<u>Regression Results</u>

```
Coefficients:
                Estimate Std. Error t-value  Pr(>|t|)
lnErgpc        1.0645784  0.0225906 47.1248 < 2.2e-16 ***
Cleanerg_rate -0.0094362  0.0018225 -5.1777 4.503e-07 ***
Agland_rate    0.0074388  0.0016322  4.5575 7.972e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    9.6818
Residual Sum of Squares: 0.7564
R-Squared:      0.92187
Adj. R-Squared: 0.91045
F-statistic: 1022.64 on 3 and 260 DF, p-value: < 2.22e-16
```

<u>(F) Significance Test :</u>

H0:   All the coefficients equal to zero.

H1:   At least one of the coefficients is not zero.

Given an F value of [1022.64], and a p-value of [<2.22e-16], we can reject H0 at the [0.05] level of significance, indicating that there is statistically significant evidence of a relationship between dependent and the independent variables.

<u>(T) Significance Test:</u>

H0: The coefficient of $X_{it} = 0$.

H1: The coefficient is not zero.

Given a t-value of [47.12] and a p-value of [<2.22e-16], we can reject H0 at the [0.05] level of significance, indicating that there is statistically significant evidence of a relationship between [ln(GHG)] and [ln(Ergpc)] holding the effects of other independent variables constant. The standard error of coefficients of ln(Ergpc) indicates the average error in estimating it is [0.023].

Given a t-value of [-5.177] and a p-value of [4.503e-07], we can reject H0 at the [0.05] level of significance, indicating that there is statistically significant evidence of a relationship between [ln(GHG)] and [Cleanerg_rate] holding the effects of other independent variables constant. The standard error of coefficients of Cleanerg_rate indicates the average error in estimating it is [0.0018].

Given a t-value of [4.557] and a p-value of [7.972e-06], we can reject H0 at the [0.05] level of significance, indicating that there is statistically significant evidence of a relationship between [ln(GHG)] and [Agland_rate] holding the effects of other independent variables constant. The standard error of coefficients of Agland_rate indicates the average error in estimating it is [0.0016].

(This is the final model, having already dealt with the issues of NMC and Autocorrelation. See the technical Appendix for details.)

【Final Regression Equation】

ln(Greenhouse Gases emission)=$\boldsymbol{\beta_i}$ + 1.06*ln(Energy use per capita) – 0.009*(Alternative and nuclear energy % of total energy use) + 0.0074*(Agricultural land % of land area)[1]

$\boldsymbol{\beta_i}$

```
> fixef(plm_2FX)
   AUS    BRA    CHN    DEU    FRA    IND    JPN    KOR    THA     UK    USA    VNM
3.6074 5.9772 7.6216 4.6262 4.2196 7.4450 5.2377 4.2565 4.5428 4.2132 5.8597 5.2504
```

The F-statistic for the overall model is significant, which means the model is valid, its independent variables do relate to the dependent variable. And each independent variables' individual t-test result shows that the variable relates to the dependent variable. So, the coefficients of each of our variables are valid. The model's R^2=0.9218 that means 92.18% of the variation in dependent variable can be explained by independent variables. And its adjR^2=0.9104 that means 91.04% of the variation in dependent variable can be explained by independent variables after adjusting for the number of independent variables. Therefore, the explanatory power of the model is very strong.

From the regression equation, we can know:

[1] lnGDPpc is not included in the final model, it was removed because of the multicollinearity problem. See Appendix Test and correction of multicollinearity section for detail

1. Holding other variables constant, a 1 % increase in Energy use per capita will have a 1.06% change in Greenhouse gases emission on average.
2. Holding other variables constant, a 1 unit increase in alternative and nuclear energy using rate will have a -0.9% change in Greenhouse gases emission on average.
3. Holding other variables constant, a 1 unit increase in proportion of agricultural land will have a 0.74% change in Greenhouse gases emission on average.

Conclusion

By using multiple regression model, I prove the initial hypothesis that the expansion of agricultural land will lead to an increase in greenhouse gas emissions for a country. And my regression model allows us to quantify the impact of agricultural land expansion on greenhouse gas emissions growth. Holding a country's current per capita energy consumption and clean energy use constant, for every one percent increase in agricultural land as a percentage of all land would increase 0.74% greenhouse gases emissions on average. This conclusion can help the government make better decisions on how to arrange the country's land use.

However, the proportion of agricultural land is only a rough proxy. I recommend that scholars continue to study the specific effects of different scenarios of agricultural land expansion on greenhouse gas production. For example, the expansion of agricultural land through deforestation, the expansion of agricultural land through reclamation of waste land, and the expansion of agricultural land through transforming urban land.