Title:

The Effects of NAFTA on U.S. and Mexico Agricultural Equipment Trade Relations

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1. Introduction:

This paper examines the impact of the North American Free Trade Agreement (NAFTA) on the trade relationship between the United States and Mexico in the agricultural equipment industry. Initially signed in 1994, NAFTA was intended to create a free trade area between the United States, Mexico, and Canada, eliminate trade barriers, and promote economic development. This paper focuses on the impact of NAFTA on the agricultural equipment industry in the United States and Mexico, as well as the impact on agricultural productivity in Mexico.

The main questions of this paper are: How has NAFTA affected agricultural equipment trade between the United States and Mexico, and how has this trade affected agricultural productivity in Mexico? As developing and developed countries, Mexico and the United States are affected in different areas. This study assesses the broader impact of NAFTA on the agricultural sector by analyzing trade data to examine changes in trade volumes and agricultural productivity.

2. Theory:

The economic theory of trade liberalization provides the basis for this analysis. Trade liberalization reduces the impact of trade barriers and tariffs on trade between countries, thereby promoting an increase in trade between the two countries. The North American Free Trade Agreement (NAFTA) promotes free trade between the United States and Mexico. Another key point of trade liberalization is **comparative advantage**, which means that a country benefits from producing goods in which it has a comparative advantage and trading these goods for goods in which other countries have a comparative advantage. Under NAFTA, the United States has a well-established industrial base and a skilled workforce, and has a comparative advantage in the production of advanced agricultural equipment. Mexico has a comparative advantage in the production of raw materials. On the other hand, Mexico's agricultural sector needs to be modernized to improve productivity. Through NAFTA, Mexico can import agricultural equipment from the United States to improve agricultural efficiency. This theory shows that NAFTA will promote the exchange of agricultural equipment between the United States and Mexico, benefiting both countries through internal technology transfer, such as the transfer of advanced agricultural technology from the United States to Mexico to improve productivity in both countries.

In the agricultural equipment industry, I believe that reducing tariffs and barriers will help Mexico obtain advanced agricultural equipment from the United States at a more affordable price, thereby increasing productivity and promoting economic development. This theory also suggests that such trade is beneficial to both countries because Mexico can increase agricultural production after obtaining advanced agricultural equipment, while the United States can increase exports and benefit from Mexico's lower production costs.

In this framework, we expect Mexico to import more agricultural equipment from the United States and agricultural productivity to increase, as evidenced by indicators such as crop yields. Research on these trends confirms that the North American Free Trade Agreement has supported economic development through technology transfer.

Existing trade agreements and economic development literature support this theoretical approach. Research suggests that free trade agreements, especially those between developed and developing countries, often leads to technology transfer, which can increase productivity in sectors where developing countries lack technological capabilities. NAFTA literature suggests that Mexico's manufacturing and industrial sectors have also benefited from the spread of U.S. technology. For example, Sandra notes in “NAFTA's Mexico: Employment, Productivity, and Incomes Ten Years Later,” that “Mexico's productivity has increased over the past decade. NAFTA may have played an important role, as Mexico has sharply cut tariffs and faced competition from its larger neighbor.” Trade liberalization can promote sustainable development by integrating developing countries into the global market.

3. Data collection:

Data for this study will be drawn from multiple sources, including the United Nations Commodity Trade Statistics Database (UN Comtrade), which will provide trade data, including agricultural equipment import and export data between the United States and Mexico. This includes detailed records of trade volume and value by product type, allowing for a focused analysis of agricultural equipment. Data from the World Bank will provide control variables such as GDP growth and population. These variables are essential for analyzing the impact of NAFTA on trade and productivity. In addition, the National Institute of Statistics and Geography of Mexico (INEGI) will provide Mexican agricultural productivity data, including indicators such as crop yields.

The dataset covers more than 20 years of trade data between the two countries, starting with the signing of NAFTA in 1994 and ending with the available data in 2014. The data include tariff rates, the tariff data applicable to Mexican imports of agricultural equipment from the United States, with particular attention to the rates before and after the entry into force of NAFTA. Trade volumes, the value and quantity of imports of agricultural equipment. Agricultural productivity, the output per worker in the Mexican agricultural sector, as a proxy for productivity. Employment growth, employment data in the agricultural sector, used to measure changes in employment growth rates before and after the entry into force of NAFTA. The challenges we encountered included data gaps in the early 1990s. These data are well suited for studying the impact of NAFTA because they capture the effects of NAFTA on trade policy, equipment access, and changes in productivity indicators after 1994.

In addition, other variables include agricultural equipment imports and exports, trade volumes, and GDP growth, which help to understand the development of trade between the United States and Mexico and its impact on the economies of both countries, as well as the long-term impact of NAFTA on agricultural productivity in Mexico.

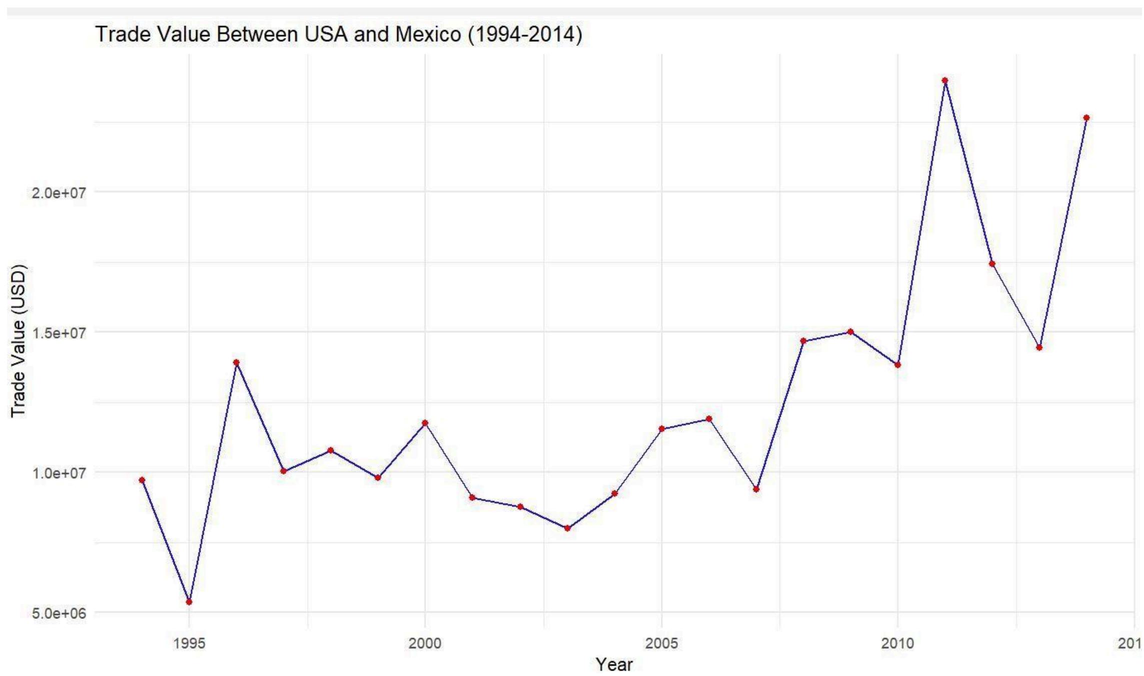
Summary of statistical tables in R Studio:

Variable	Observations	Mean	Std_Dev	Min	Max
USA GDP Growth (%)	21	2.8	1.37	-0.1	4.8
Mexico GDP Growth (%)	21	2.9	3.93	-6.2	7.1
Trade Value (Million USD)	21	12.73	4.92	5.36	23.98

4. Analysis:

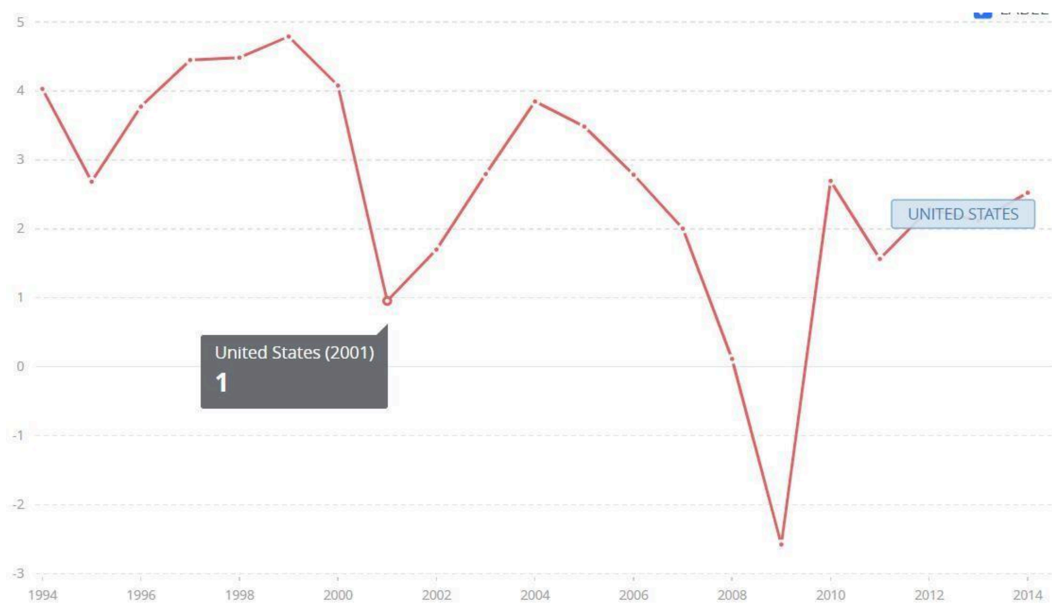
Reviewing data on trade in agricultural equipment between the United States and Mexico from 1994 to 2014, a preliminary review of the data shows that, after the signing of the North American Free Trade Agreement, trade generally trended upward, except during the 2008 economic crisis. In addition, Mexico's imports of agricultural equipment from the United States increased significantly, exceeding 15 million U.S. dollars. This is consistent with the theoretical expectation that trade would increase after the United States and Mexico signed the North American Free Trade Agreement, which lowered tariffs and trade barriers.

A preliminary descriptive analysis suggests that agricultural productivity in Mexico is trending upward, which is associated with increased imports of equipment. However, further analysis is needed to confirm causality. I also plotted the volume of trade between the United States and Mexico over time in R, and the results show a significant increase in trade after 1994.

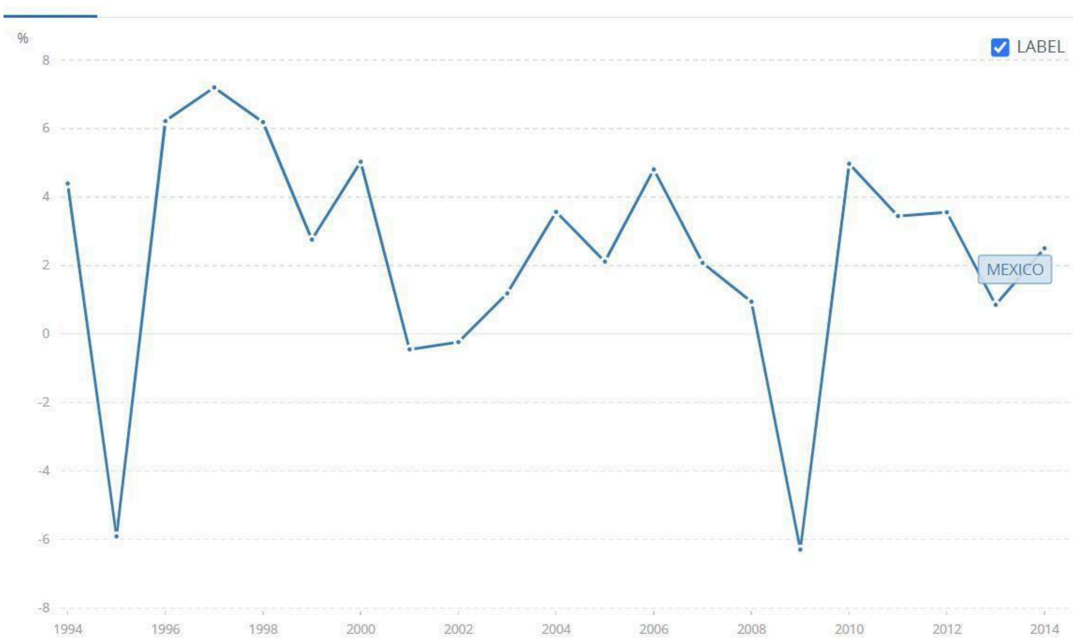


The plot of trade value for agriculture equipment between USA and Mexico

Also, we can see US GDP annual growth and Mexico GDP annual Growth



United States GDP annual growth rate



Mexico GDP annual growth rate

In addition, We use a regression model to test the impact of NAFTA on agricultural productivity in Mexico. The regression model examines the relationship between productivity and three independent variables: tariff rates, exposure and employment growth. The model is described in detail below:

$$\log(\text{Productivity})=\beta 0 + \beta 1 * \text{Tariff Rates} + \beta 2 * \text{Trade Exposure} + \beta 3 * \text{Job Growth} + \epsilon t$$

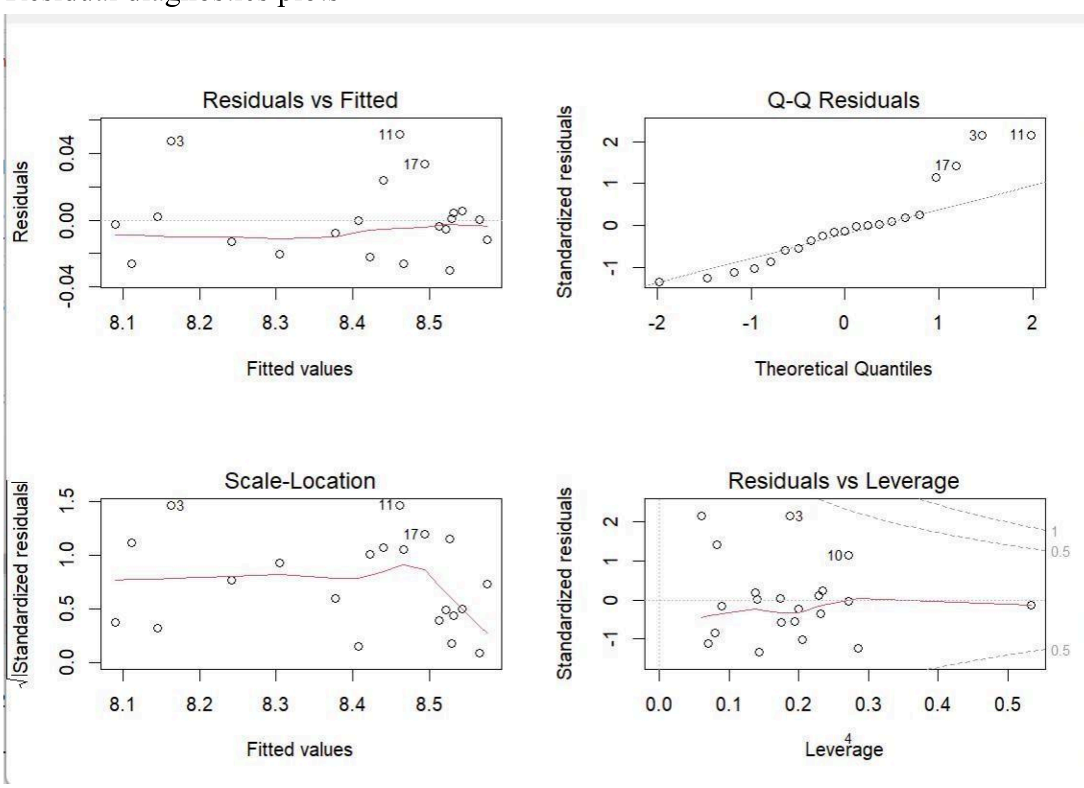
Where: β1: measures the impact of reduced tariff rates on productivity. β2: indicates the impact of trade openness on productivity. β3: reflects the relationship between employment growth and productivity.

The model assumes that changes in tariff rates under the North American Free Trade Agreement are exogenous, which allows us to explain the impact of NAFTA-related trade policies on productivity.The coefficient of the tariff rate (β1) is expected to be positive, indicating that after the tariff is reduced, productivity will increase due to the use of equipment.

5. Interpretation of results:

```
> summary(model)

Call:
lm(formula = log(Productivity) ~ Tariff_rate + Trade_exposure +
    job_Growth, data = productivity_data)

Residuals:


      Min        1Q    Median        3Q       Max
-0.030226 -0.013087 -0.002390  0.004306  0.051335

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)     9.603659   0.130655  73.504  < 2e-16 ***
Tariff_rate    -0.005096   0.001567  -3.253  0.00468 **

Trade_exposure -0.009658   0.002879  -3.355  0.00376 **
job_Growth     -0.051930   0.003195 -16.254 8.61e-12 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.02454 on 17 degrees of freedom
Multiple R-squared:  0.9804,    Adjusted R-squared:  0.9769
F-statistic: 283.1 on 3 and 17 DF,  p-value: 1.048e-14
```

Residual diagnostics plots



Intercept: 9.603659**,** which is the expected log of productivity when all other variables (tariff rate, trade risk and employment growth) are zero. It represents the baseline level of productivity, but may not be meaningful in itself. The intercept is significant ($p < 2e-16$) and is indicated by three asterisks .

Tariff rate: -0.005096. The negative coefficient indicates that, other things being equal, a one-unit increase in the tariff rate is associated with a 0.0051 decrease in productivity. This means that productivity tends to increase with a decrease in tariffs (i.e. due to NAFTA), which may be due to better access to foreign machinery and technology. The p-value of 0.00468 is lower than the critical value of 0.01, so the result is statistically significant. This indicates that changes in tariff rates have a significant impact on productivity.

Trade exposure: -0.009658. The negative coefficient for trade exposure indicates that an increase in trade exposure is associated with a decrease in productivity, all other variables being held constant. This result is counter-intuitive and may indicate that while trade openness generally brings competitive advantages, in some industries or adjustment periods, it may also have a negative impact on productivity. The p-value is 0.00376, indicating that the coefficient is statistically significant at the 0.01 level. This finding indicates a significant negative correlation between trade openness and productivity.

Employment growth: -0.051930, the coefficient indicates a strong negative correlation between employment growth and productivity. Holding other variables constant, for every unit increase in employment growth, the logarithm of productivity decreases by 0.0519. This result suggests that one way to improve productivity may be to slow employment growth by mechanizing or increasing efficiency to reduce the demand for labor. The p-value is extremely low (8.61e-12), indicating high statistical significance.This strongly supports the view that productivity gains may come at the cost of employment growth.

Multiple R-squared: 0.9804, **adjusted R-squared**: 0.9769, indicating that the model explains 97.7% of the variation in productivity. The high R-squared value indicates that the model fits well, for example, the independent variables (tariff tariff rate, trade risk, and employment growth) can effectively explain changes in productivity.

F-statistic: 283.1 (3 and 17 DF), p-value of 1.048e-14, it can confirm that the model as a whole is statistically significant.

A decrease in tariff rates is associated with an increase in productivity, which supports the theory that NAFTA tariff reductions have a positive impact on productivity by allowing access to foreign technology and equipment. Contrary to expectations, higher trade risk is associated with a decrease in productivity. This may indicate that increased competition or higher adjustment costs in the agricultural sector may have a negative impact on productivity. This result may require further research. Increases in productivity appear to be inversely related to employment growth, which may be due to mechanization in agriculture reducing labor demand. These results suggest that while NAFTA trade policies may have increased productivity through lower tariffs, they have also had a complex effect on employment growth and productivity dynamics due to trade exposure. The negative correlation with trade exposure highlights the potential challenges of competition and market adjustment under open trade policies.

Mexico's agricultural productivity increased significantly under NAFTA. This suggests that NAFTA helped increase trade and improve productivity. However, future research could benefit from analyzing other control variables or sector-specific productivity indicators to explore the influencing factors in specific contexts. It would also be helpful to explore the impact of NAFTA on other industries in the United States and Mexico.

6. Conclusion

This study examines the impact of the North American Free Trade Agreement (NAFTA) on trade and productivity in the agricultural sector in the United States and Mexico. The empirical evidence shows that NAFTA significantly increased trade in agricultural equipment and had a positive impact on agricultural productivity in Mexico. This study examines the impact of NAFTA on productivity and employment growth in the Mexican agricultural sector by analyzing the effects of tariff reductions, trade exposure, and employment growth. The results show that lower tariffs (a direct result of NAFTA) have a positive impact on productivity. This result is consistent with the theory that lower tariffs under trade agreements can increase productivity by facilitating access to advanced machinery and technology from abroad. However, the analysis also reveals an unexpected negative correlation between trade risk and productivity, suggesting that increased openness to international trade may have a negative impact on productivity in the short term due to competitive pressures or adjustment costs. In addition, the negative correlation between productivity and employment growth suggests that productivity gains in the agricultural sector may come at the expense of employment, as mechanization reduces the demand for labor. In addition, this is partly due to the fact that the scale of exports is still relatively small.

In the article “NAFTA, 20 Years Later: Do the Benefits Outweigh the Costs?”, Mauro states: “However, the problem in Mexico is that the export sector is not large enough to provide employment for the majority of the population...Inequality has emerged not because low-wage workers are paid even less, but because most workers are paid more.” This highlights the employment and inequality issues that NAFTA can bring about, and it is something that we need to study further in the future in terms of the impact of NAFTA on income inequality and the labor market in Mexico.

Overall, this study is very detailed and thorough. Although NAFTA has stimulated productivity growth by reducing tariffs, the increased risk of trade may have had a mixed impact. Productivity has increased, but employment growth has slowed, which may have further affected workers' wages or other aspects.

From the perspective of empirical research, the evidence presented in this paper is reliable, with statistically significant results and a high degree of model fit. This paper references many authoritative literature. However, there is room for improvement in future research. For example, causal inference on the impact of NAFTA on Mexico's agricultural sector can be strengthened by using a longer time frame or the control group difference method.

7. Reference:

1. Sandra Polaski, February 25, 2004, "Mexican Employment, Productivity and Income a Decade after NAFTA",https://carnegieendowment.org/posts/2004/02/mexican-employment-productivity-and-income-a-decade-after-nafta?lang=en

2.Mauro Guillén, February 19, 2014, "NAFTA, 20 Years Later: Do the Benefits Outweigh the Costs?", https://knowledge.wharton.upenn.edu/article/nafta-20-years-later-benefits-outweigh-costs/

3. United Nations Commodity Trade Statistics Database.

4. Mexican National Institute of Statistics and Geography (INEGI)

5.World Bank data

6. R Studio code.

The plot of trade value for agriculture equipment between the USA and Mexico from 1994 to 2014.

```r
# Existing data (1994-2005)
years <- c(1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005)
trade_values <- c(9715828, 5362251, 13899561, 10039594, 10775869, 9799214, 11736903,
                  9071626, 8745863, 7989524, 9226320, 11531675)

# Additional data (2006-2014)
years_additional <- c(2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014)
trade_values_additional <- c(11887368, 9390935, 14678575, 15008301, 13814176, 23979575,
                             17419205, 14433616, 22648779)

# Combine both datasets
years_combined <- c(years, years_additional)
trade_values_combined <- c(trade_values, trade_values_additional)

# Create a data frame with the combined data
trade_data_combined <- data.frame(Year = years_combined, Trade_Value_USD = trade_values_combined)
```

Summary(model)

Residual diagnostics plots

```
productivity_data <- data.frame(

  Productivity = c(3253,3455,3678,3245,3960,3748,4317,4476,4447,4739,4976
                  ,4628,4964,5238,5251,5062,5053,4898,4999,5096,5156),
  Tariff_rate= c(12,12,15,15,14,16,18,18,15,18,10,9,8,6,6,5,8,8,7,7,3),
  Trade_exposure=c(16,21,23,23,25,25,26,23,23,25,27,27,28,28,29,28,30,32,33,32,33),
  job_Growth = c(25,23,22,23,19,20,17,17,17,16,16,16,15,14,14,15,15,14,14,14,14)
)

# Fit the linear model
model <- lm(log(Productivity) ~ Tariff_rate + Trade_exposure+ job_Growth, data = productivity_dat
summary(model)
```

```
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```

```
# Diagnostic plots for the linear model
par(mfrow = c(2, 2))  # Arrange plots in a 2x2 grid
plot(model)
```