TIME SERIES ANALYSIS FOR FORECASTING CARBON DIOXIDE (CO₂) EMISSIONS IN THAILAND

Varunee Pusengaek, Asst. Prof. Dr.Kuntalee Chaisee and Asst. Prof. Dr.Watha Minsan

Department of Statistics, Faculty of Science, Chiang Mai University, Chiang Mai, 50200, Thailand

*E-mail address: Varunee_p@cmu.ac.th

FACULTY OF SCIENCE
CHIANG MAI UNIVERSITY

ABSTRACT

This study focuses on forecasting carbon dioxide (CO_2) emissions time series in Thailand across three sectors: the electricity generation sector, the transportation sector, and the industrial sector. The study uses publicly available data from the Office of Energy Policy and Planning, covering the period from January 1987 to December 2022, covering 444 months. The data is divided into two sets: a training dataset from January 1987 to December 2022, containing 432 months, and a test dataset from January 2023 to December 2023, containing 12 months. Two statistical forecasting methods are applied: the decomposition methods and Holt-Winters exponential smoothing method. The models are evaluated by comparing the Mean Square Error (MSE), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE) to determine the most accurate forecasting model for each sector. The findings of the study reveal that smoothing with Holt-Winters exponential smoothing method.is the most suitable model for forecasting the electricity generation sector and the industrial sector. Additionally, the decomposition methods is identified as the most appropriate choice for forecasting the transportation sector.

INTRODUCTION

Climate change is a global challenge, and carbon dioxide (CO_2) emissions are a major contributing factor. In Thailand, monitoring and forecasting CO_2 emissions is crucial for sustainable development and environmental policy planning. This study employs time series analysis to predict future CO_2 emissions, helping policymakers implement effective strategies to mitigate climate change impacts.

OBJECTIVE

1. To study and compare two forecasting methods for predicting CO_2 emissions in the industrial, electricity generation, and transportation sectors in Thailand.

2. To identify the most suitable forecasting method that provides the most accurate predictions for CO_2 emissions from the three sectors in Thailand.
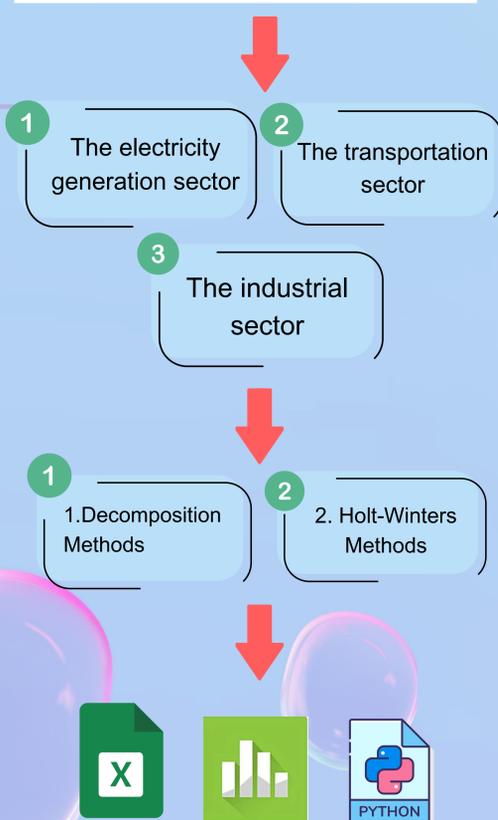
MATERIALS AND METHODS

Energy Policy and Planning Office
MINISTRY OF ENERGY

Monthly data from January 1987 to December 2023, totaling 444 observations.

The data for each sector is divided into two sets:
✅ Training Set: January 1987 – December 2022 (432 observations)
✅ Test Set: January – December 2023 (12 observations)

1. The electricity generation sector
2. The transportation sector
3. The industrial sector

1. Decomposition Methods
2. Holt-Winters Methods

Analyzed data by using 3 program

RESULT

1. Comparison of forcasted and Actual values
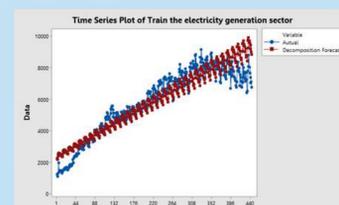
The electricity generation sector
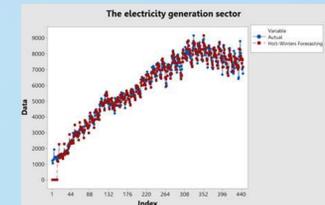

Fig.1 Decomposition Method

Fig.2 Holt-Winters Method
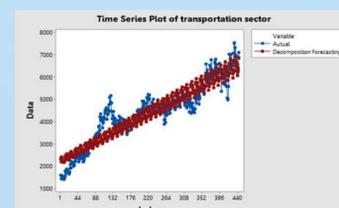
The transportation sector.
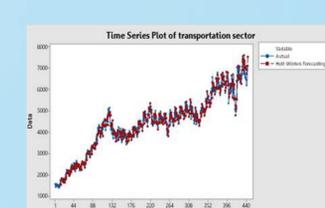

Fig.3 Decomposition Method

Fig.4 Holt-Winters Method
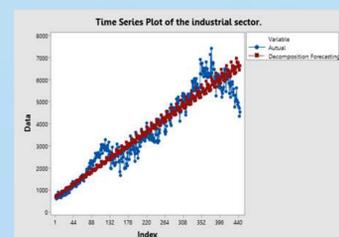
The industrial sector
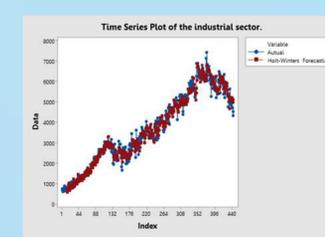

Fig.5 Decomposition Method

Fig.6 Holt-Winters Method

2. Forecasting Error Measurement

Table 1: Comparison of Forecasting Errors Between the Two Methods

Method	Electricity Sector			Transport Sector			Industry Sector		
	MAE	MSE	MAPE	MAE	MSE	MAPE	MAE	MSE	MAPE
Decomposition	1819.07	3453784.13	24.96	283.05	130791.96	4.04	1693.65	2954939.92	34.80
Holt-Winters	415.50	228712.57	5.75	380.89	161184.21	5.69	305.25	125152.24	6.33

CONCLUSION

This study presents a comparison and selection of forecasting methods suitable for predicting CO_2 emissions from the electricity generation, transportation, and industrial sectors in Thailand. the study found that the Holt-Winters model was the most appropriate for the electricity generation and industrial sectors, while the decomposition model was the most suitable for the transportation sector. The selection was based on the lowest error values, including MAE, MSE, and MAPE.

REFERENCES

- Hantayathorn, W., & Jomnonkhwao, S. (2024). Forecasting CO_2 emissions from Thailand's transportation sector: A comparison of AI models. Journal of Forecasting, 6(2), 462–484.
- Naphatchan, D. (2023). Forecasting CO_2 emissions from Thailand's industrial sector. Rajamangala Univ. of Tech. Srivijaya Res. J., 15(2), 408–422.
- Mingkwan, Y., & Yingchai, R. (2023). Comparing models for CO_2 emission forecasting in electricity generation. Lat Krabang Sci. J., 32(2), 122–126.