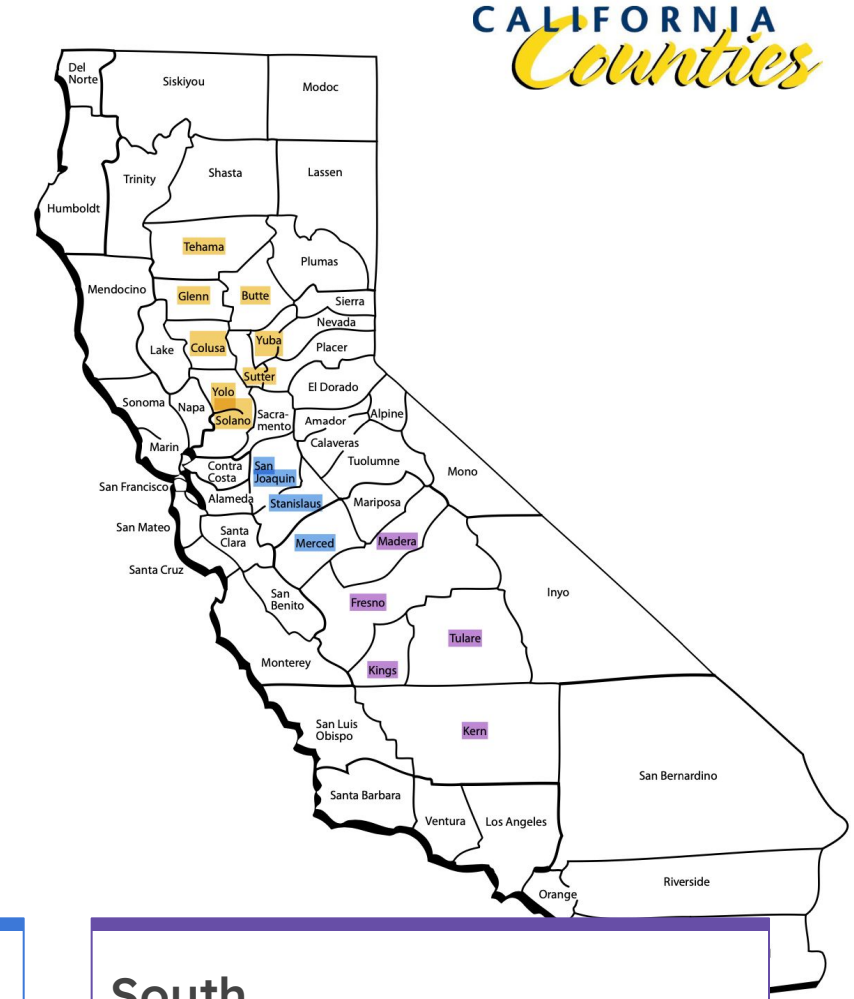
Almond Prices, Production, and California Weather. (1980 to 2021)

Doni Obidov & Joe Mallonee

California 🌻

- ***80% of the world's almond supply.***
- Exported $4.9B worth in 2019.
- Concentrated geography (16 counties) provides an ideal context for analysis.

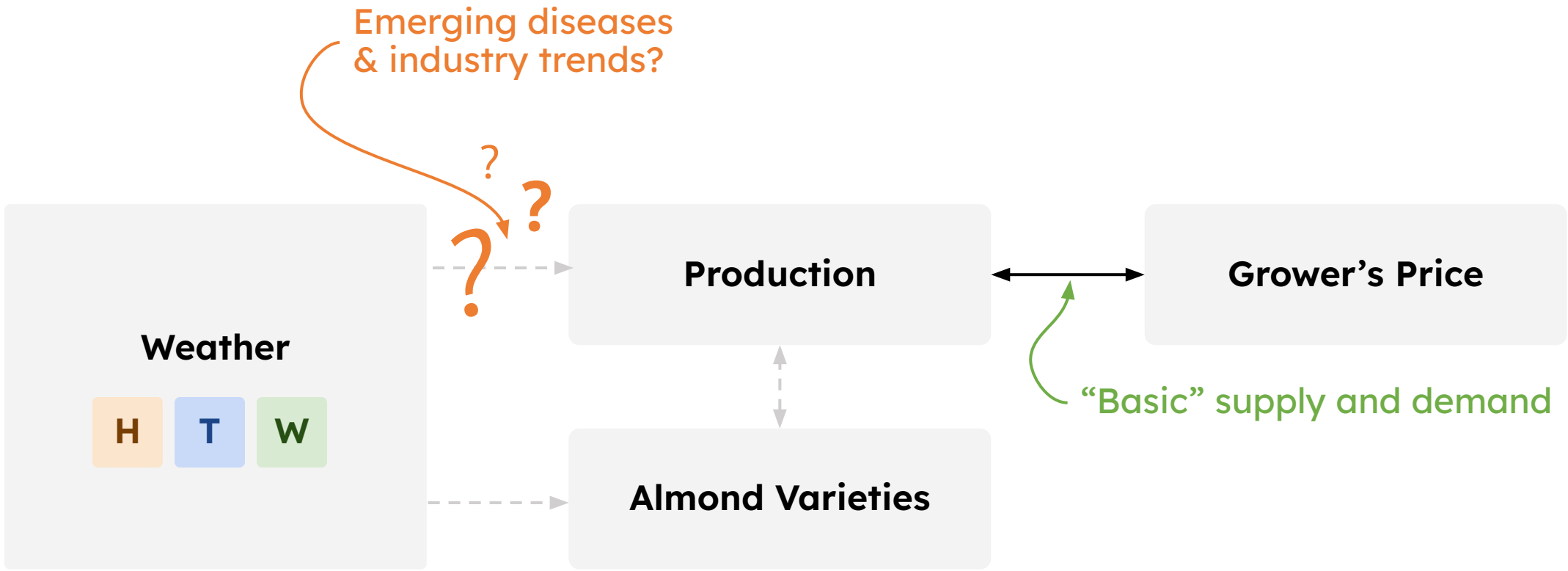


North
Butte, Colusa, Glenn, Solano, Sutter, Tehama, Yolo, Yuba

Central
Merced, San Joaquin, Stanislaus

South
Fresno, Kern, Kings, Madera, Tulare

Research Goals



Research Goals

You *might* assume: weather conditions influence the production and price of almonds. **Is this true?**

?

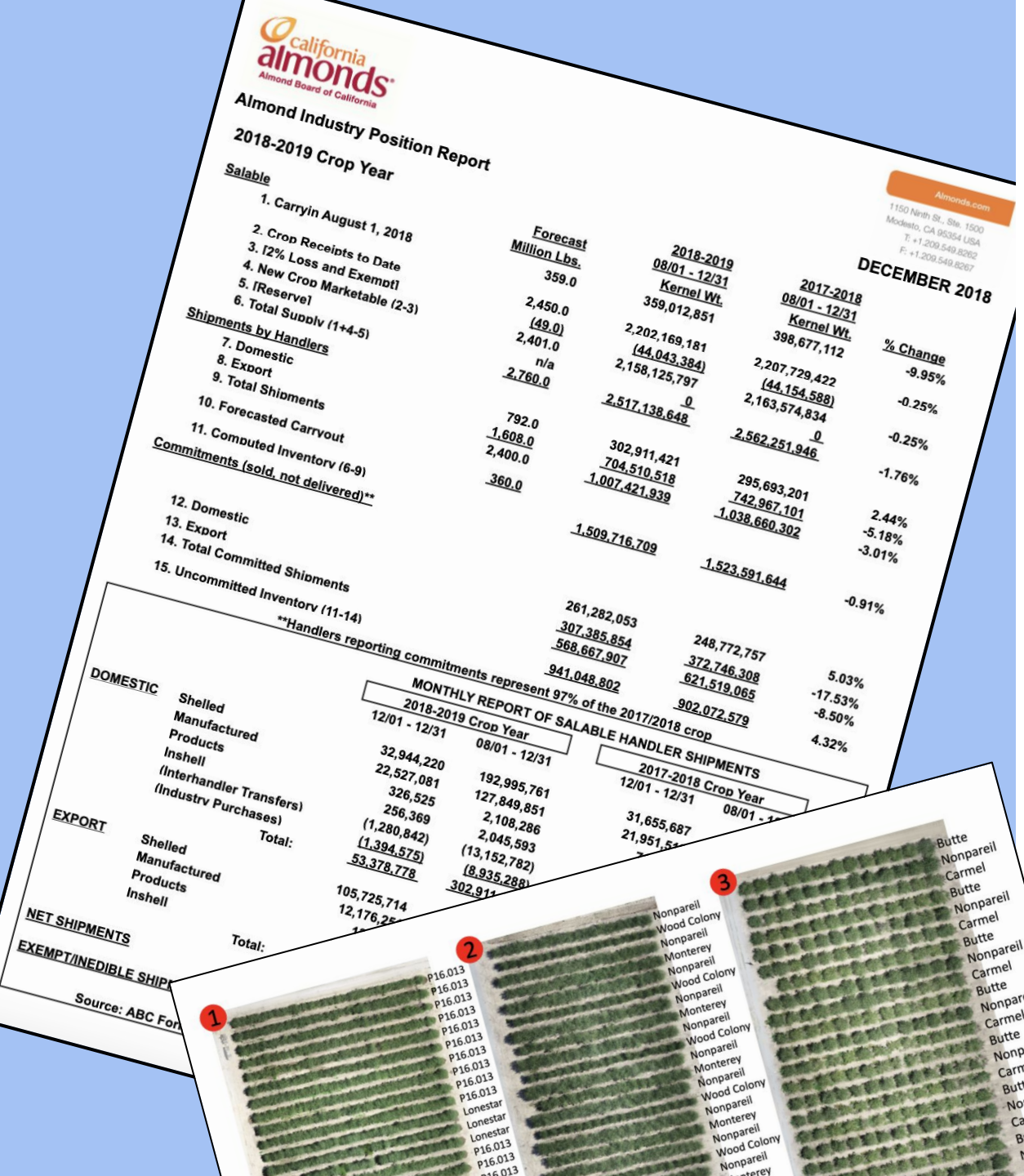
Can we identify factors that *consistently* improve BIC?

(we're not forecasting!)

?

Can regressors/covariates lead to more parsimonious models?

(simpler models with equal BIC performance?!)



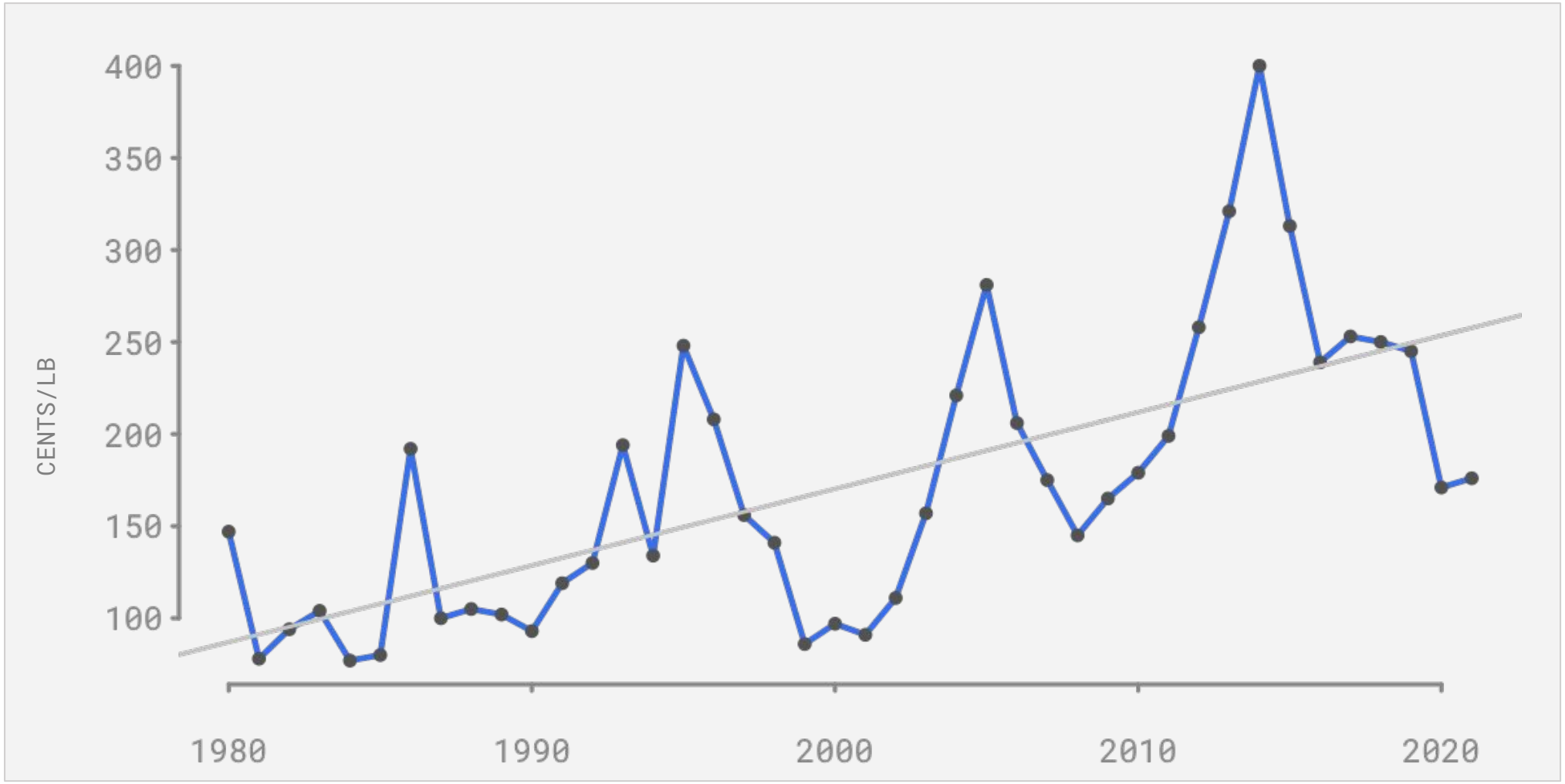
Limitations

- Data integrity
- Reporting frequency, duration
- Shifts in recording practices

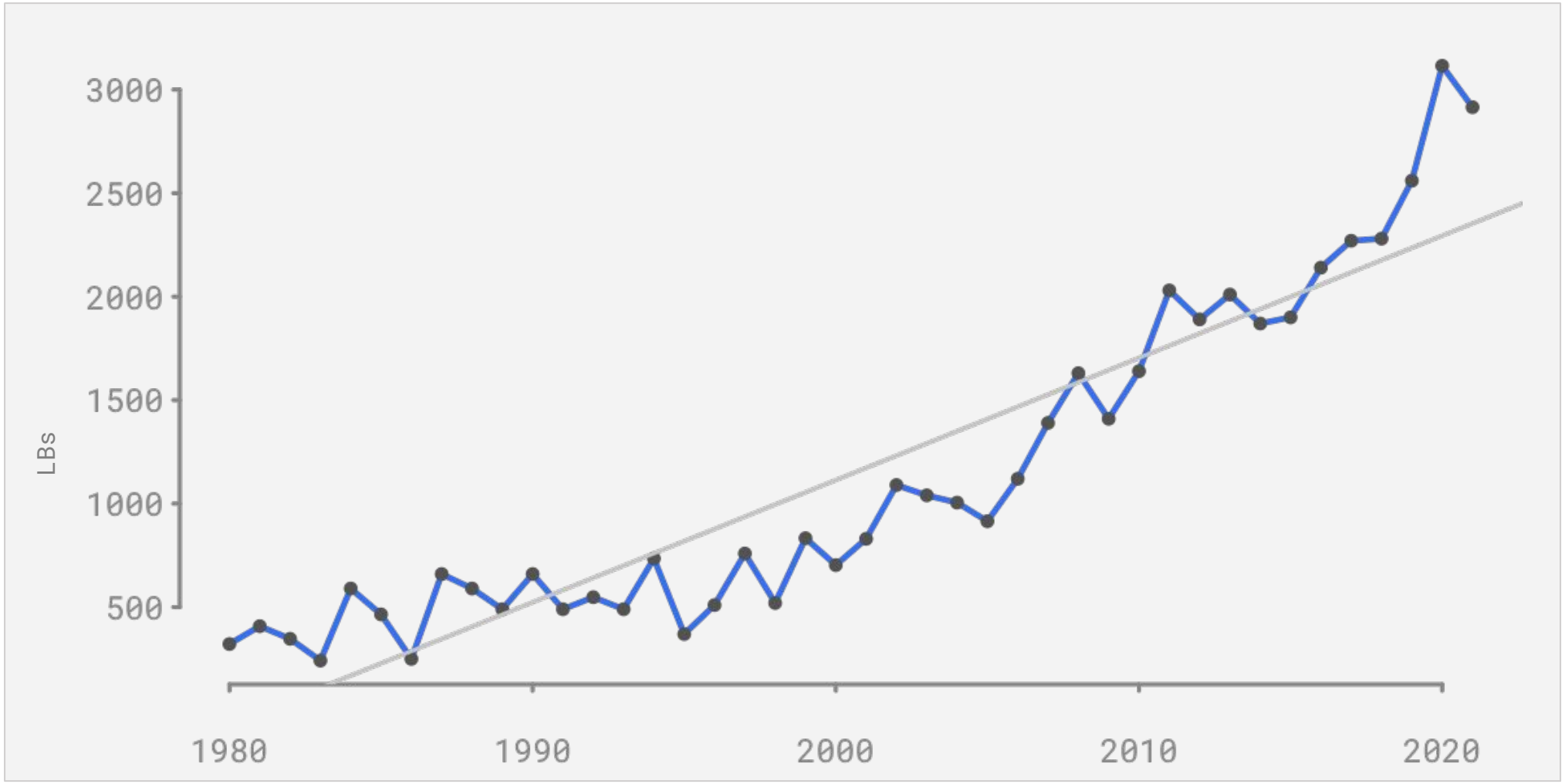
Approach

- Dropped unreliable data
- Sourced 41 *most recent* years
- Combined data sets

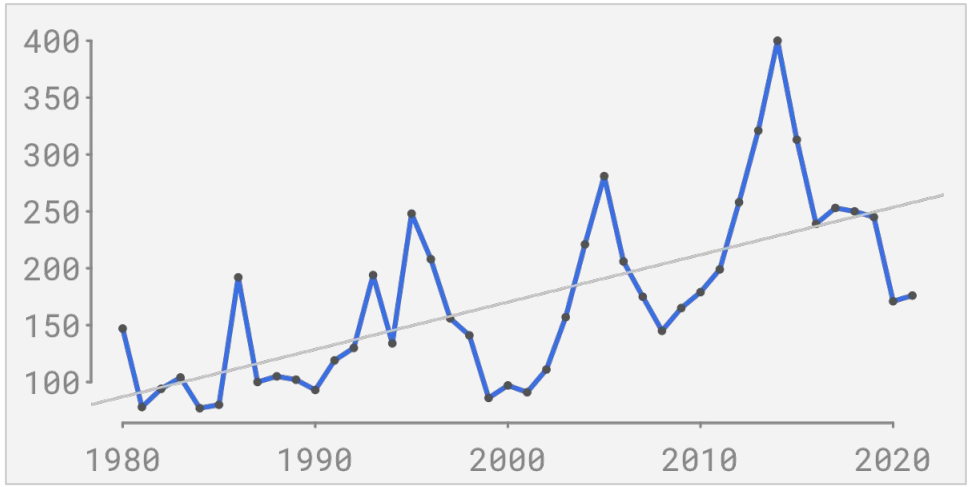
Price of California Almonds, 1980 to 2021

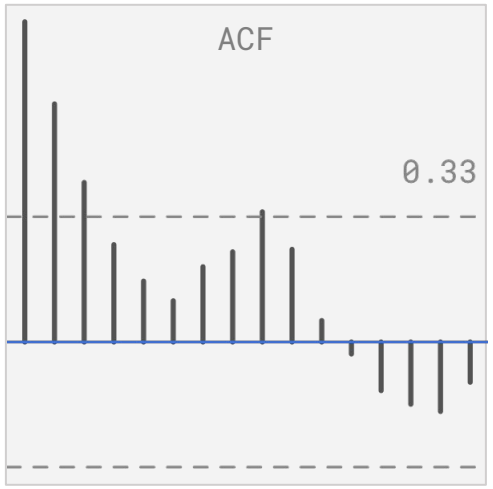


Production of California Almonds, 1980 to 2021



Price



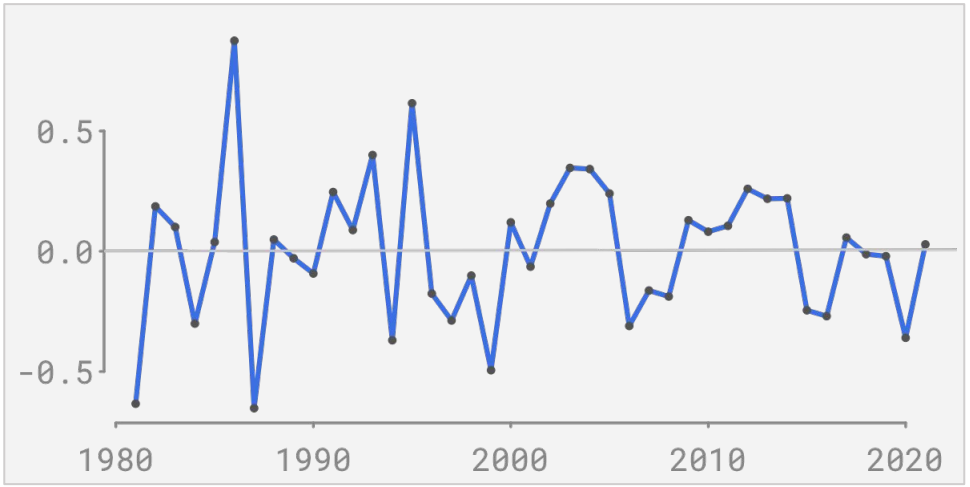


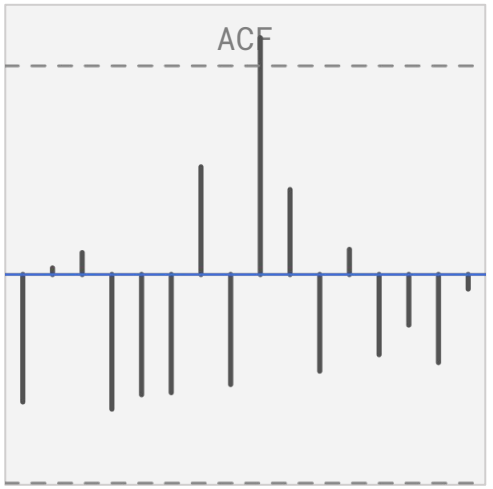
? **ADF** 0.049

? **PP** 0.045

X **KPSS** 0.013

diff log Price



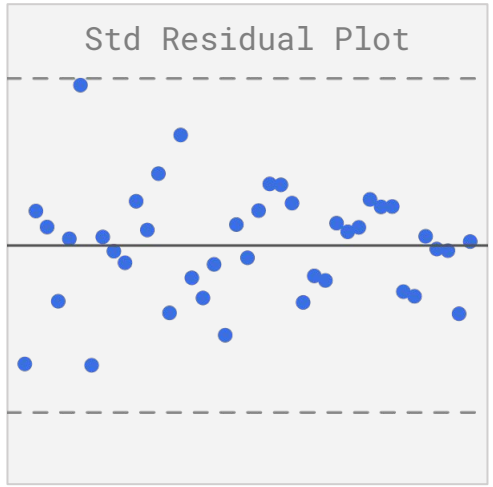


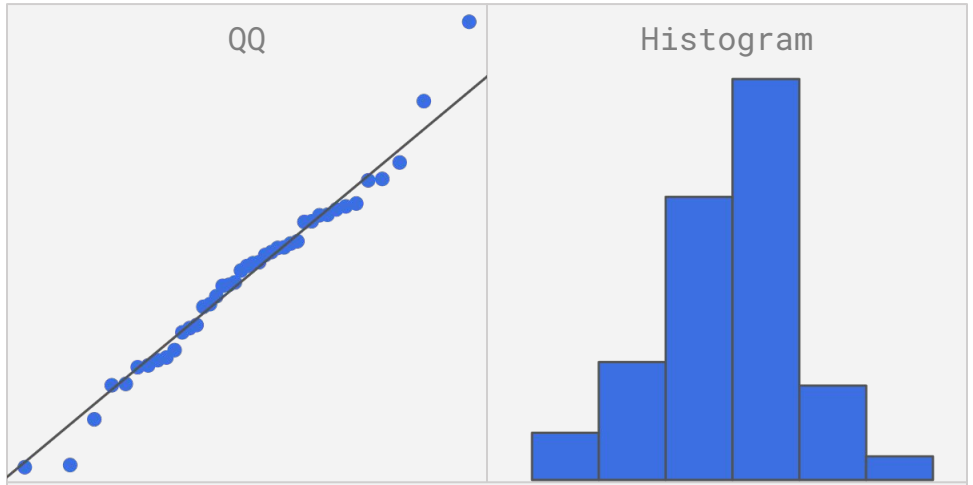
✔ **ADF** 0.038

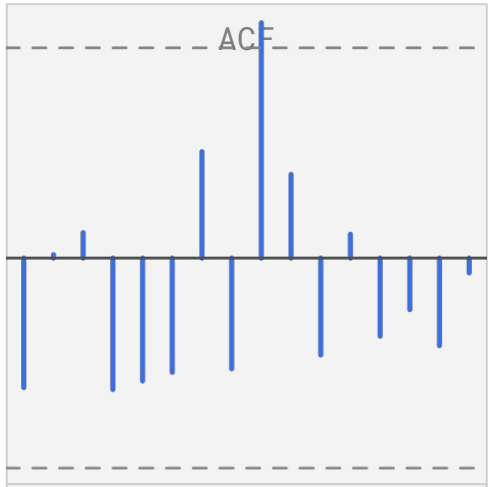
✔ **PP** 0.010

✔ **KPSS** 0.100

diff log Price, Residual Analysis







✔ **Zero-Mean**

? **Homoscedasticity**

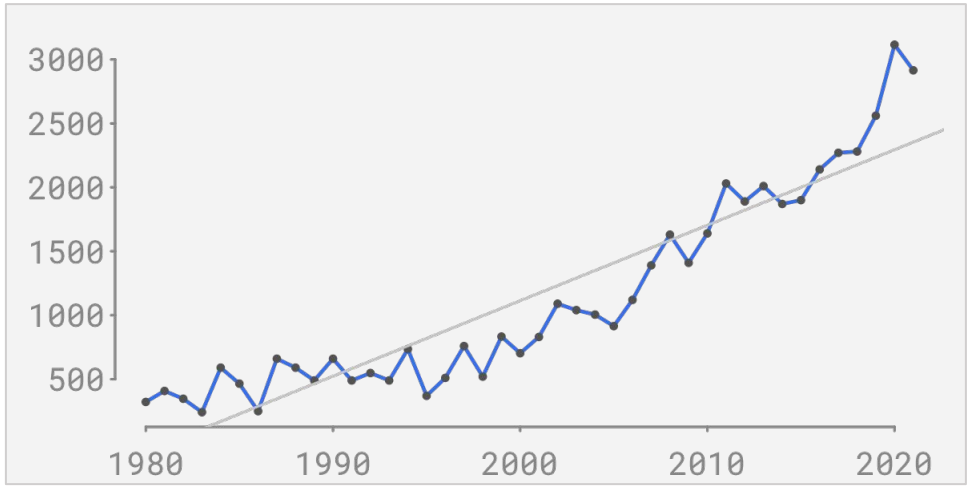
✔ **Shapiro-Wilks** 0.598

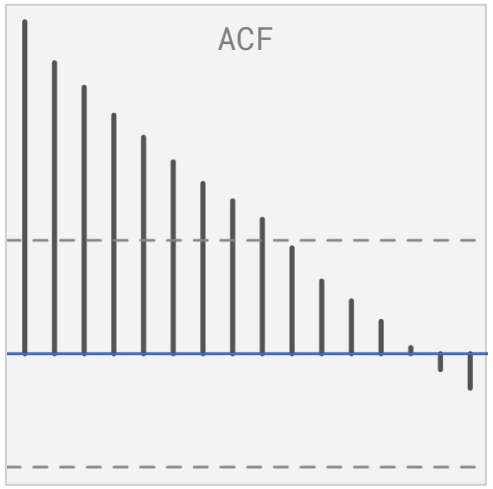
✔ **Normality**

✔ **Runs** 0.780

✔ **Independence**

Production



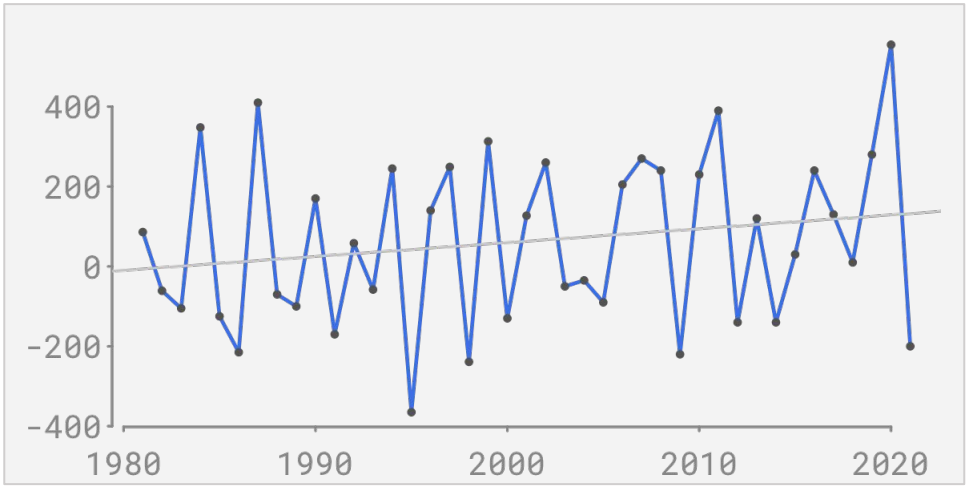


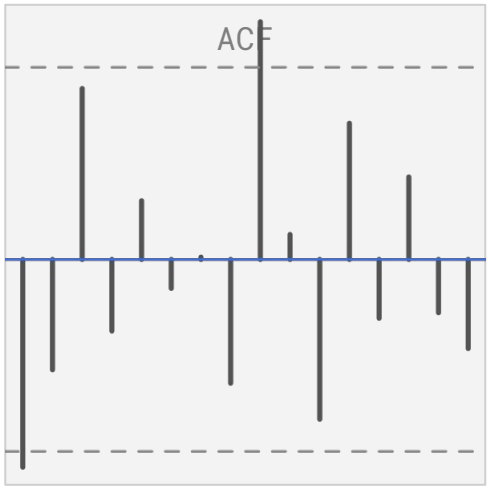
X **ADF** 0.990

X **PP** 0.704

X **KPSS** 0.010

diff Production



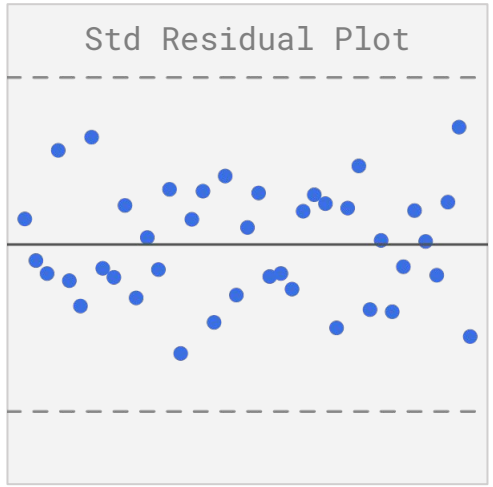


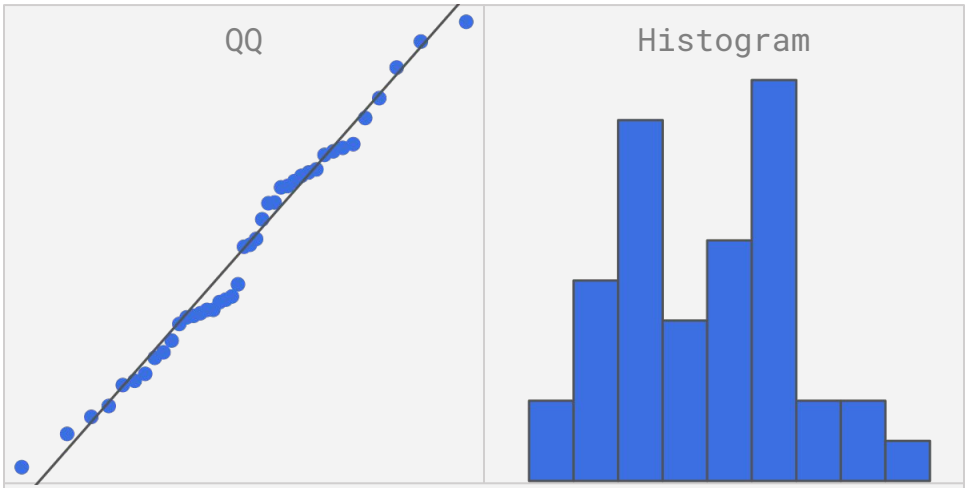
✔ **ADF** 0.016

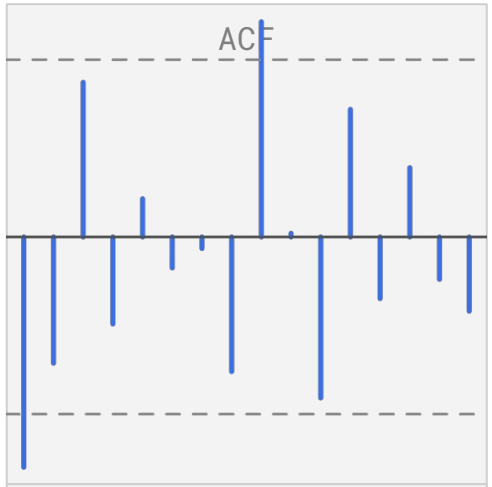
✔ **PP** 0.010

✔ **KPSS** 0.083

diff Production, Residual Analysis







✔ **Zero-Mean**

✔ **Homoscedasticity**

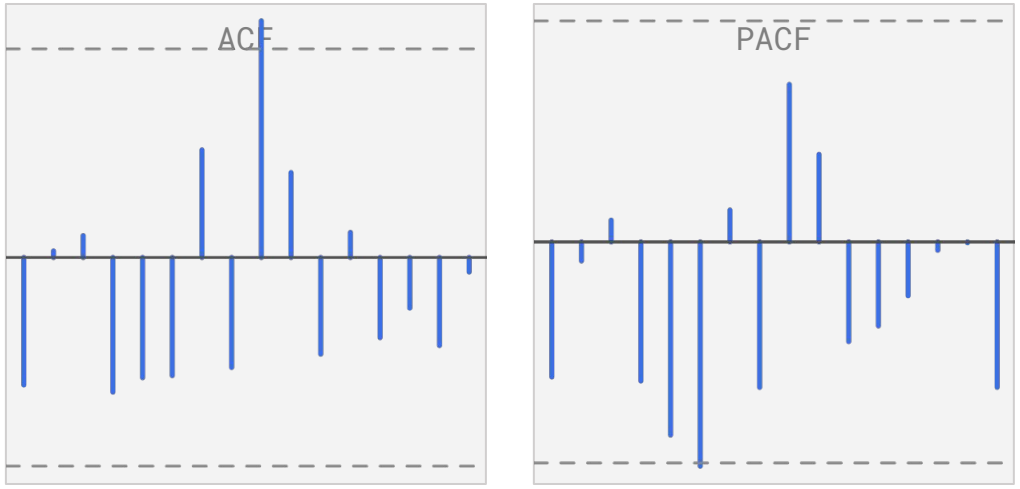
✔ **Shapiro-Wilks** 0.590

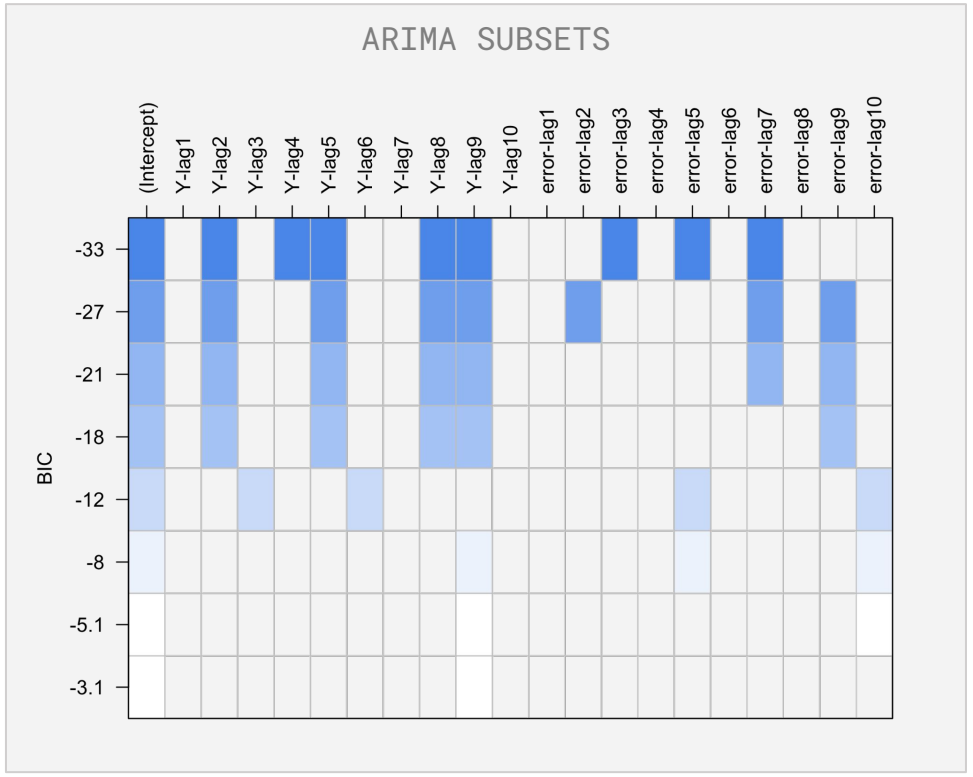
✔ **Normality**

? **Runs** 0.056

✔ **Independence**

diff log Price, Candidate Models





ARIMA(0,0,0)

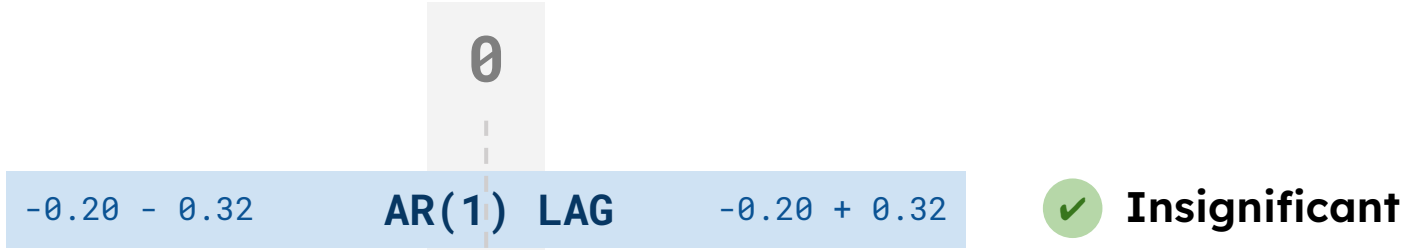
BIC: 26.5878

ARIMA(9,0,7)

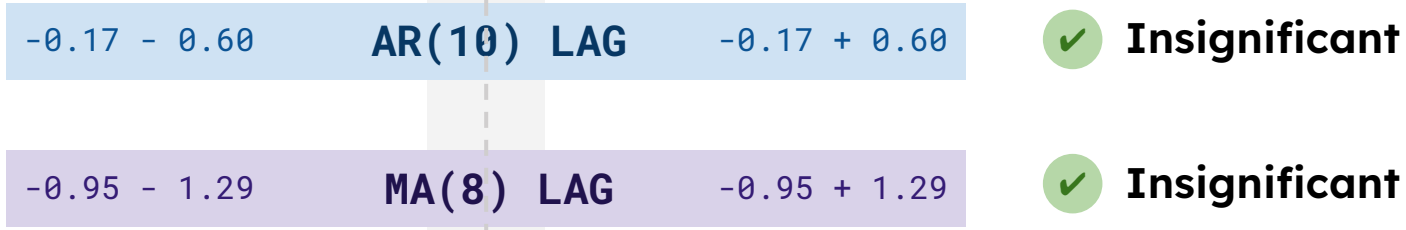
BIC: 52.24535

diff log Price, Overfitting

ARIMA(0,0,0)

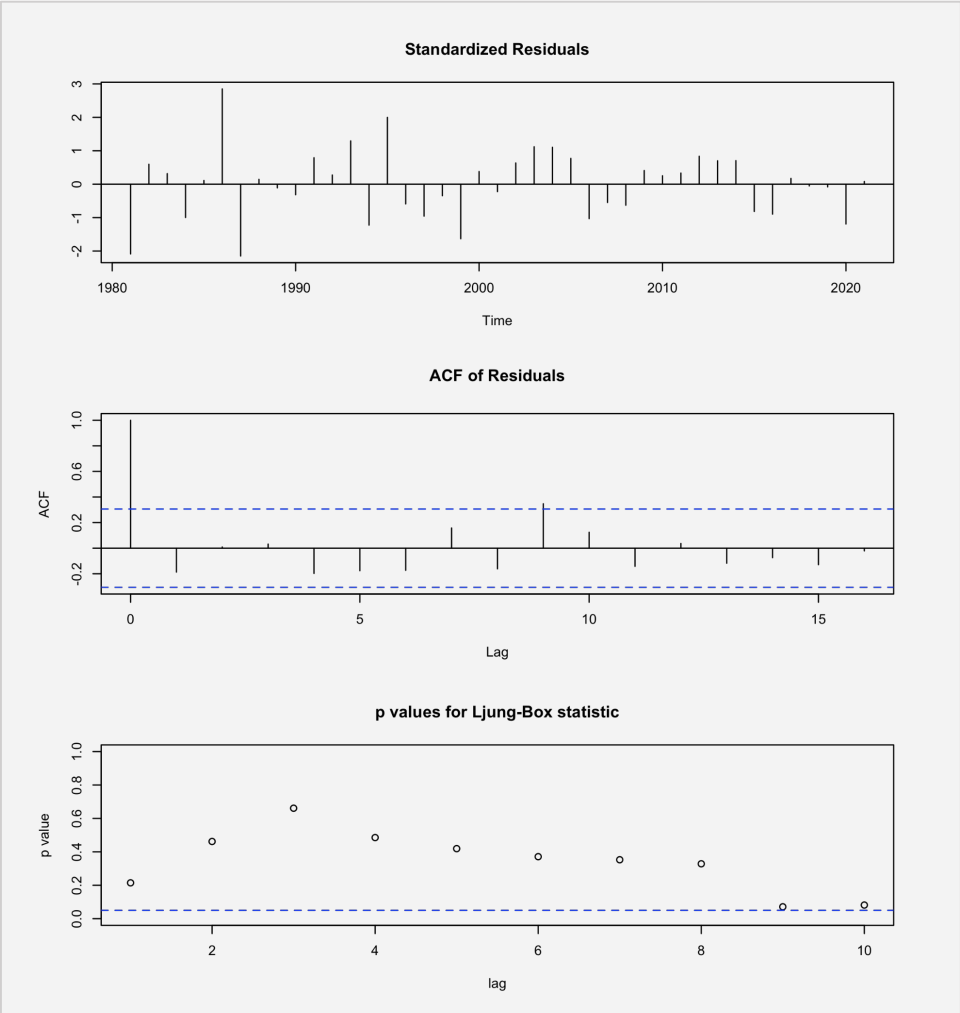


ARIMA(9,0,7)

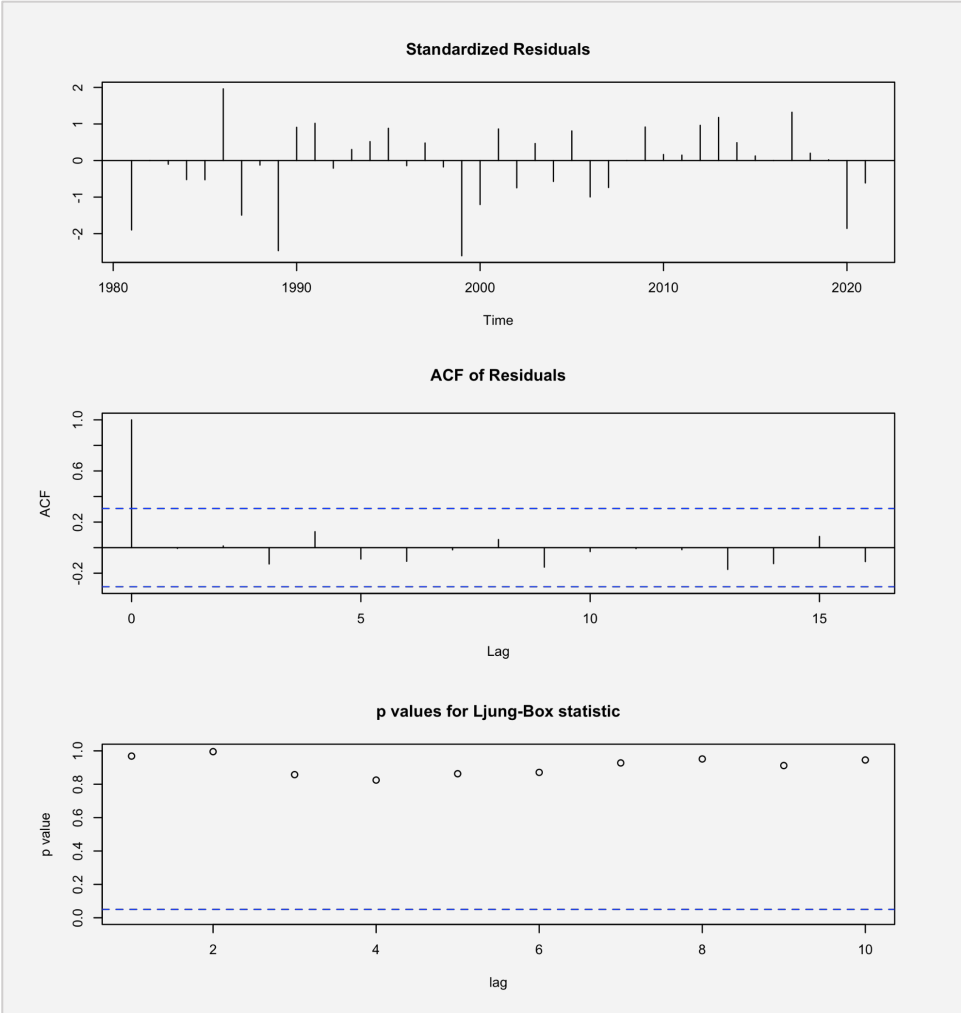


diff log Price, ARIMA Residual Analysis

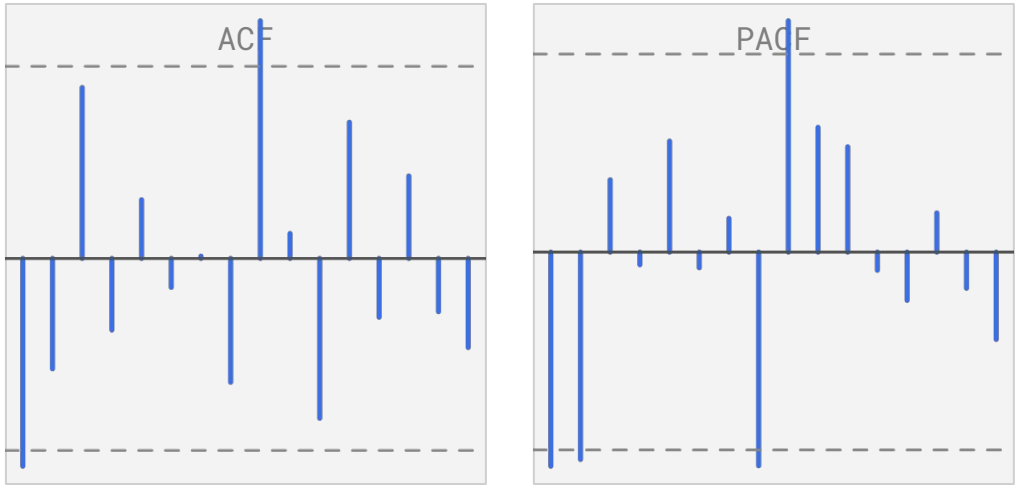
✔ ARIMA(0,0,0)

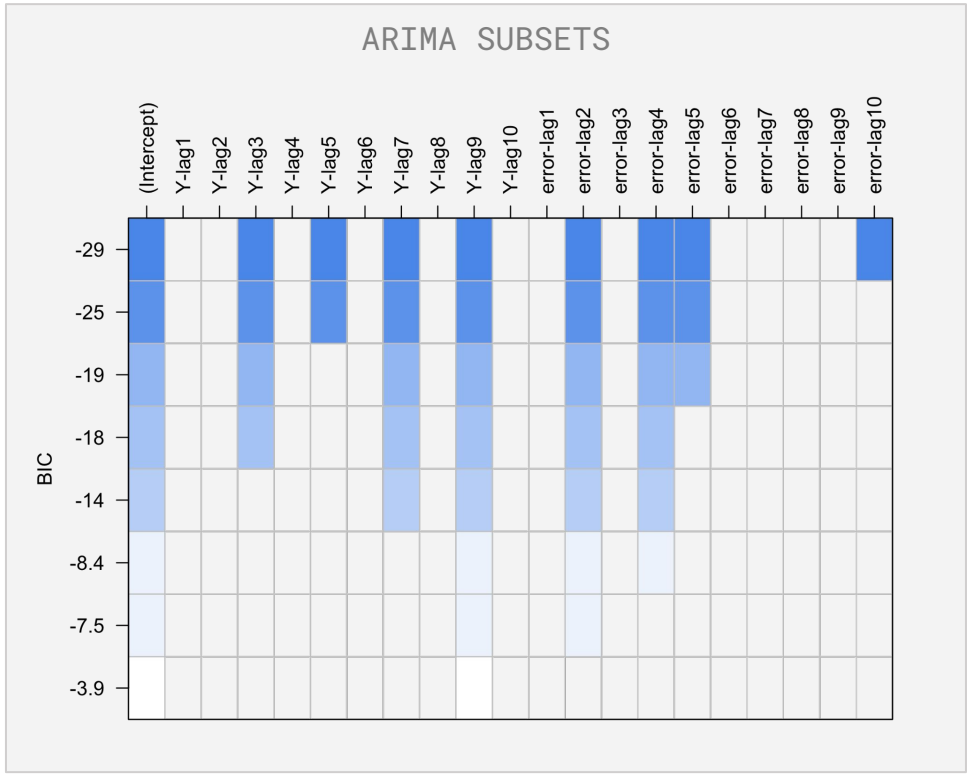


✔ ARIMA(9,0,7)



diff Production, Candidate Models





ARIMA(0,0,1)

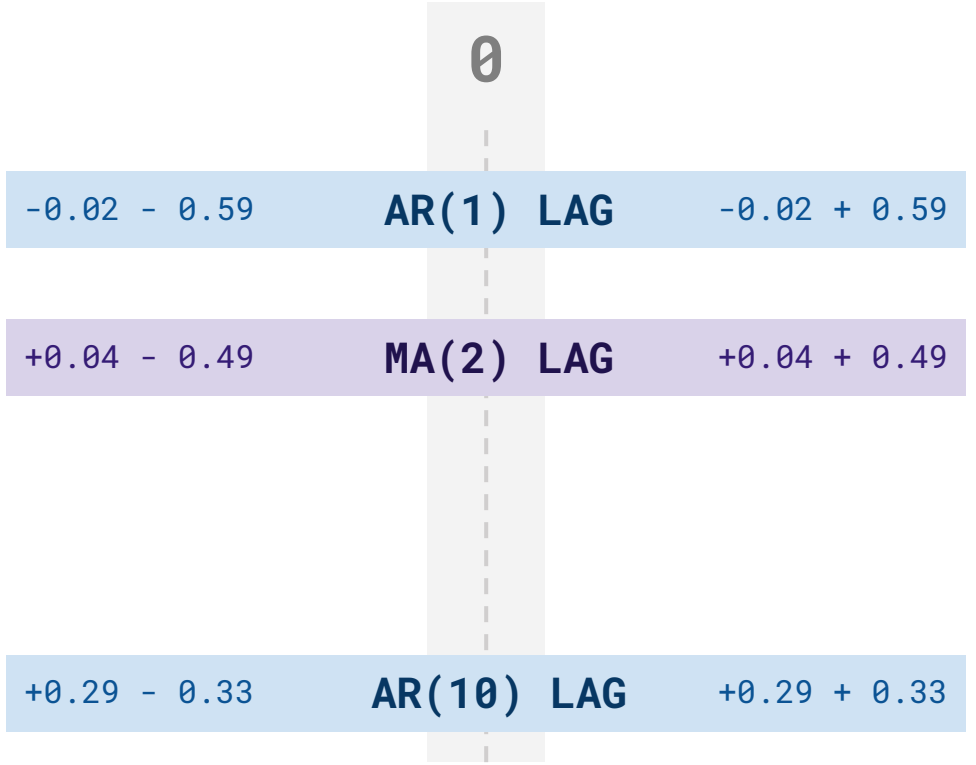
BIC: 559.2685

ARIMA(9,0,0)

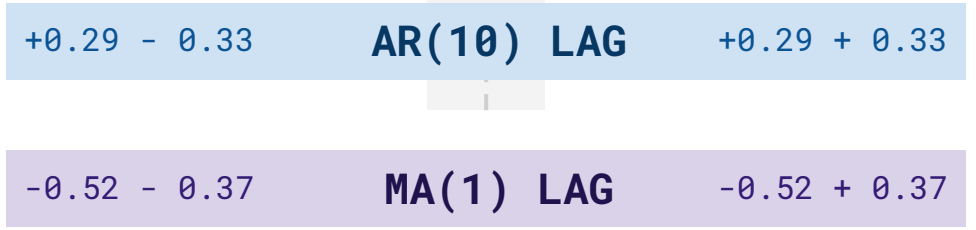
BIC: 569.1044

diff Production, Overfitting

ARIMA(0,0,1)

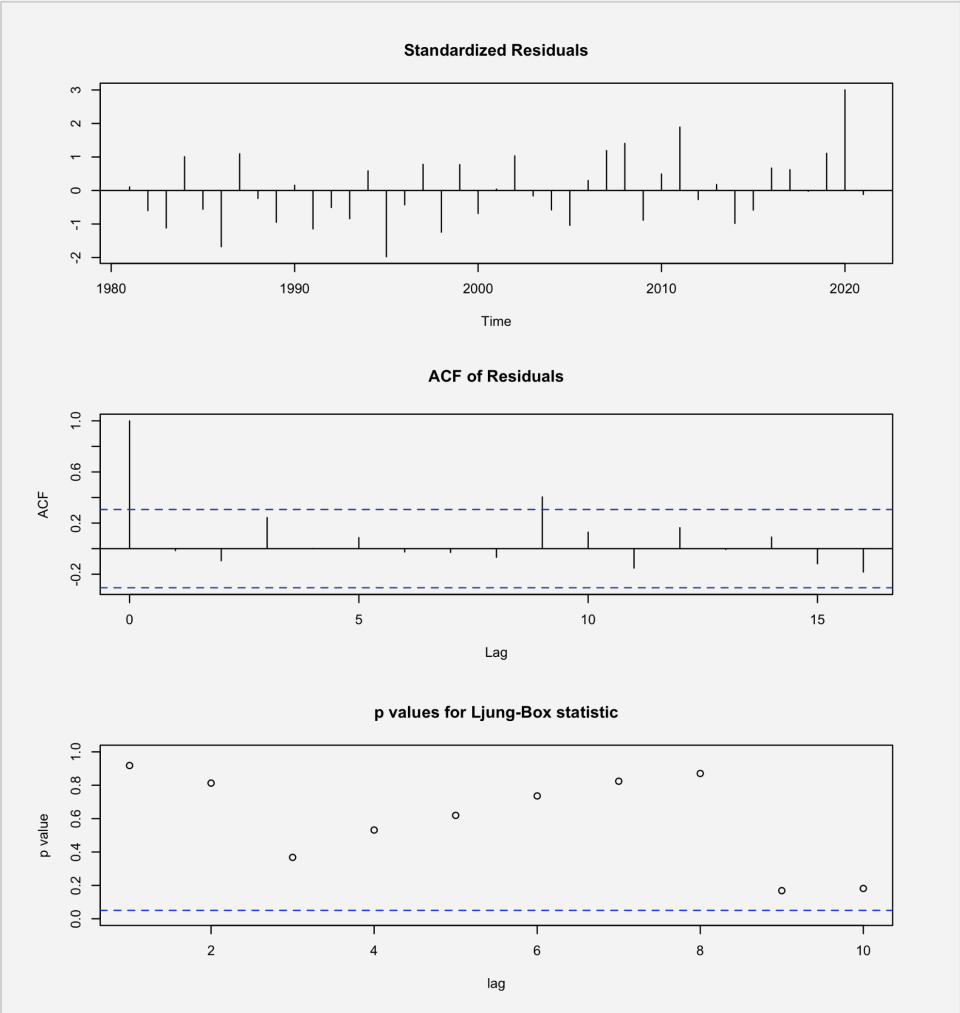


ARIMA(9,0,0)

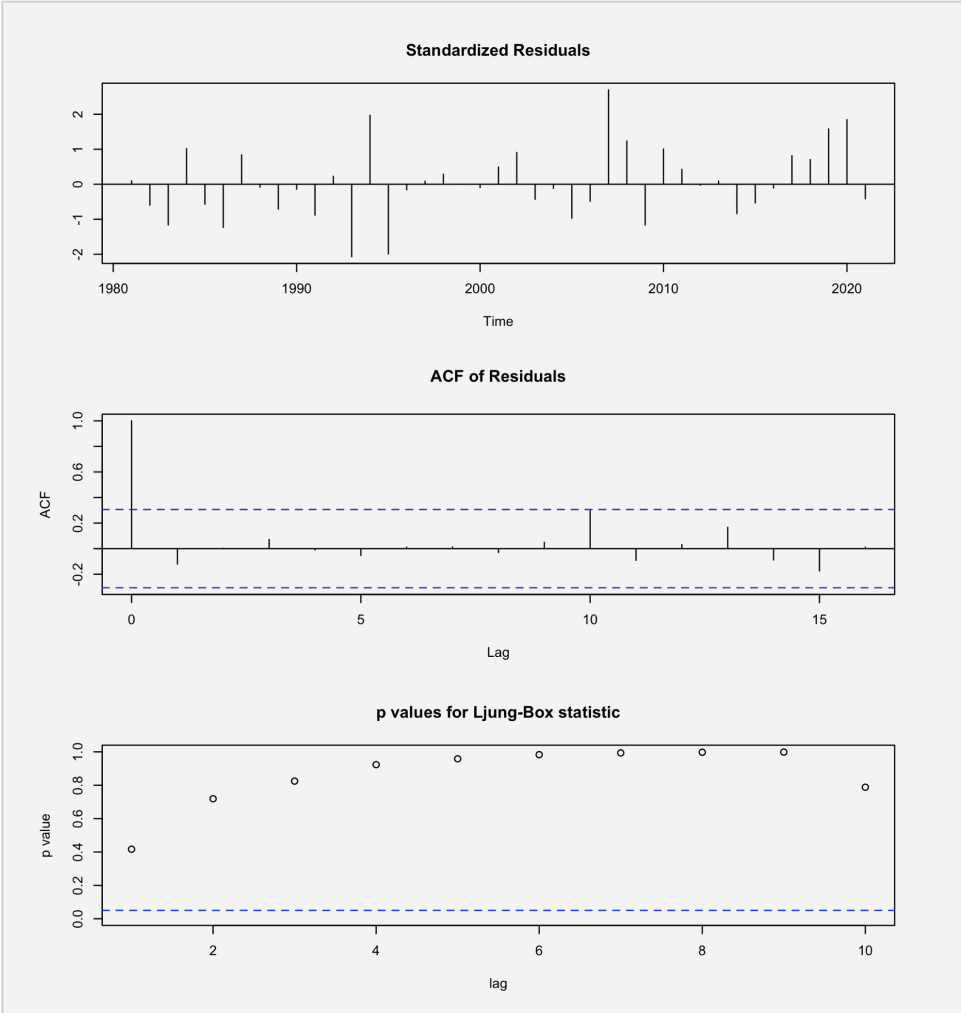


diff Production, ARIMA Residual Analysis

✔ ARIMA(0,0,1)



✔ ARIMA(9,0,0)



And now, the weather.

Humidity

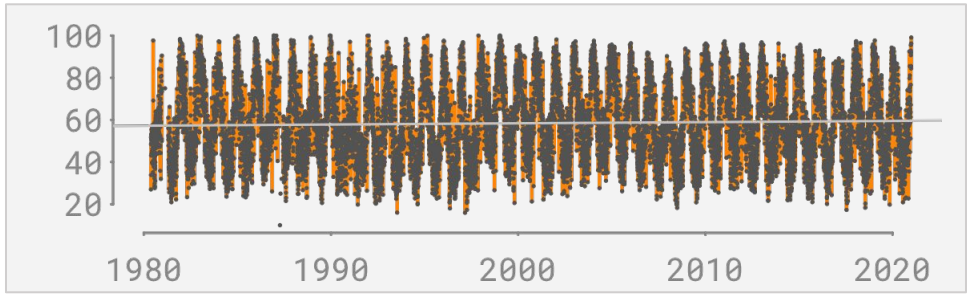
Temperature

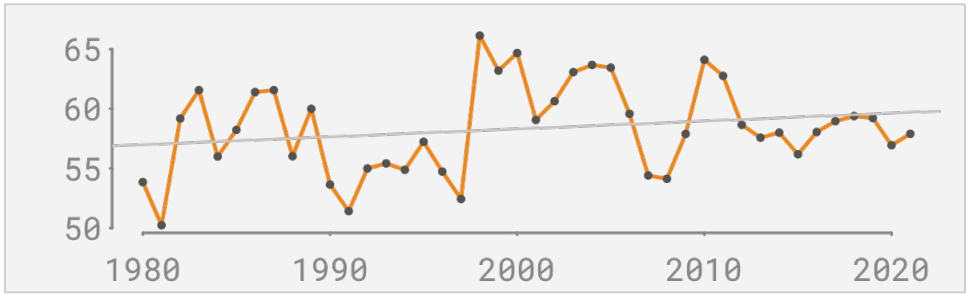
Windspeed

Weather

yearly avg Weather*

H





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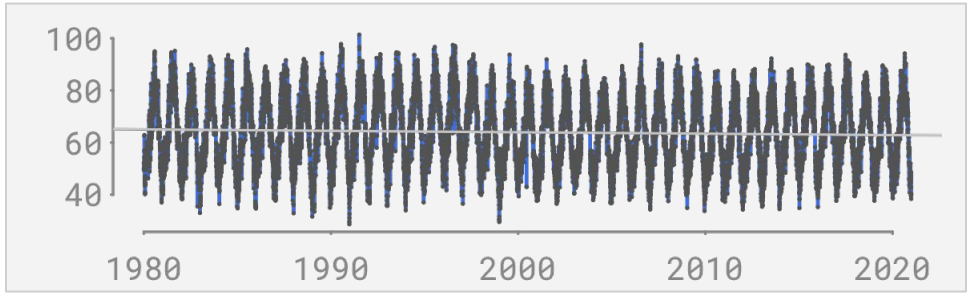

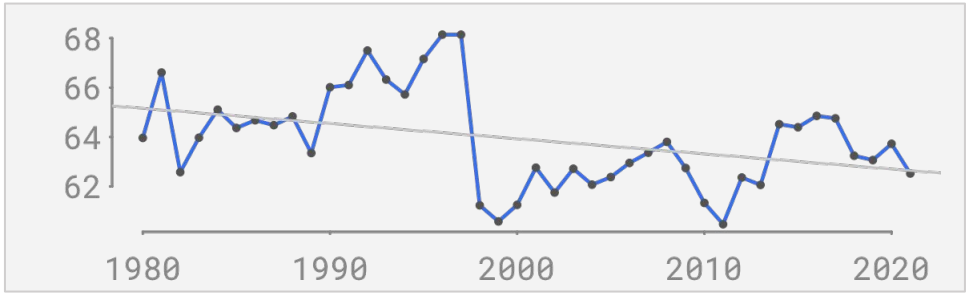

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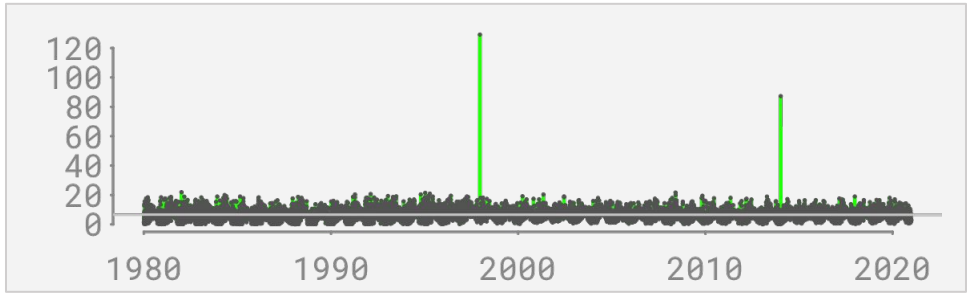
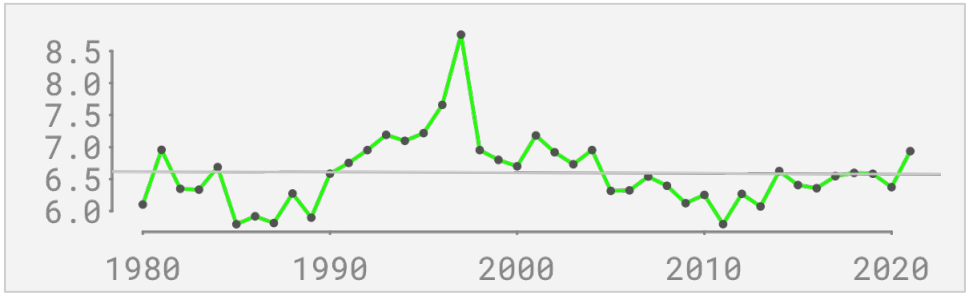




diff log Price, Weather Covariates

				BIC
ARIMA(0,0,0)	H	T	W	29.48383
	H	T		**25.96474**
	H		W	27.95859
		T	W	33.75498
	H			**25.74740**
		T		30.22771
			W	30.05483
				26.58779

				BIC
ARIMA(9,0,7)	H	T	W	55.94549
	H	T		58.31152
	H		W	54.72239
		T	W	58.15431
	H			55.92905
		T		59.17534
			W	57.97431
				52.24535

diff Production, Weather Covariates

				BIC
ARIMA(0,0,1)	H	T	W	560.3088
	H	T		**556.7073**
	H		W	559.8764
		T	W	566.5588
	H			**557.6343**
		T		562.9416
			W	562.8474
				559.2685

				BIC
ARIMA(9,0,0)	H	T	W	573.2787
	H	T		570.4709
	H		W	570.3970
		T	W	573.1860
	H			**566.9554**
		T		570.2323
			W	569.7328
				569.1044

C.I.’s for Weather Condition Coefficients

diff log Price

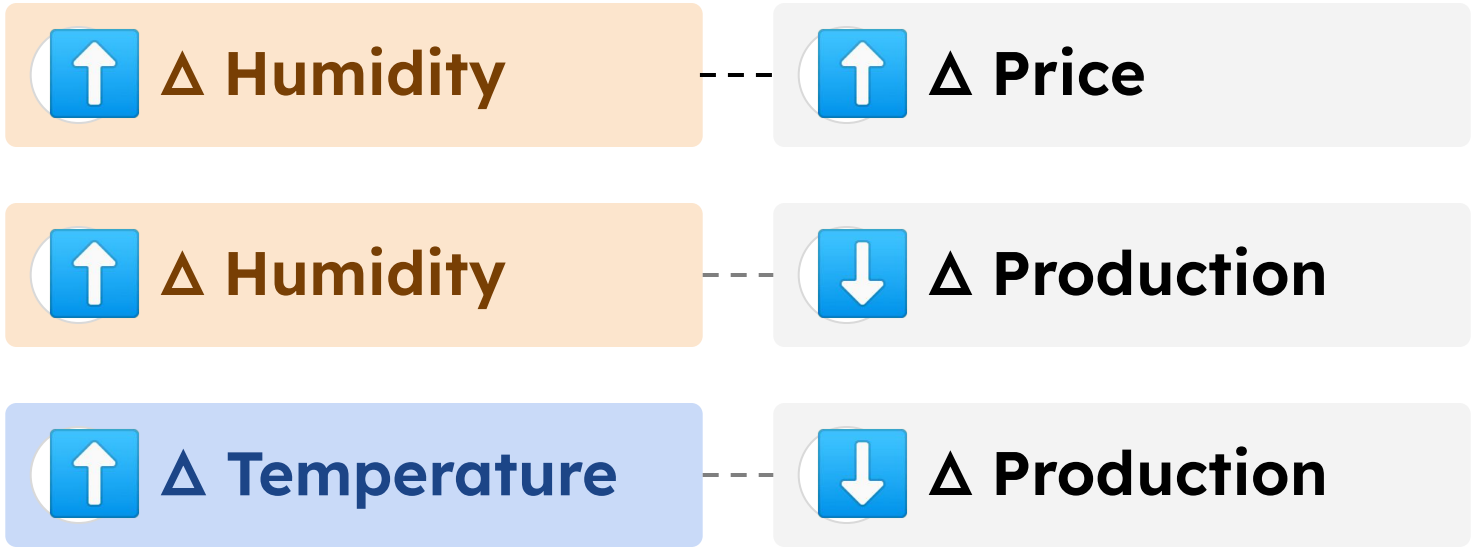
ARIMA(0,0,0)	H		0.0251 ± 0.0115	✔ Significant

diff Production

ARIMA(0,0,1)	H	T	-34.659 ± 10.335	-53.455 ± 24.019	✔ Significant

Conclusions

- Weather regressors reduce model complexity & improve BIC



- *Potential* feature selection (humidity, humidity and temperature)