



# Multiple Linear Regression Analysis of Carbon Emissions and Economic-Related Factors in Thailand

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## Abstract

This study examines factors affecting CO<sub>2</sub> emissions in Thailand and develops a forecasting model. Using multiple linear regression analysis of secondary data from EPPO (2015-2023), 15 independent variables across 4 categories were analyzed: Demographics: population, foreign tourists, unemployed persons; Energy: power generation by fuel type, crude oil production; Economy/Agriculture: economic indicators, animal quota, agricultural import/export values, construction area; Transportation: domestic flights, air cargo weight, vehicle sales (commercial, passenger, motorcycle). Analysis at 0.05 significance level identified six factors significantly affect CO<sub>2</sub> emissions: Power generation by type of fuel, Production of crude oil, Export value of agricultural products, Domestic aircraft moment, Passenger car sales, and Motorcycle sales.

## Introduction

The world is increasingly aware of the impacts of climate change, driven by the rise in greenhouse gases (GHGs) such as methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), and carbon dioxide (CO<sub>2</sub>). These gases trap heat in the atmosphere, leading to global warming. Human activities, particularly economic growth, energy consumption, transportation, and industrial processes, are major contributors to the increase in CO<sub>2</sub> emissions. This has widespread effects on the environment, ecosystems, and human health. Regarding CO<sub>2</sub> emissions in Thailand, reports indicate that Thailand's CO<sub>2</sub> emissions have been increasing at an average rate of 2-3% annually, with a continuous upward trend over the past 10 years. The factors affecting CO<sub>2</sub> emissions can be divided into 4 areas: energy consumption, waste management, industrial processes, and agriculture.

## Objectives

- To analyze factors affecting CO<sub>2</sub> emissions in Thailand
- To develop a forecasting model for CO<sub>2</sub> emissions

## Results

Forecasting model	$\hat{\beta}$	Std. error	t-value	p-value
(Constant)	5969.000	1181.500	5.052	0.000
Power generation by type of fuel	0.536	0.060	8.867	0.000
Export value of agricultural products	0.013	0.007	1.905	0.060
Domestic aircraft moment	0.046	0.011	4.328	0.000
Production of crude oil	0.013	0.004	3.228	0.000
Passenger car sales	0.019	0.009	2.253	0.030
Motorcycle sales	0.006	0.003	2.200	0.030

## Methodology



### Data Collection and Preparation

data was collected on demographics, economy, energy, and environment from January 2015 to December 2023, comprising 15 independent variables, followed by data cleaning for analysis.



### Regression analysis and Forecasting

- Analyze linear relationships with dependent variables
- Check for correlations between independent variables
- Select independent variables using the stepwise regression technique
- Verify the appropriateness of the obtained model

$$y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_kx_k + \varepsilon$$

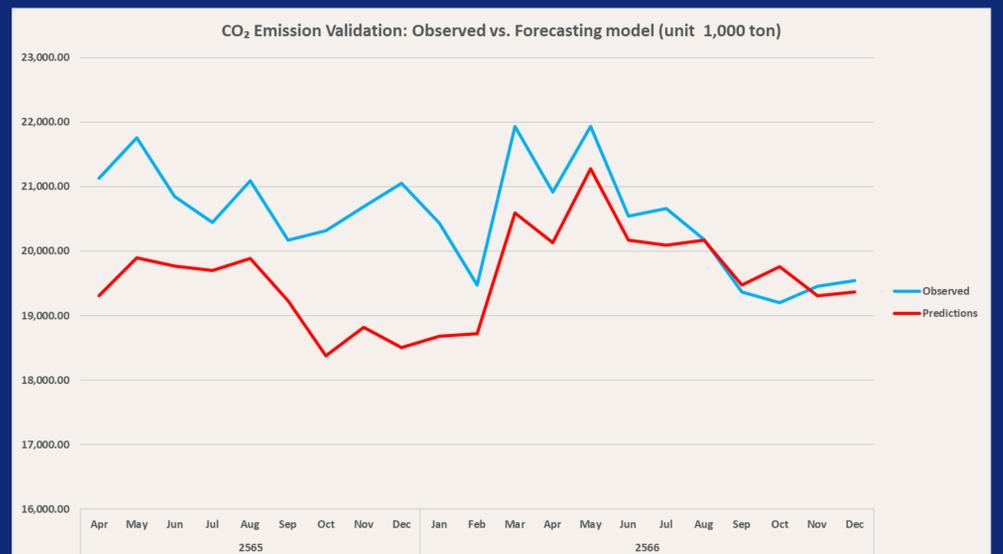
where:

- y is dependent variable
- x<sub>1</sub>, x<sub>2</sub>, ..., x<sub>j</sub> is independent variable where j = 1, 2, ..., k
- β<sub>0</sub> is Intercept (the value of y when all independent variables are zero)
- β<sub>1</sub>, β<sub>2</sub>, ..., β<sub>k</sub> is regression coefficients represents the change in y for a one-unit increase in x<sub>k</sub>
- ε is error term where ε ~ N(0, σ<sup>2</sup>)



### Model Adequacy and Model Accuracy

After obtaining a model that verified, the forecasting model's accuracy and its ability to predict future outcomes will be evaluated using the following criteria: Adjusted R<sup>2</sup>, RMSE, MAE, and MAPE.



Model Adequacy		Model Accuracy		
R-squared	Adjusted R-squared	RMSE	MAE	MAPE
0.763	0.745	1,232.20	1,010.55	4.86

## Reference

- Salam, MD. A. & Noguchi, T. (2010). Impact of human activities on carbon dioxide (CO<sub>2</sub>) emissions: A statistical analysis. Environmental Monitoring and Assessment, 144(1-3), 111548.
- Mostafa, K. A., & Seyedaliakbar, S. M. (2019). Impact of energy consumption and economic growth on CO<sub>2</sub> emission using multivariate regression. Energy Strategy Reviews, 29, 12.

## Conclusion and discussion

Six key factors significantly impacted emissions: power generation by fuel type, domestic flights, agricultural exports, crude oil production, passenger car sales, and motorcycle sales, all showing moderate positive correlations with CO<sub>2</sub> levels. This means that when these variables increase in value, they result in an increase in CO<sub>2</sub> emissions as well. The Adjusted R-squared value shows that the model has significantly high explanatory power. When considering model accuracy, the RMSE and MAE values are not too high, indicating that the model has good accuracy in predicting CO<sub>2</sub> emissions to a certain degree. The MAPE value is less than 5%, demonstrating that this model is reliable and can be used for forecasting efficiently. These research findings are consistent with previous studies which found that energy and transportation factors have a significant relationship with CO<sub>2</sub> emission levels.