

A photograph of an oil field with several pumpjacks in the foreground and background. The sky is clear and blue. A large black rectangular box is overlaid on the image, containing the title text. Another smaller black box is overlaid on the image, containing the author's name.

Forecasting Gas Prices in California

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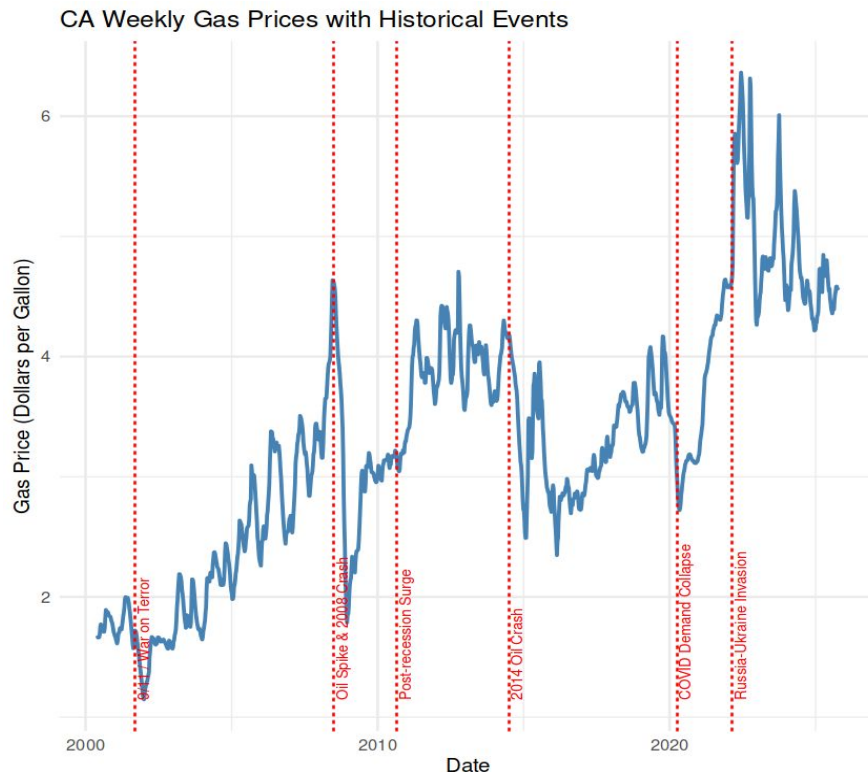
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Motivation

- Gas prices affect everyone: commuters, businesses, and global markets
- Influence inflation, consumer spending, and political decisions
- California gas prices are consistently higher than the U.S. average
- Highly volatile: driven by supply and demand, geopolitics, policies, and global shocks
- Our goal: analyze historical trends and apply forecasting techniques to predict future trends in gas prices

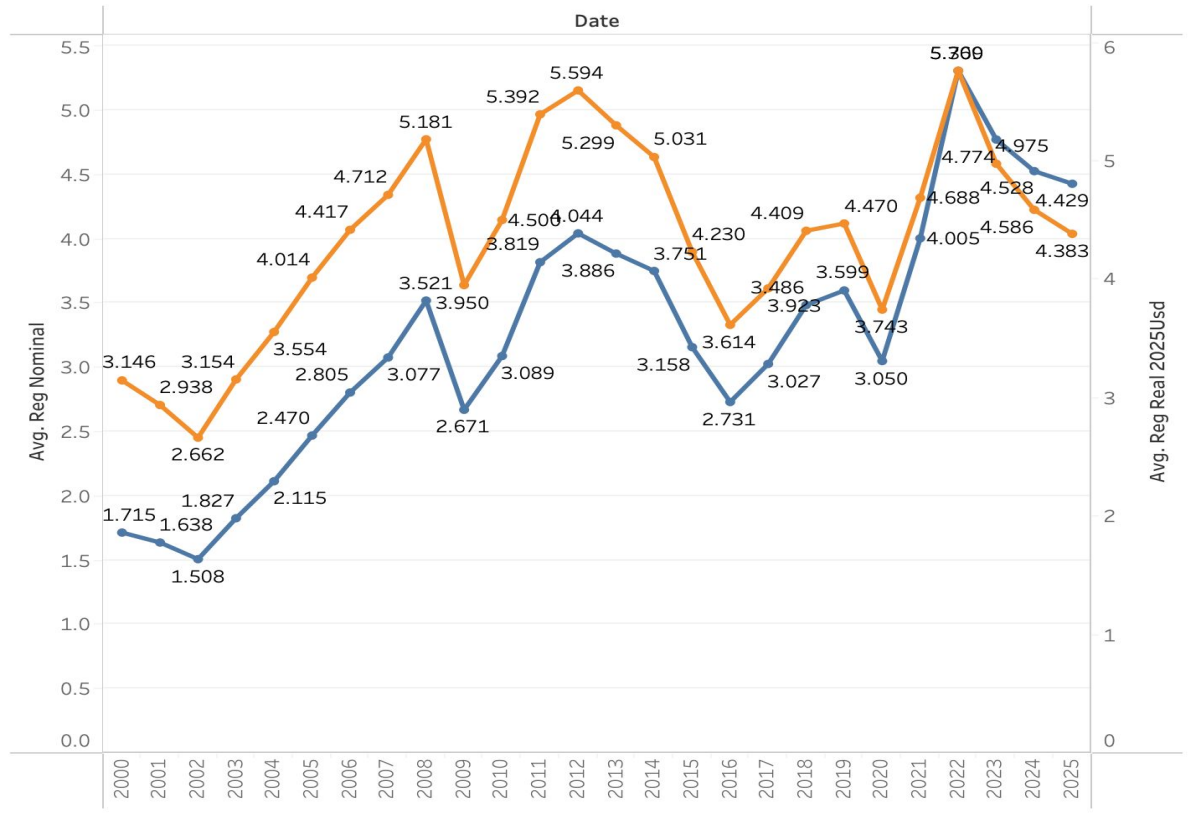
Gas Price Trends Over Time (2000 - Present)



- Long-term upward trend with sharp volatility
- **2001 War on Terror:** early spike
- **2008 Oil Spike & Crash:** sharp rise then collapse
- **2010 Post-Recession Surge:** prices rebounded
- **2014 Oil Crash:** significant drop
- **2020 COVID Demand Collapse:** record lows
- **2022 Russia-Ukraine Invasion:** record highs above \$6

Average Regular CA Gas Prices vs Adjusted for Inflation

- Inflation-adjusted prices allow fair comparisons over time
- Used CPI data from Bureau of Labor Statistics
- January 2025 set as the base month
- **Example:** gas costing \$3.50 per gallon in 2008 is equivalent to \$5.20 per gallon in 2025



9/11 & War on Terror

- The Middle East is home to some of the world's largest oil reserves
- After September 11 attacks, travel and economy slowed down, leading to a drop in gas prices
- Because of the uncertainty, companies started paying more for oil, which made gas more expensive
- As businesses went back to normal over the next year, the demand for gas increased and prices rose steadily



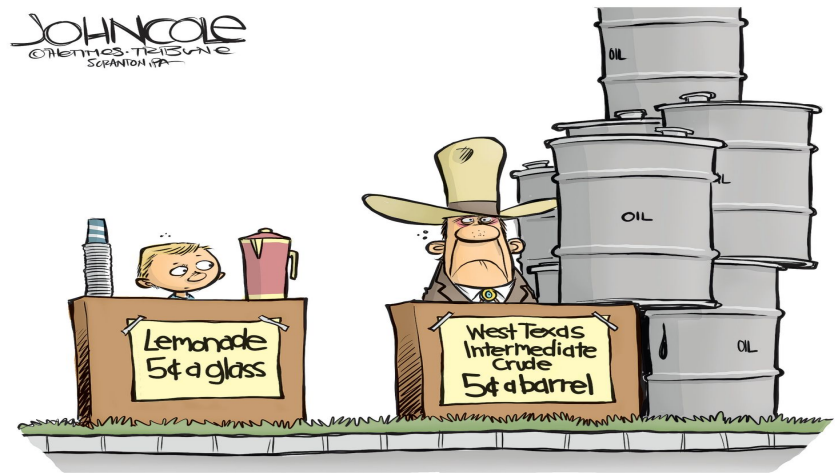
2008 Recession

- Gas prices spiked in mid 2008 as global demand and tight supply drove oil to record highs before the recession
- The financial crisis and economic slowdown caused a steep drop in gas demand and prices
- As the economy stabilized post-2009, prices then rebounded and gradually increased once again



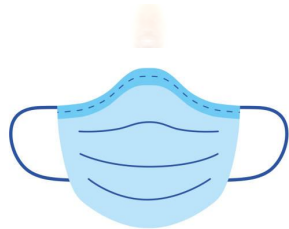
2014 Oil Crash

- Post Recession Surge
- 2014-2016
- U.S. oil production increased from 5 million barrels per day in 2008 to 9 million barrels per day in 2015
- Receding geopolitical concerns
- Shifting OPEC policies
- One of the three biggest declines since WW2



2020 COVID Pandemic

- Global lockdowns caused demand for oil to collapse, pushing prices to record lows
- As economies reopened, demand rebounded faster than supply
- Oil producers and refineries were slow to ramp up production
- Supply chain disruptions created a shortage effect, driving prices higher
- COVID-19 caused a demand-driven increase in gas prices during recovery



2022 Russian-Ukrainian War

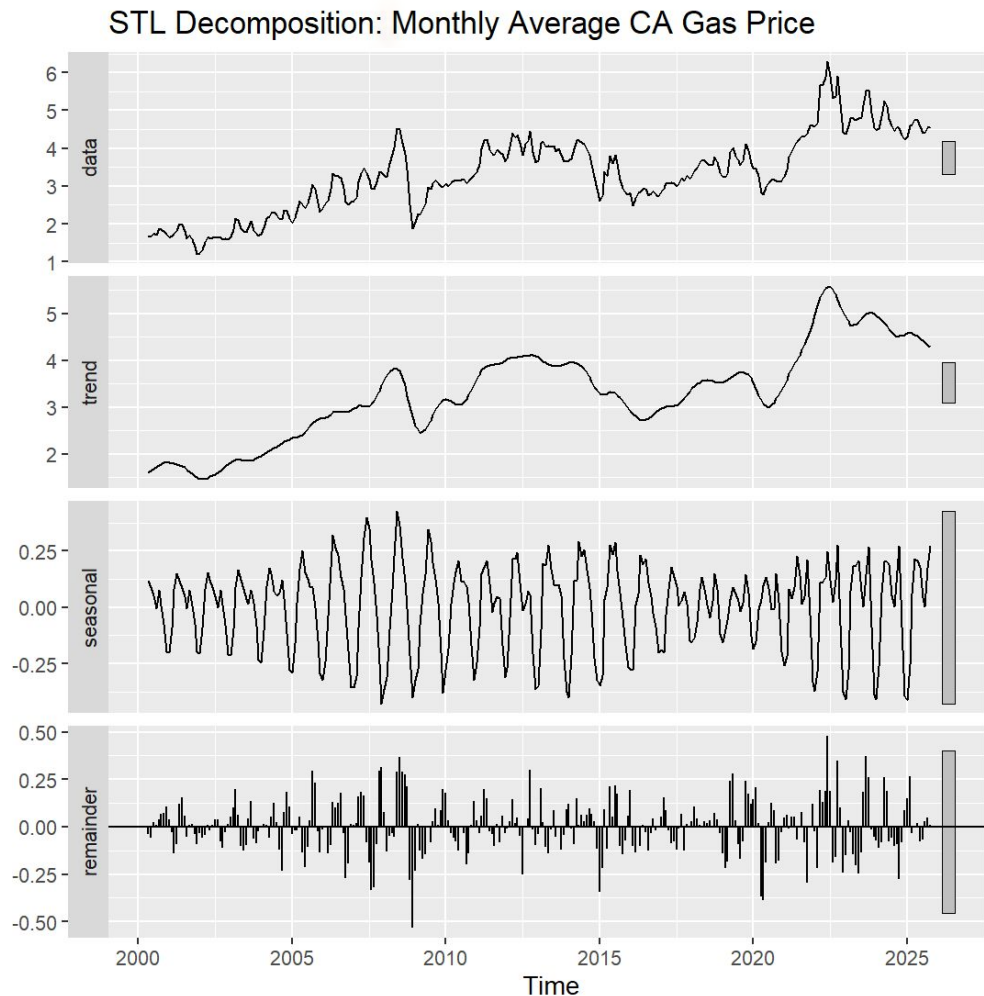
- Russia invaded Ukraine in February 2022
- Russia is one of the world's largest exporters of oil and natural gas
- After the sanctions, the US had to release oil from strategic reserves which only provided short term relief
- The war caused supply-driven increase in gas prices since major global supply was cut off



Seasonal Decomposition

Decomposed data into 3 components:

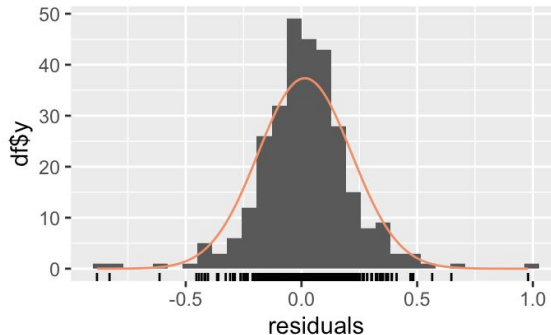
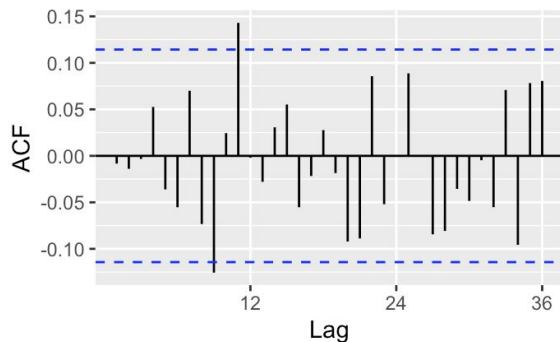
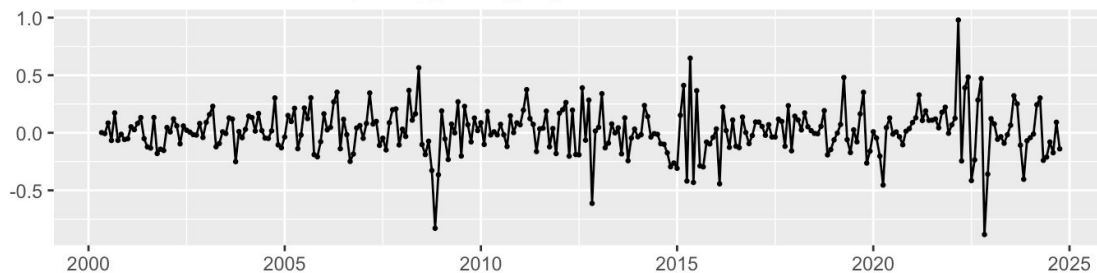
- Trend
- Seasonal
- Residuals



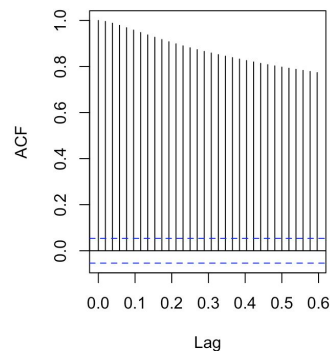
Seasonal ARIMA

- SARIMA(p,d,q)(P, D, Q)s model selected using auto.arima(): **ARIMA(1,1,3)(0,0,1)[12]**

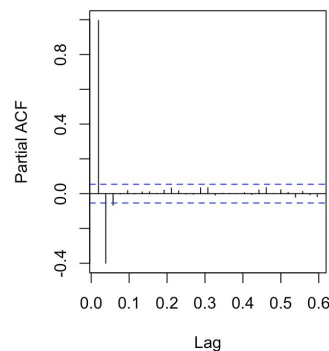
Residuals from ARIMA(1,1,3)(0,0,1)[12]



ACF of Weekly Gas Prices

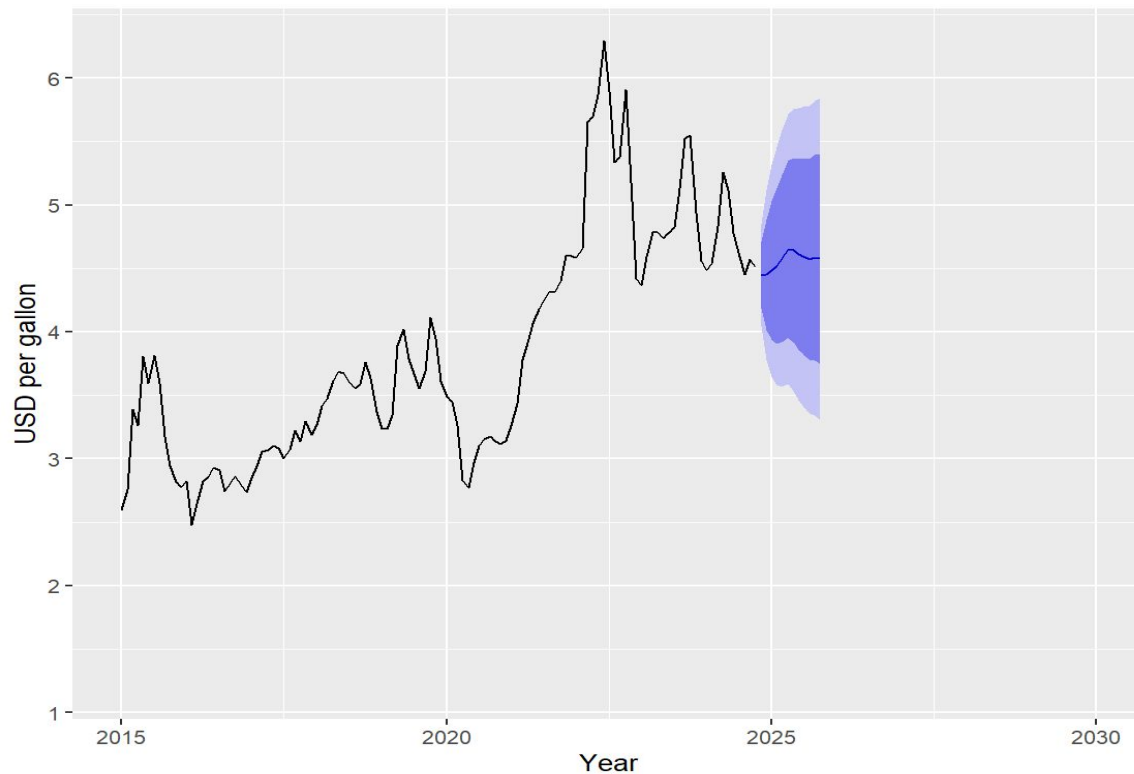


PACF of Weekly Gas Prices

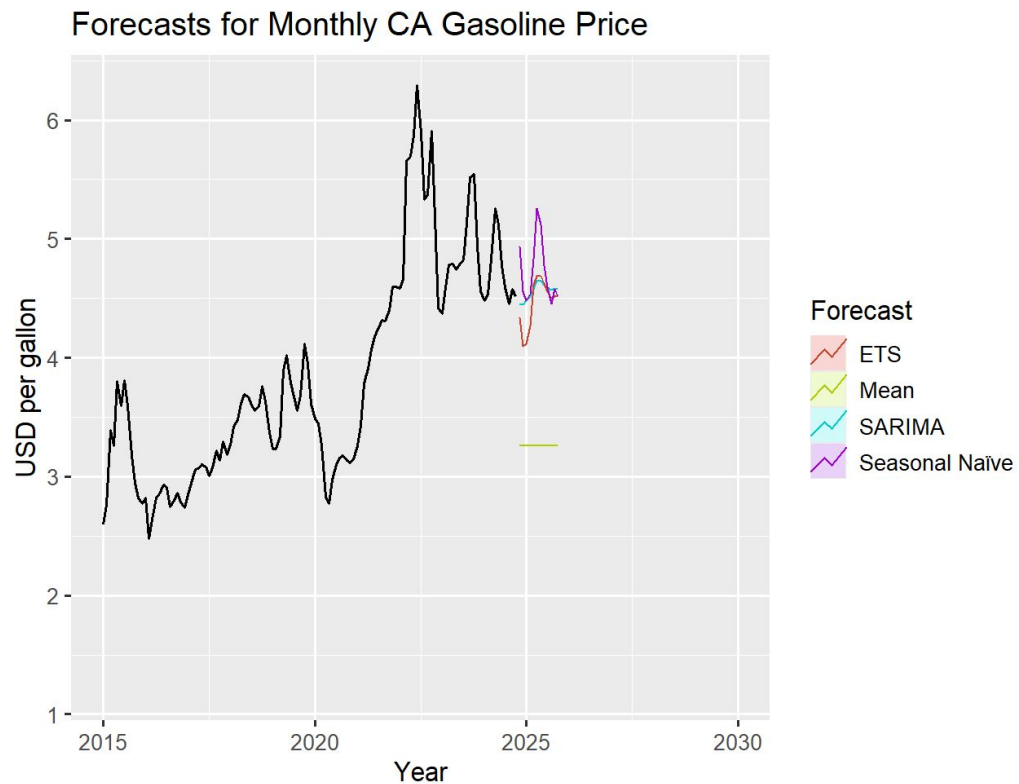


Seasonal ARIMA Forecast

SARIMA Forecast: Monthly CA Gas Price



Forecast Comparison



	RMSE	MAE	MAPE
S-ARIMA	0.12	0.101	2.265
Exponential Smoothing (ETS)	0.133	0.101	2.257
Seasonal Naïve	0.287	0.227	5.04

Forecast Based on Expert Judgement

- **EIA** forecasts a further decrease of about 18¢ /gal ($\approx 6\%$) in 2026 for U.S. average retail gasoline prices.
- **Nationwide gas consumption** is expected to decline as vehicle fleet efficiency continues to improve.
- **Exception:** West Coast region is projected to see higher gas prices.
 - Closure of Phillips 66 refinery will lead to reduced regional production



Conclusion

- **Key Findings:**
 - Our models were fitted to capture potential seasonal patterns in gas prices
 - The models produced different predictions, ranging from around \$4.10 to \$4.60 (Seasonal Naive) in comparison to the mean of \$3.25, indicating forecast uncertainty
- **Challenges in Forecasting Gas Prices:**
 - Volatility within historical data dominates underlying seasonal patterns and makes it difficult to distinguish visually
 - Major price spikes correspond to external shocks such as the COVID-19 pandemic
 - Limitations to time series forecasting as it cannot predict geopolitical events, economic shocks, or policy changes that drive price movements
- **Potential next steps: increase model complexity**
 - Perhaps consider probabilities of certain world events occurring