since $|f\text{-statistics}| > F$, we reject the null hypothesis that all the slope coefficients are zero simultaneously and conclude that our model is significant at 5% level of significance.

The F-test concludes that our model is true.

Coefficient significance (t-tests)

Carbon emission

$$H_0 : \beta_1 \leq 0$$

$$H_1 : \beta_1 > 0$$

$$t_c = 2.021$$

Reject H_0 if $|t_{\beta_1}| > t_c$ and negative.

$$|t_{\beta_1}| = 7.571$$

Since $|t_{\beta_1}| > t_c$ and positive, we reject H_0 and conclude that carbon emission is statistically significant at 5% level of significance.

Agricultural growth

$$H_0 : \beta_2 \leq 0$$

$$H_1 : \beta_2 > 0$$

$$t_c = 2.021$$

Reject H_0 if $|t_{\beta_2}| > t_c$ and negative.

$$|t_{\beta_2}| = 1.090$$

Since $|t_{\beta_2}| < t_c$, we fail to reject H_0 and conclude that agricultural growth is not significantly different from zero.

Biofuel Consumption

$$H_0 : \beta_3 \leq 0$$

$$H_1 : \beta_3 > 0$$

$$t_c = 2.021$$

Reject H_0 if $|t_{\beta_3}| > t_c$ and negative.

$$|t_{\beta_3}| = 3.783$$

Since $|t_{\beta_3}| > t_c$, we reject H_0 and conclude that Biofuel consumption is statistically significant at 5% level of significance.

Multicollinearity

The correlation coefficient of carbon emission and agricultural growth is 0.2288014

,which shows a very weak positive correlation between them.

The correlation coefficient of carbon emission and biofuel consumption is 0.7780265, which indicates a strong positive correlation between them.

The correlation coefficient of agricultural growth and biofuel consumption is 0.4958031, which indicates a weak positive correlation between them.

Autocorrelation

$$H_0 : \rho \leq 0$$

$$H_1 : \rho > 0$$

$$dl = 1.38$$

$$du = 1.67$$

Reject H_0 if $DW < dl$

Inconclusive if $dl < DW < du$

$DW = 1.8529$ which is greater than $dl = 1.38$

$DW > dl$, we failed to reject the null hypothesis and conclude that there is a positive serial correlation.

Heteroskedasticity

$H_0 : \alpha_1 = \alpha_2 = \alpha_4 = \alpha_5 = \alpha_6 = 0$

$H_1 : H_0$ is false.

Degrees of freedom = 6

Reject H_0 if $N \cdot R^2 >$ chi-square value

$N \cdot R^2 = 50 \cdot 0.1512 = 7.56$

Chi-square critical value = 12.59

Since $N \cdot R^2 < 12.59$, we failed to reject H_0 of homoskedasticity and conclude that the model does not have heteroskedasticity.

Conclusion & future research

Our model predicts a rise in global temperature in a particular year (annual) by 0.00008744 degree Celsius due to a unit of million metric ton increase in carbon emissions level, holding agricultural growth and biofuel consumption constant. The global temperature rises by 0.02436-degree Celsius due to a unit percent rise in agricultural growth, holding all the other independent variables constant in our model. Similarly, a unit TWH of rise in consumption of biofuel, increase the global temperature by 0.00008107 degree Celsius.

The above conclusion indicates that there is not much difference between the effect of carbon emission and biofuel consumption on global temperature and our test also concludes that they are significantly different than zero.

Therefore, we should think about the consumption of biofuel also. In the beginning of the research we had an idea that the biofuels don't contribute to the global warming and maintain the level of carbon in our atmosphere, but the regression model indicates that it is somewhat equally responsible for the rise in global temperature as the carbon emissions from fossil fuels.

The agricultural growth on the other hand shows a rise of temperature much more than the other two variables but this variable turned out to be not significantly different than zero in the test. Its correlation with other explanatory variables is also weak as we have seen in the correlation coefficients above. It may not have any effect on global temperature but there isn't enough information on this analysis to prove that.

The adjusted R-squared is 0.876, it means that 87% of the variation in the dependent variable is explained by the independent variables of this model

and our model is a good fit. However, if we keep on adding independent variables in our model ,our model will lose its precision.

This model also has autocorrelation and to deal with that we can use Generalized Least square test or Newey-West Standard Errors method. With the White test we concluded that this model does not have Heteroskedasticity. The model has strong multicollinearity between carbon emission and biofuel consumption.

In future we can increase the size of the sample ,if possible, to reduce the impact of multicollinearity.

For future research we could think of per country contribution in global temperature by considering each country's carbon emissions level, renewable energy use and deforestation or urbanization level.