

What was the effect of the pandemic on various Danish timeseries? - An analysis using SAS

Focus is on usable results, but also the choice of model

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Data is downloaded from Statistics Denmark, [Statistikbanken](#)

English version:

<https://www.statistikbanken.dk/statbank5a/>

Monthly data up to summer 2021

The strategy is to analyze data up to December 2019, that is the period before the pandemic was an issue. Then we forecast observations the whole year 2020 and the first half of 2021 to see the effect of the pandemic.

As an example, we consider the numbers of nights stayed on hotels by Danes and by foreigners.

Data is monthly for January 2004 - July 2021.

First we apply seasonal exponential smoothing by Winthers method

The method considers series with a trend with monthly increment b_t which could be time varying. The seasonal component is multiplicative so X_t/S_t is the seasonally adjusted value of the series at time t .

$$\tilde{X}_t = \alpha \frac{X_t}{S_{t-12}(May)} + (1 - \alpha)(\tilde{X}_{t-1} + b_{t-1}),$$

$$b_t = \gamma(\tilde{X}_t - \tilde{X}_{t-1}) + (1 - \gamma)b_{t-1}$$

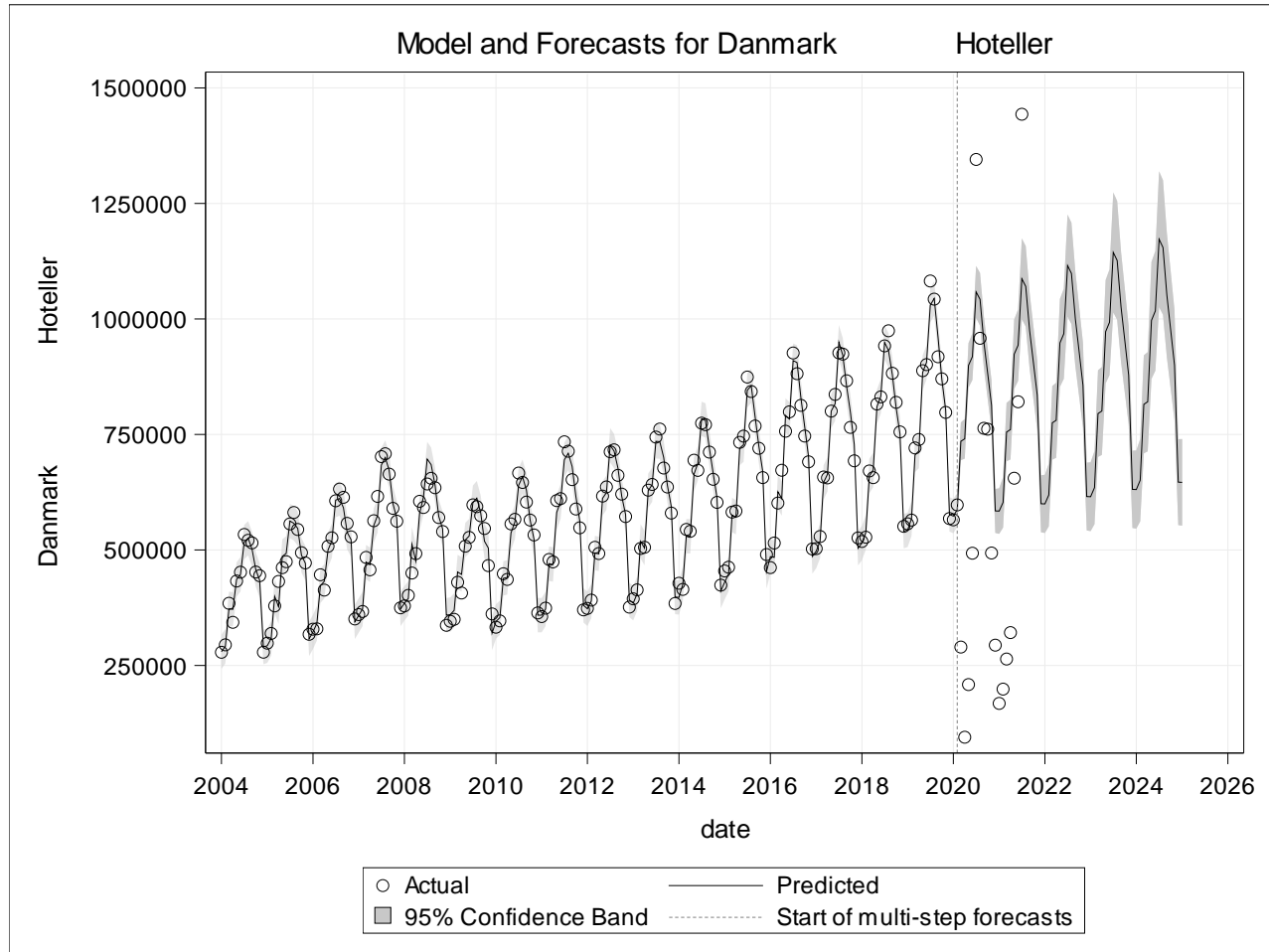
and

$$S_t(May) = \omega \frac{X_t}{\tilde{X}_t} + (1 - \omega)S_{t-12}(May).$$

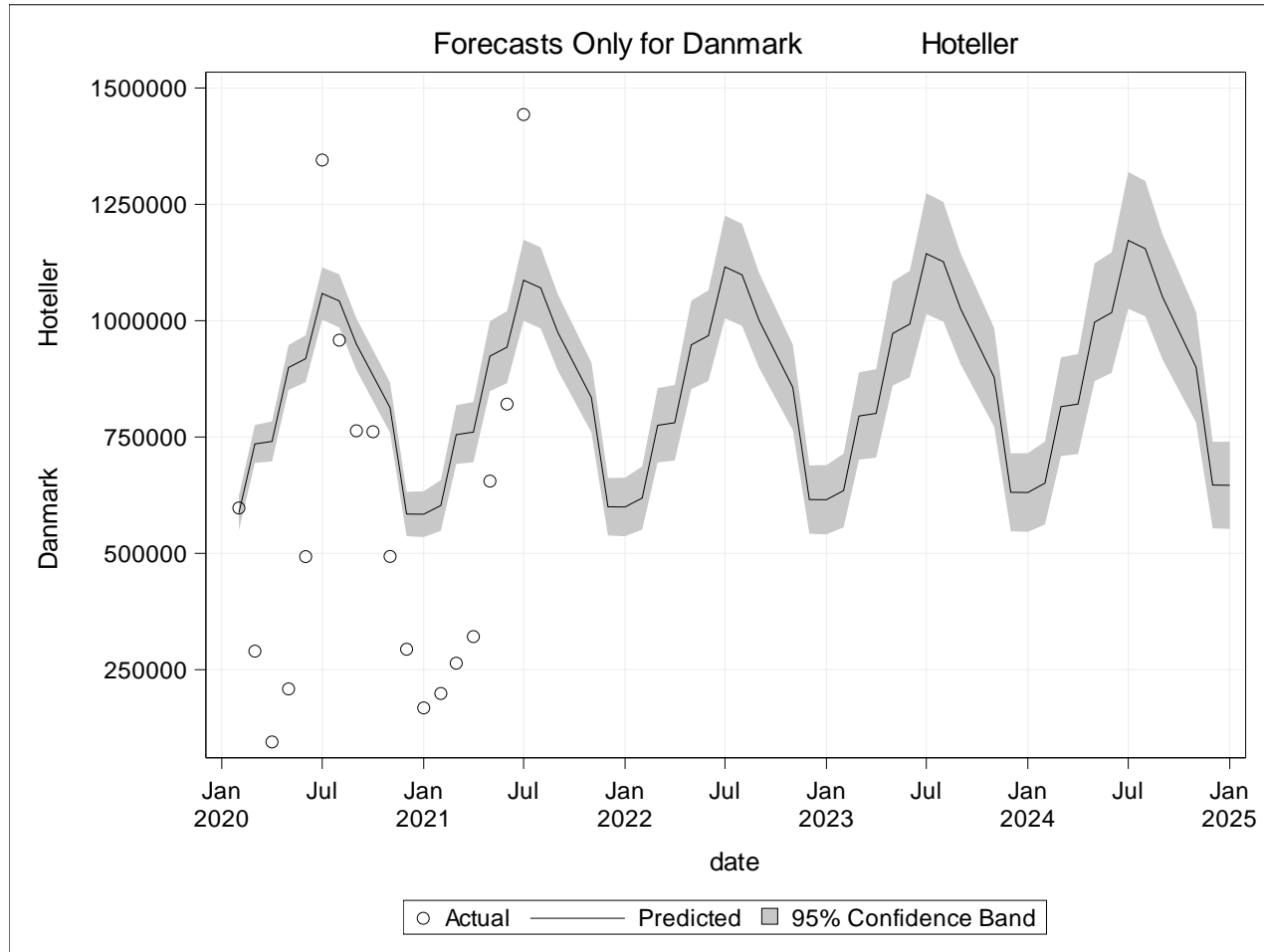
The code is very simple!

```
proc esm data=... back=18 lead=60 plot=all  
print=estimates;  
id date interval=month;  
forecast numeric /method=winters;  
run;
```

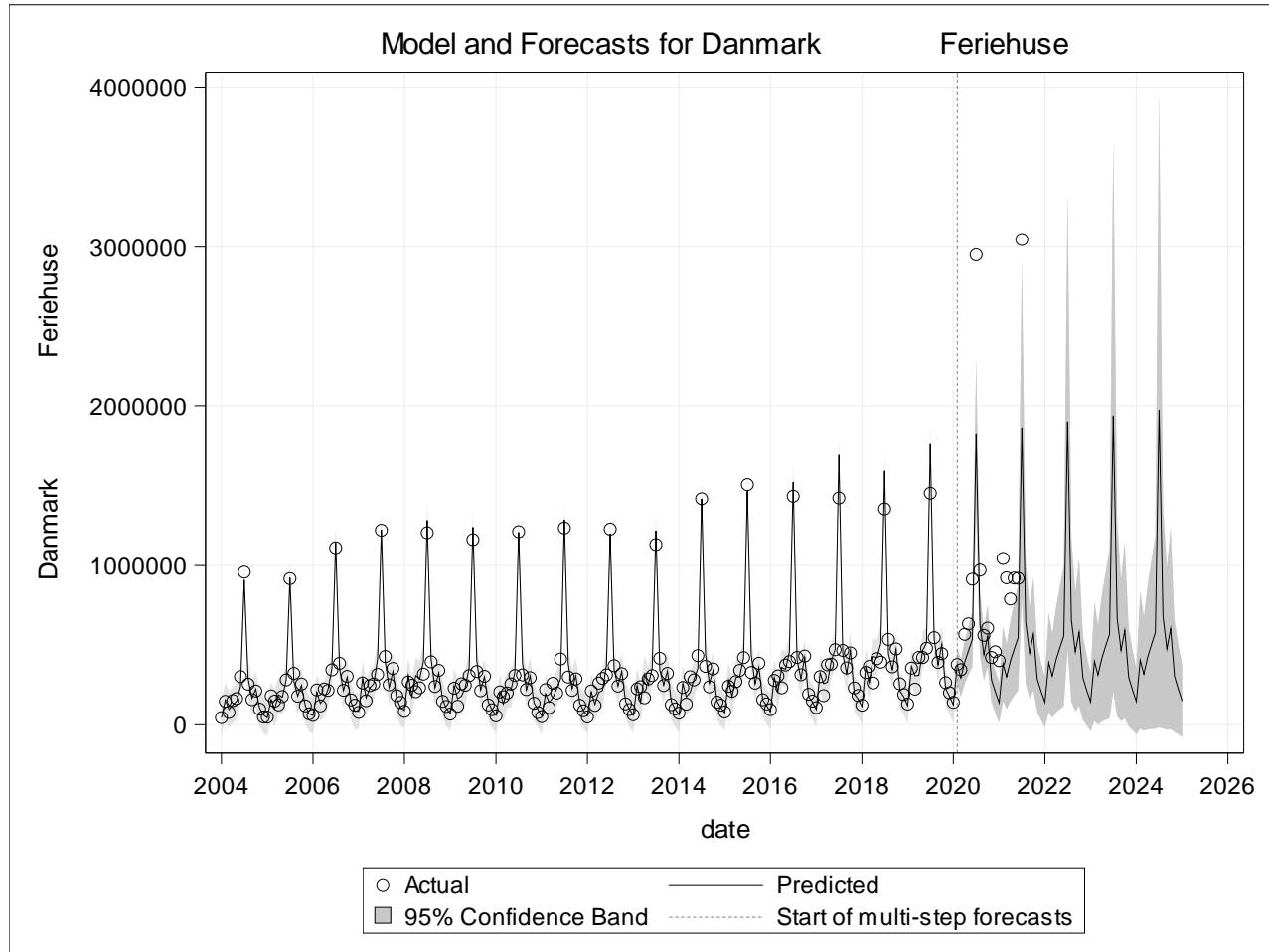
Hotels Danes



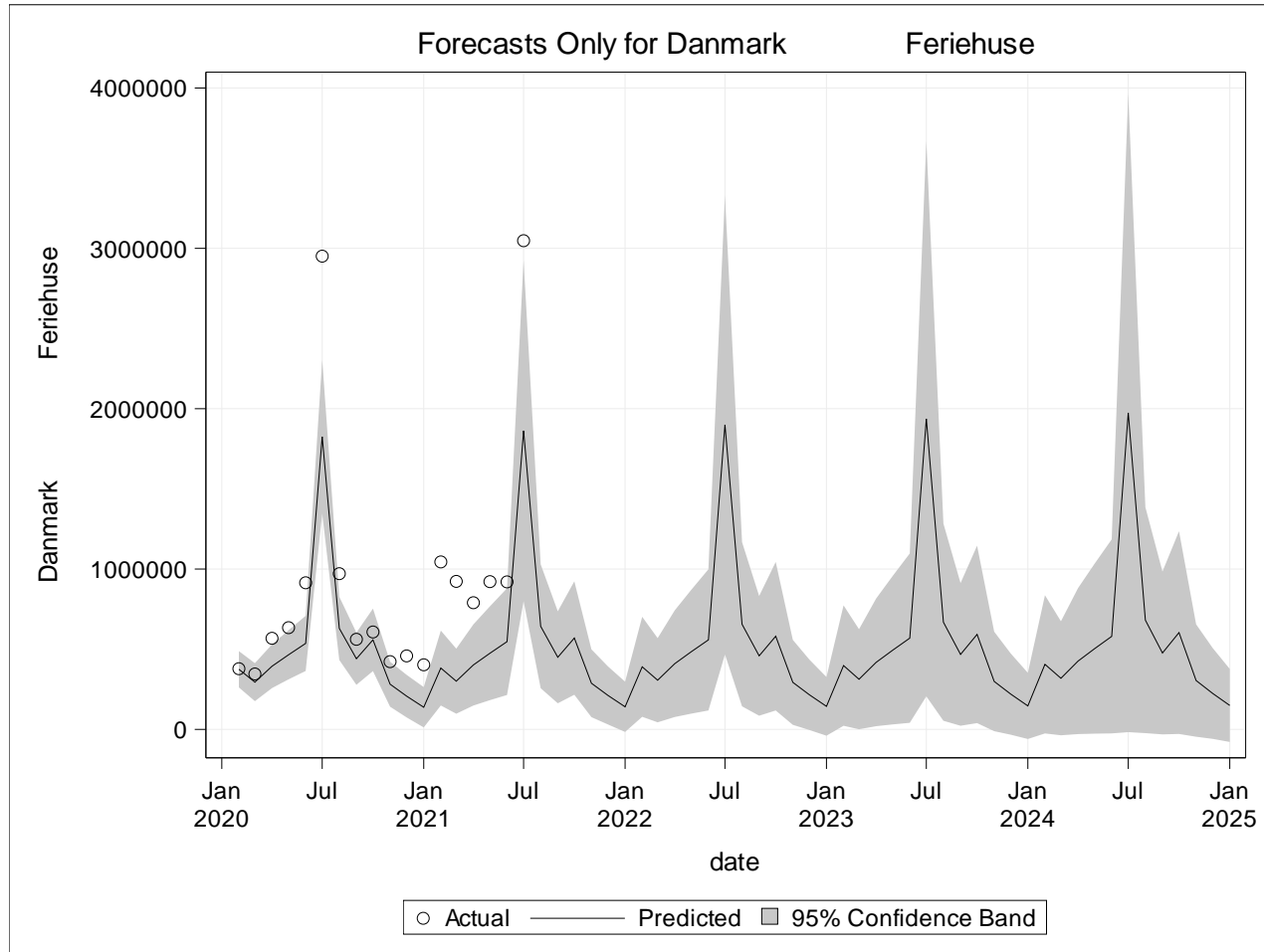
Hotels Danes



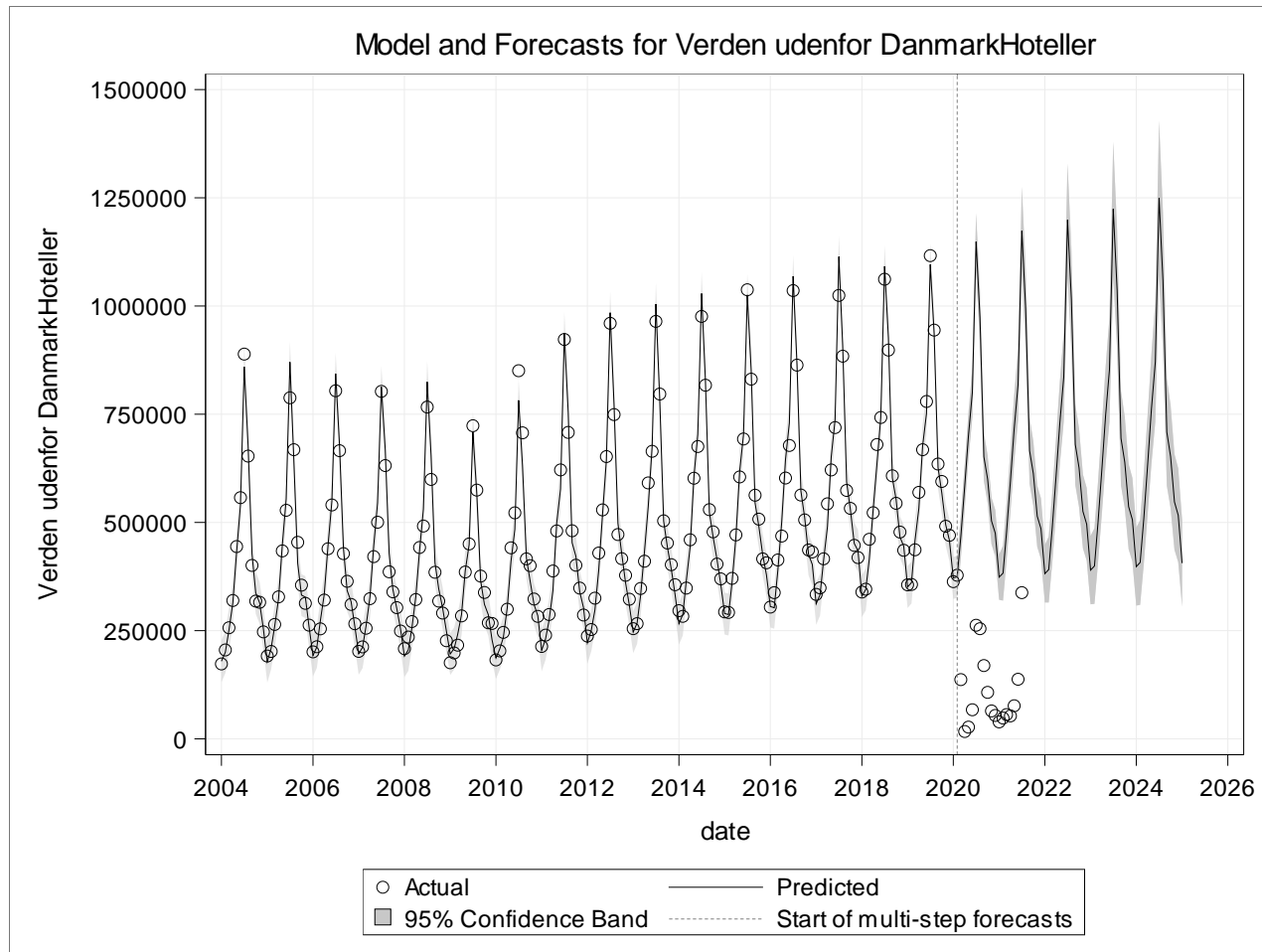
Holiday homes - cottages Danes



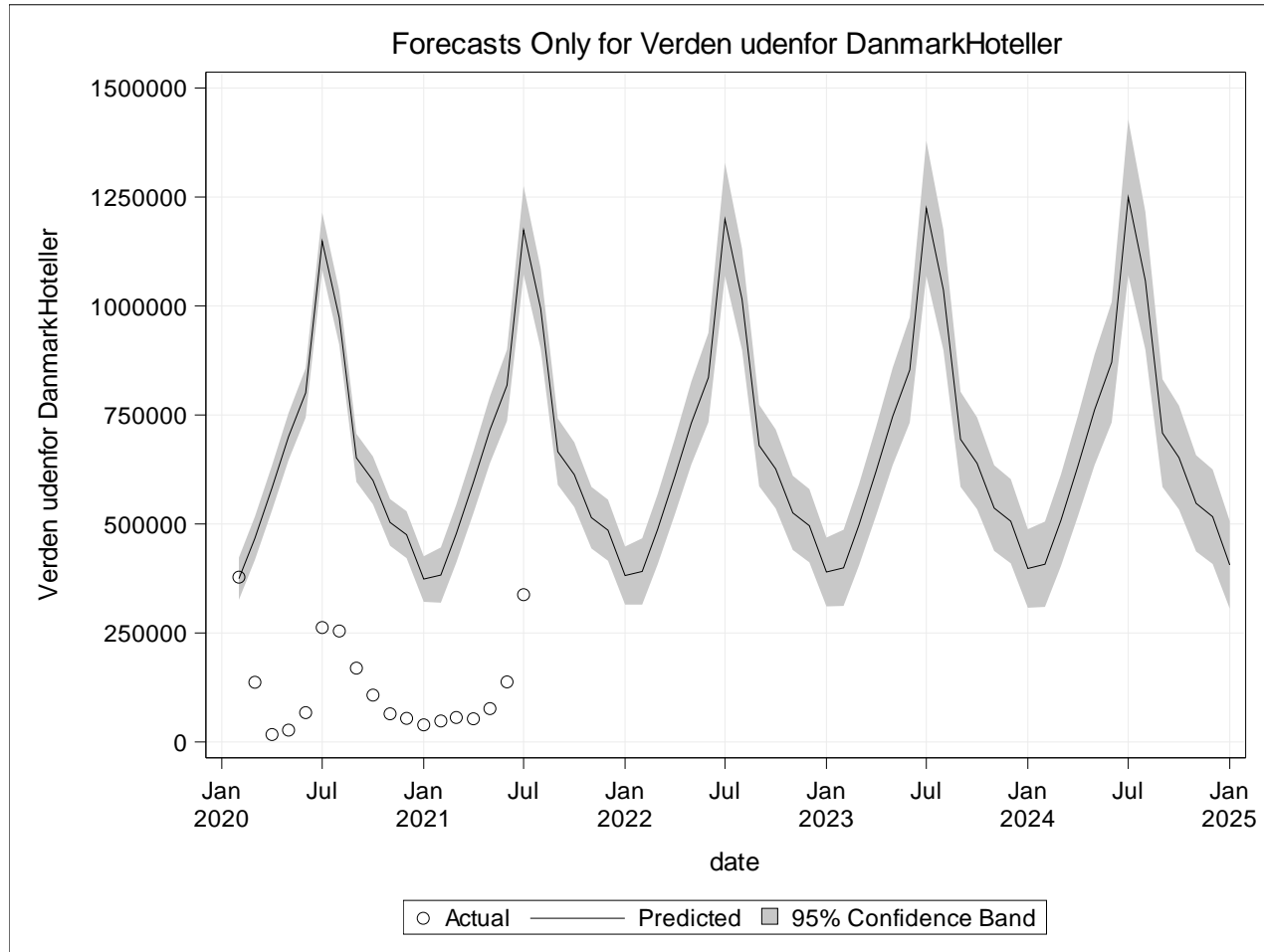
Holiday homes - cottages Danes



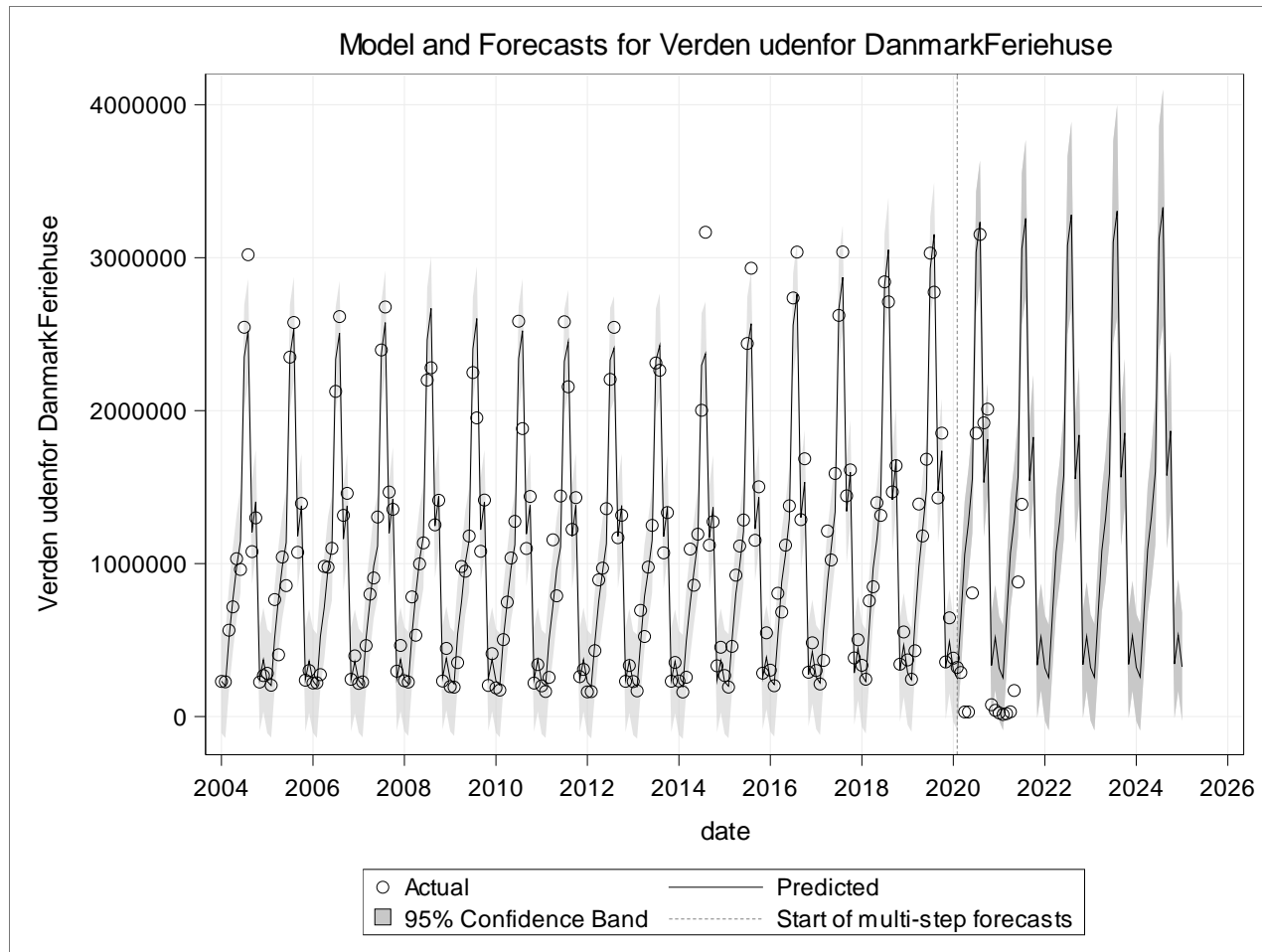
Hotels Foreigners



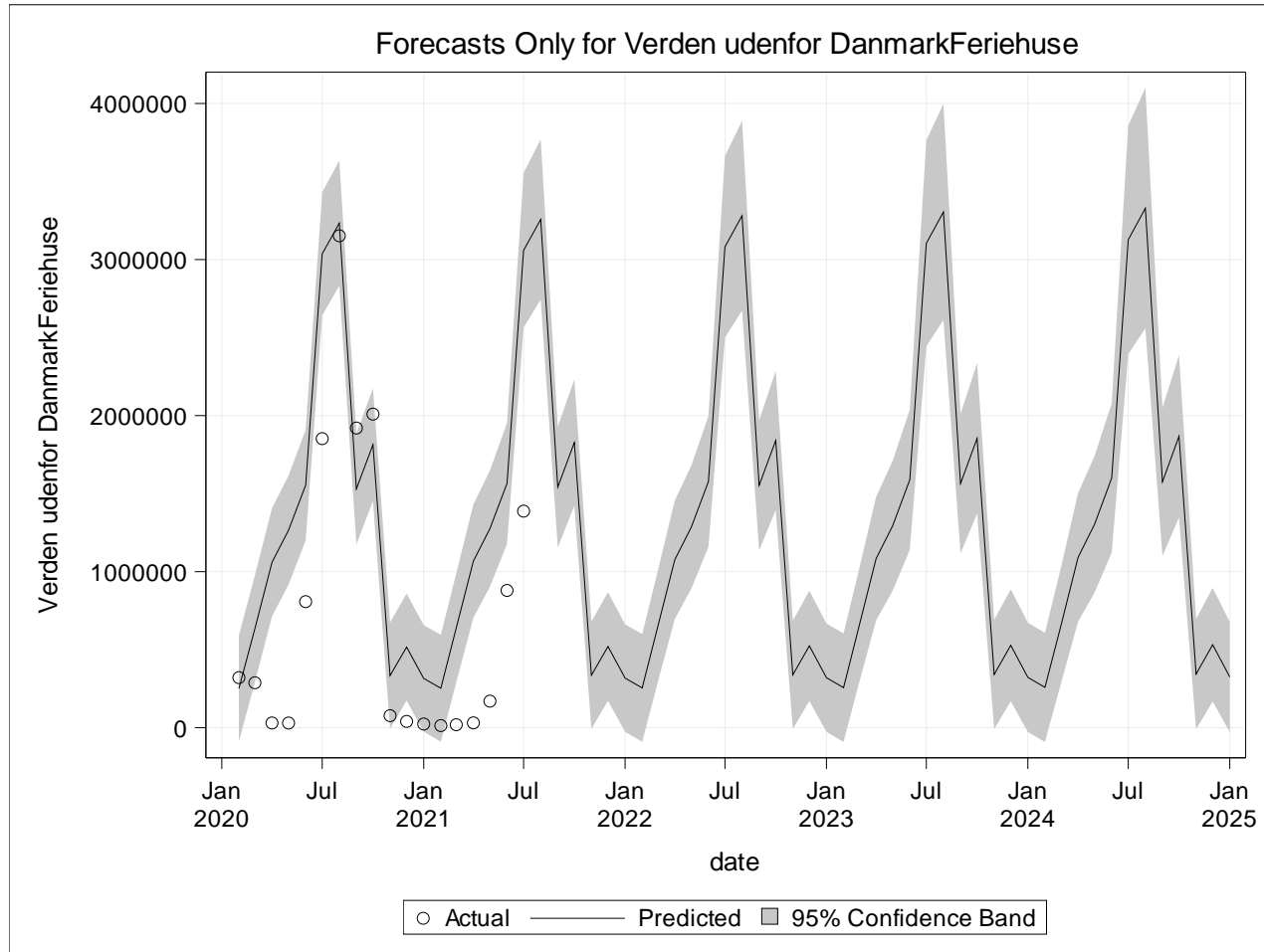
Hotels Foreigners



Holiday homes - cottages Foreigners



Holiday homes - cottages Foreigners

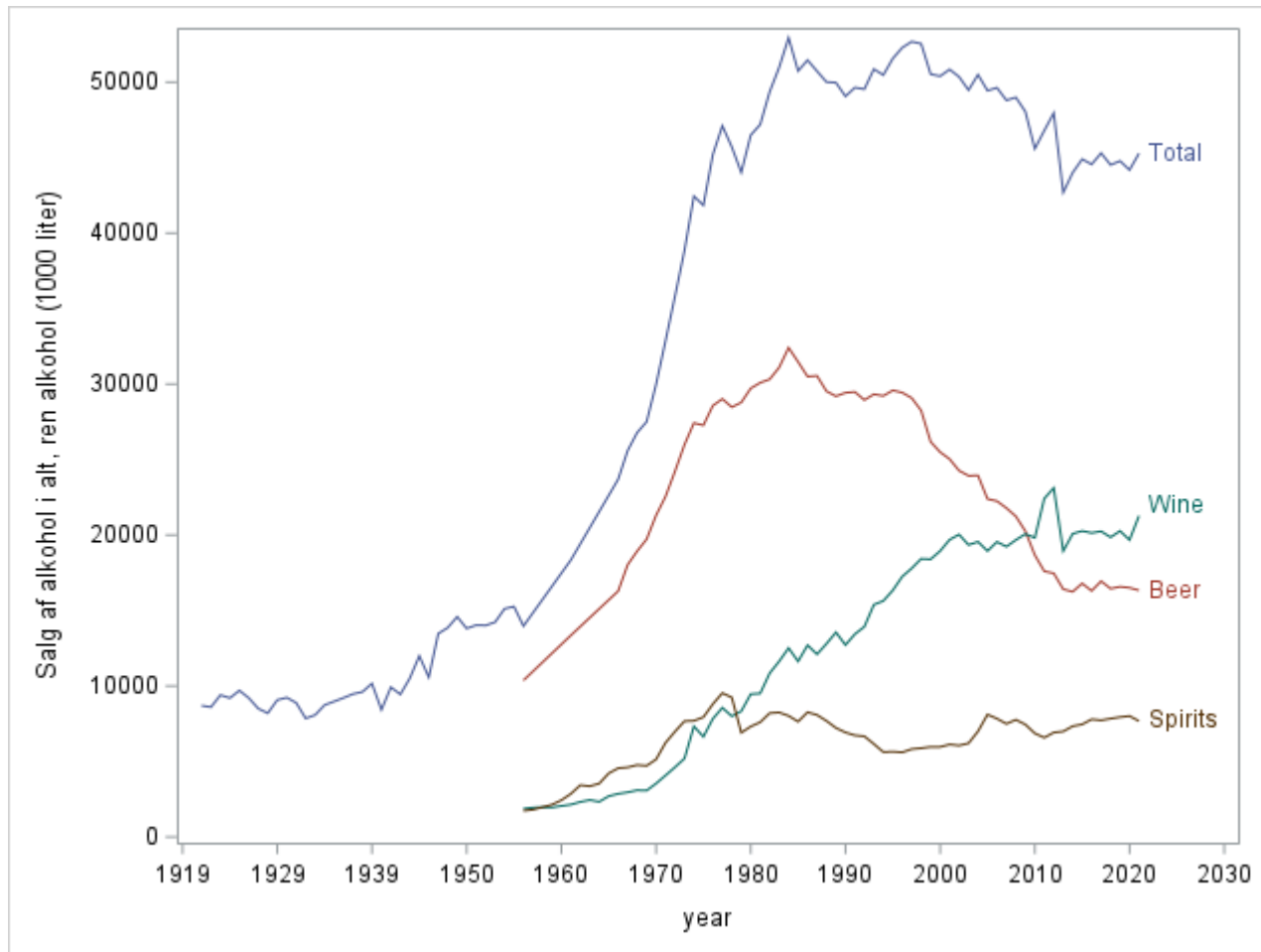


What did the Danes do in our holidays?

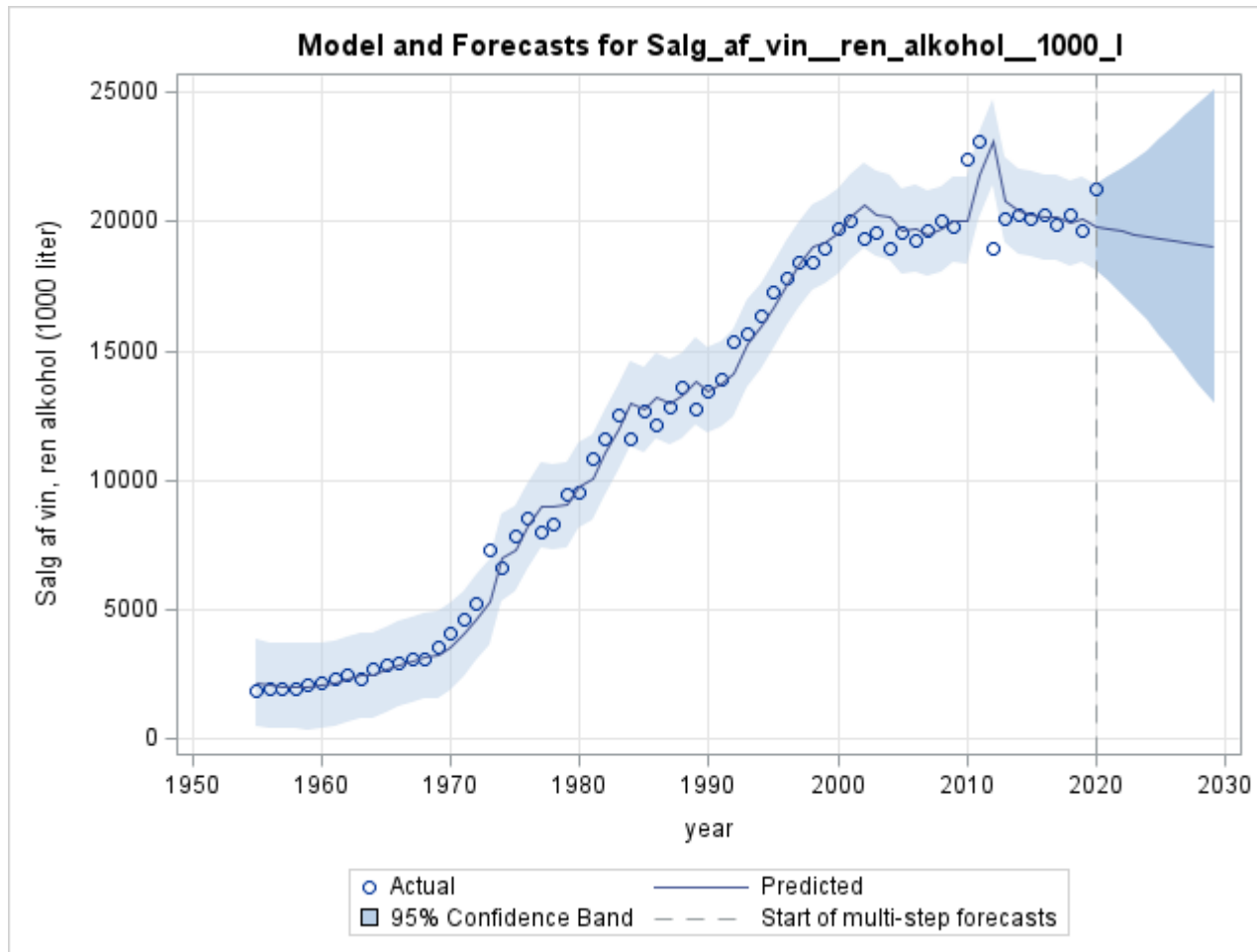
Well we could not drink alcohol abroad

- So why not drink in our country instead!

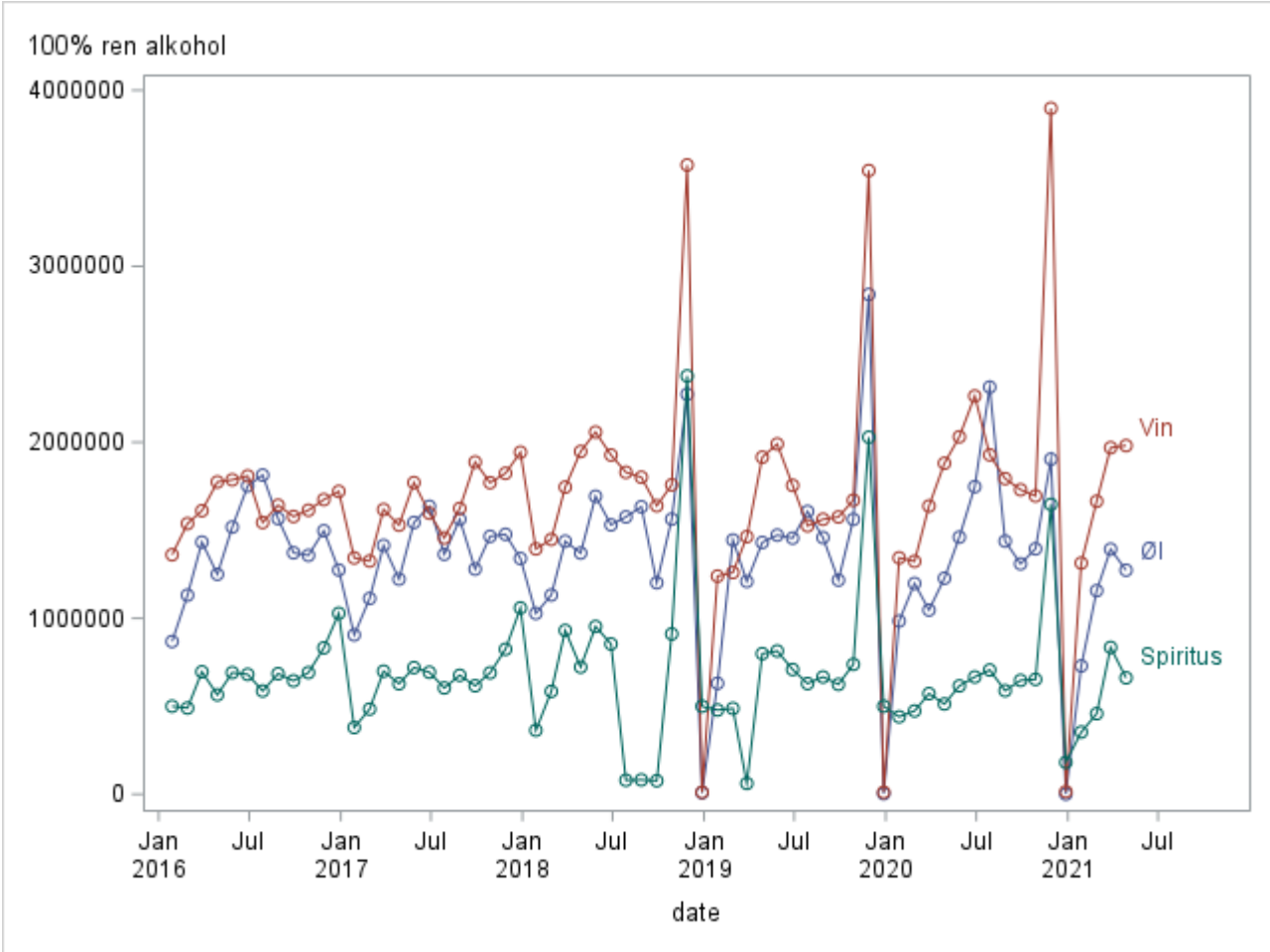
Well, perhaps not...

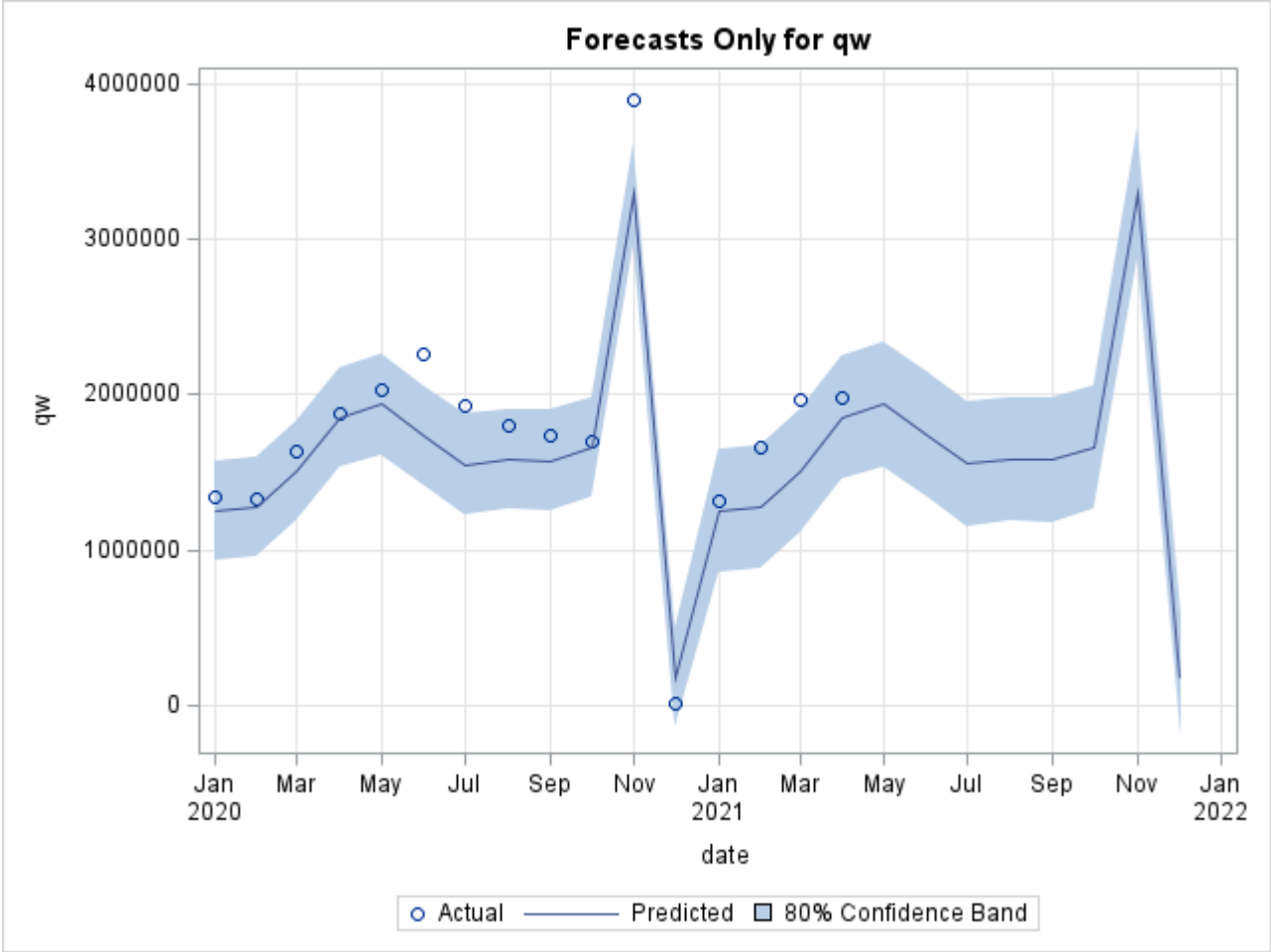


Forecasts for sales of wine made by exponential smoothing



Monthly data - the series is observed from January 1997





Model identified **automatically** by PROC X12

$$(1 - \varphi_1 B - \varphi_2 B^2 - \varphi_3 B^3) (1 - B) (1 - B^{12}) Y_t = (1 - \theta_1 B) (1 - \Theta_1 B^{12}) \varepsilon_t$$

```
PROC X12 data=... date=date;  
var qw;  
automdl ;  
outlier;  
forecast lead=24;  
ods output ForecastCL=predicted;  
x11 mode=add;  
output out=out a1 d10 d11 d12 d13;  
run;
```

Nonseasonal differences: 1

Seasonal differences: 1

Exact ARMA Maximum Likelihood Estimation

For Variable qw

Parameter	Lag	Estimate	Standard Error	t Value	Pr > t
Nonseasonal AR	1	-0.07886	0.06606	-1.19	0.2337
	2	0.13643	0.06806	2.00	0.0461
	3	0.19510	0.06480	3.01	0.0029
Nonseasonal MA	1	0.94332	0.02891	32.63	<.0001
Seasonal MA	12	0.84765	0.03773	22.47	<.0001



More simple model

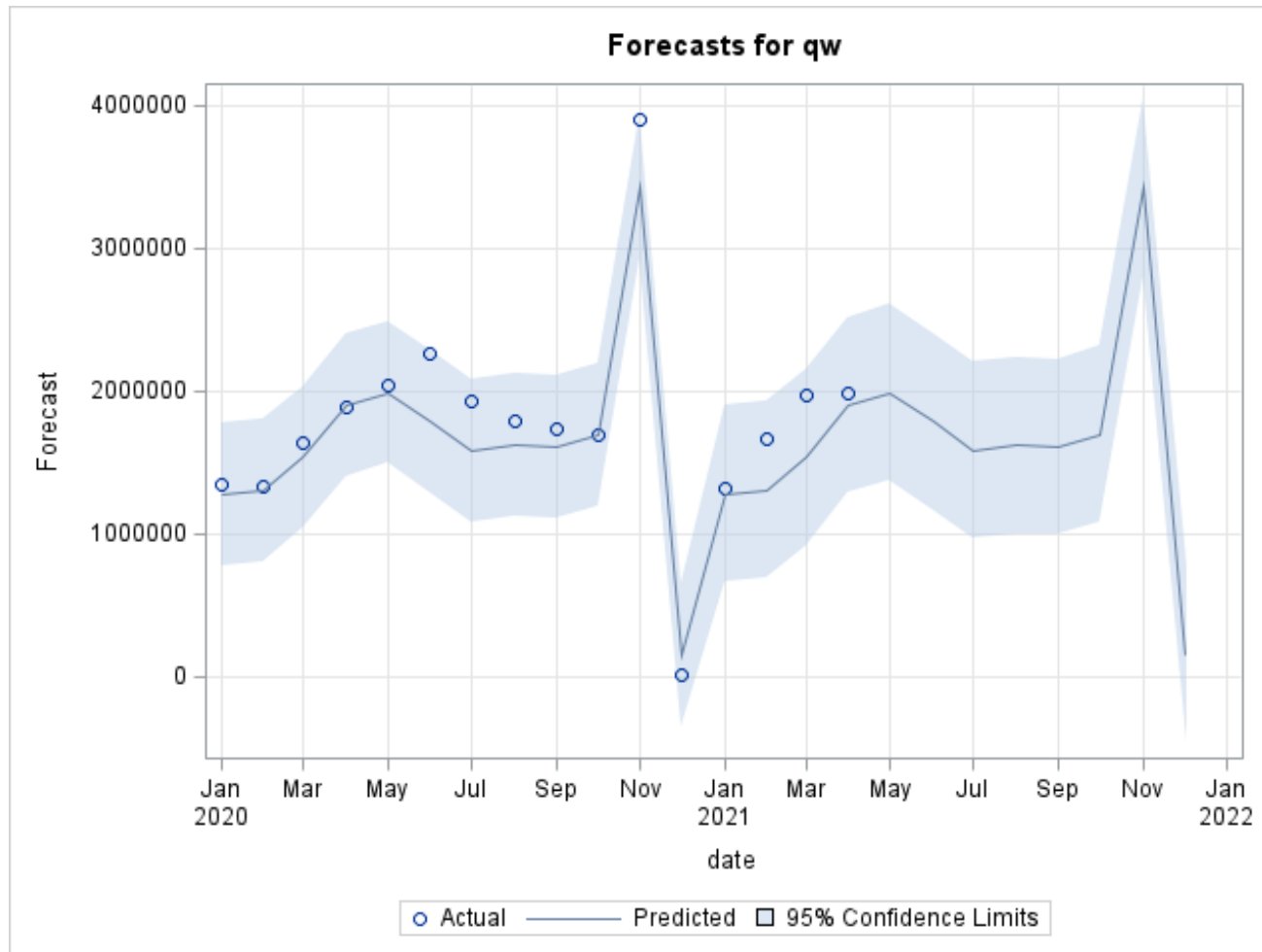
$$(1 - B^{12})Y_t = (1 - \Theta_1 B^{12})\varepsilon_t$$

```
proc arima data=alko.samletmonth plots=all;
  identify var=qw(12);
  estimate q=(12) noint method=ml;
  forecast id=date interval=month printall back=16
lead=24 out=b;
run;
```

Maximum Likelihood Estimation

Parameter	Estimate	Standard Error	t Value	Approx Pr > t	Lag
MA1,1	0.27118	0.05990	4.53	<.0001	12

This model is simple and could be improved by more parameters.
However, it works fine!



Thanks' for Your attention!