

Evaluation of different ARIMA models incorporating the impact of COVID-19 for the forecasting of the prescription rates of antibiotics in the UK between 2013 to 2023

INTRODUCTION

Accurate forecasting the usage of medicines of public health interest, such as antibiotics, may allow stakeholders and regulators to coordinate for ensuring the availability of those medicines meet the necessary amount to supply the population. However, the COVID-19 pandemic altered drastically the trends and behaviour of daily life which difficulties forecasting after it.

OBJECTIVE

To compare different ARIMA models for the forecasting of usage of antibiotics.

METHODS

- Study design: Retrospective analysis including all individuals in



- Exposure: monthly use of 6 antibiotics

- Outcome: incidence rates of antibiotic use

- Study period: Jul 2013 to May 2023

- Statistical methods: ARIMA and ARIMA with Exogenous Variable (ARIMAX) models. (Figure 1)

This study was run under the scenario that the available data ended in Nov 2022, and we forecasted the usage of antibiotics for the next 6-months. We have used the remaining data up to May 2023 to test the accuracy of the models pretending we received these subsequent data later.

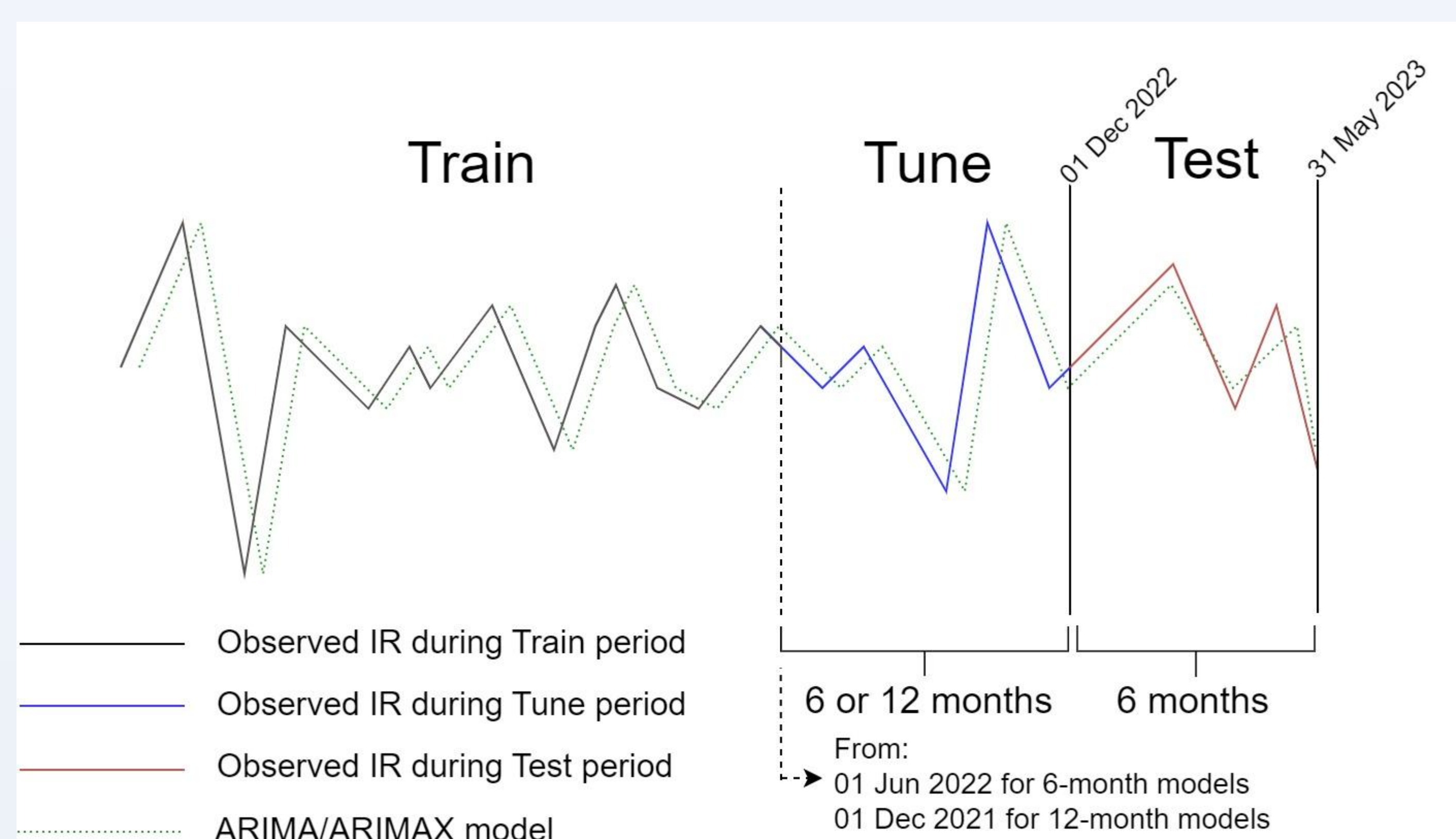


Figure 1. Graphical representation of the time periods where the ARIMA/ARIMAX models were trained, tuned and tested. ARIMAX includes a model term from Jan 2020 to Dec 2021 to account for the effect of the COVID-19 pandemic. Tune period: used to evaluate the model's predictive performance with accuracy metrics MAE (mean absolute error) and MAPE (mean absolute percentage error). Test period: used to evaluate the 6-month forecasted through the train and tune periods

RESULTS

After fitting the ARIMA models, the average ratio between the 6- and 12-month showed that using a tune period of 6-month were more accurate than using 12-month (average ratio was 0.66 for MAE and, 0.64 for MAPE). The test period metrics also favoured the 6-month models (average ratio was 0.96 for MAE and, 0.95 for MAPE).

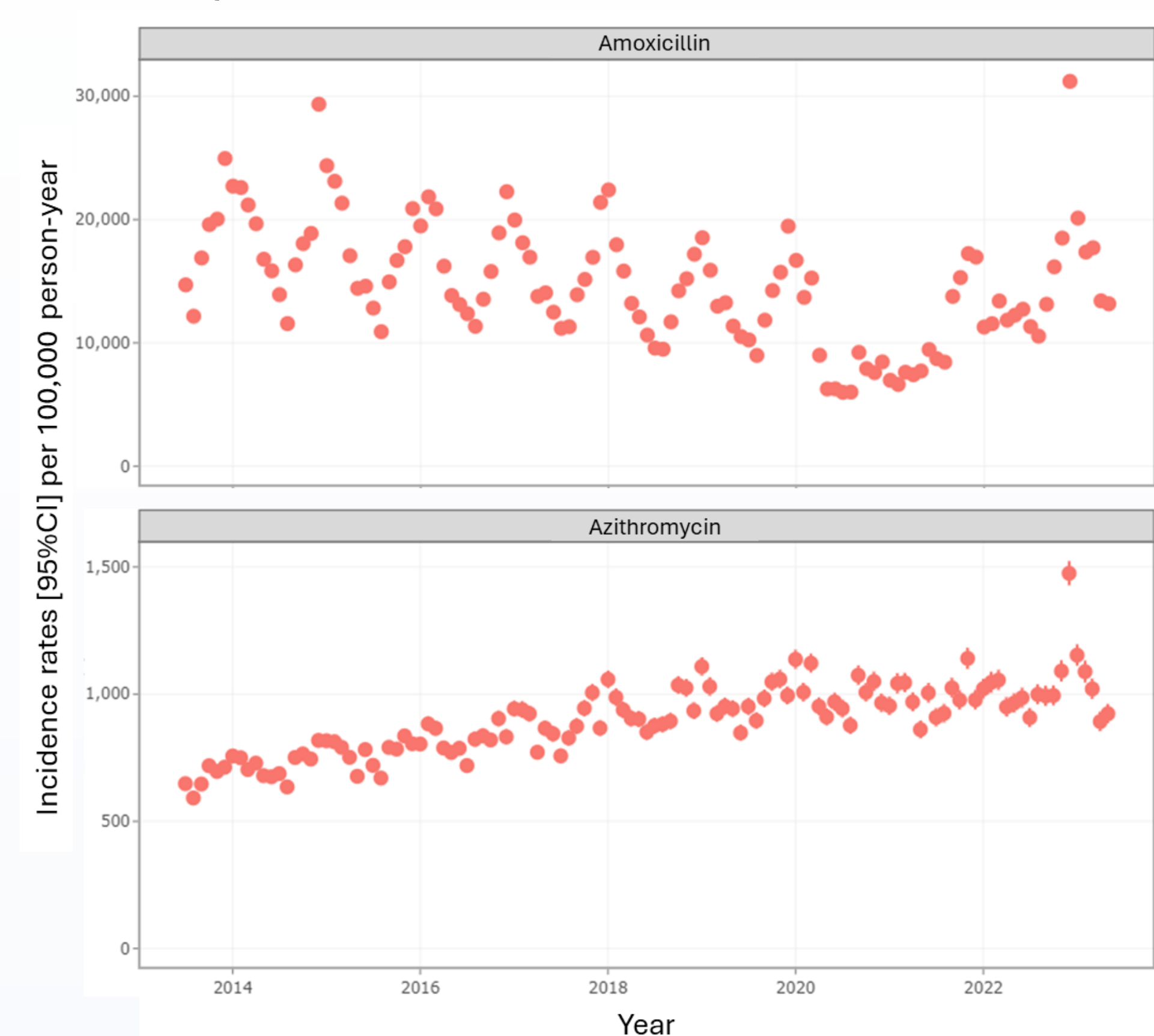


Figure 2. Incident use of amoxicillin and azithromycin in CPRD Gold between 2013 and 2023. We observed a seasonality pattern with peaks around Nov-March months in antibiotics with an indication for bacterial infections frequent in winter, such as the two presented in this figure.

Predicted IR using ARIMA and ARIMAX for azithromycin

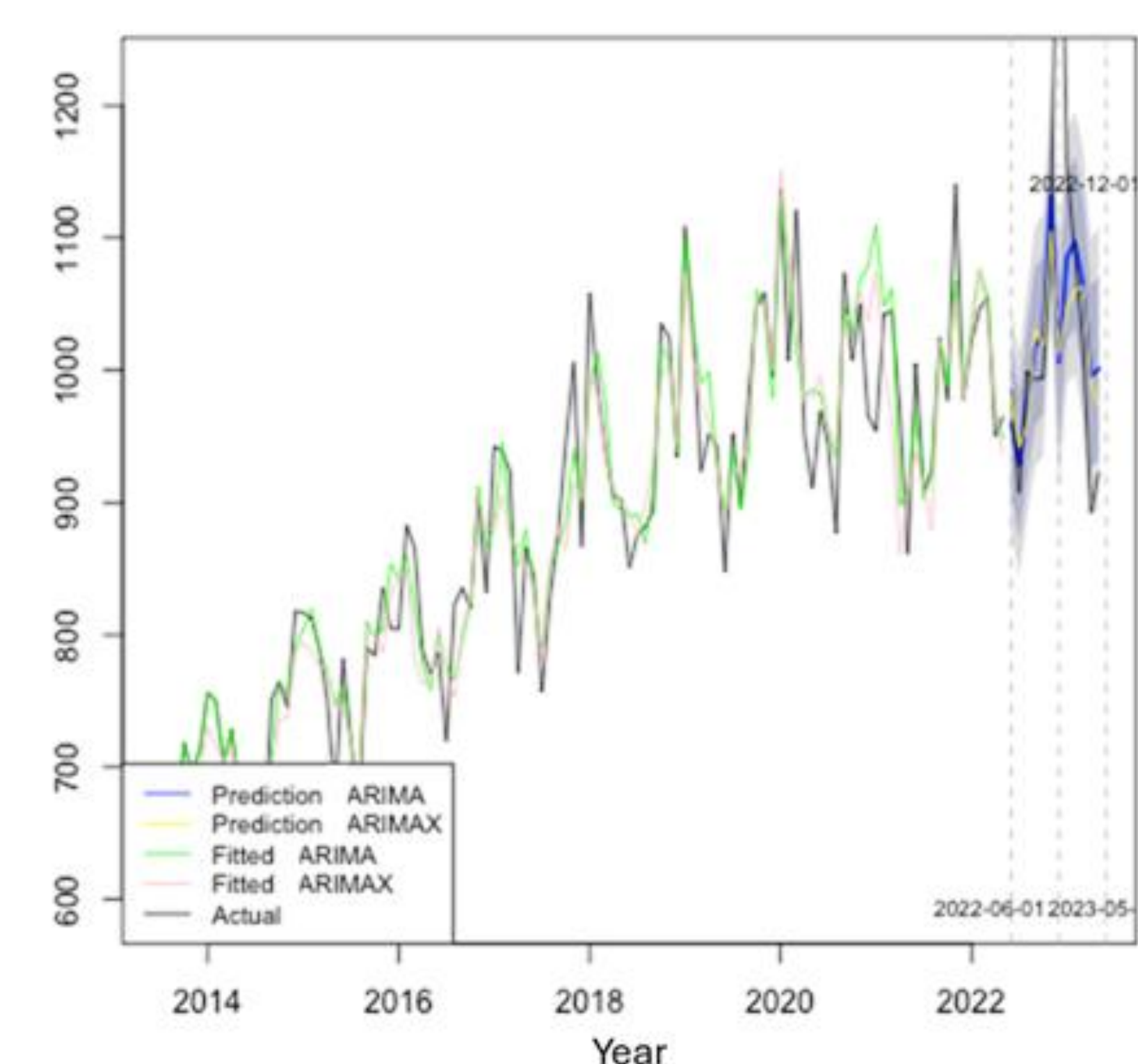


Figure 3. ARIMA and ARIMAX models for the use of azithromycin. When comparing ARIMA vs ARIMAX models, the tune period indicates that ARIMA may be more reliable (average ratio was 0.96 for MAE and, 0.95 for MAPE). However, when the test period was evaluated, the ratios favoured the ARIMAX (average of 1.08 for both, MAE and MAPE).

CONCLUSIONS

Use of 6-months for validating the forecast of ARIMA models produced more accurate predictions in the following 6 months than using 12-month validation. The addition of a term that modelled the effect of COVID-19 pandemic between Jan 2020 and Dec 2021 is recommended for time series analyses including this period.

DISCLOSURE

This study was funded by EMA and performed via DARWIN EU®. The study funder was involved in revising the study protocol and the objectives and reviewing the study report including the results. This communication represents the views of the DARWIN EU® Coordination Centre only and cannot be interpreted as reflecting those of the European Medicines Agency or the European Medicines Regulatory Network.