# Manhattan Rental Market

## Is it as easy as supply and demand?

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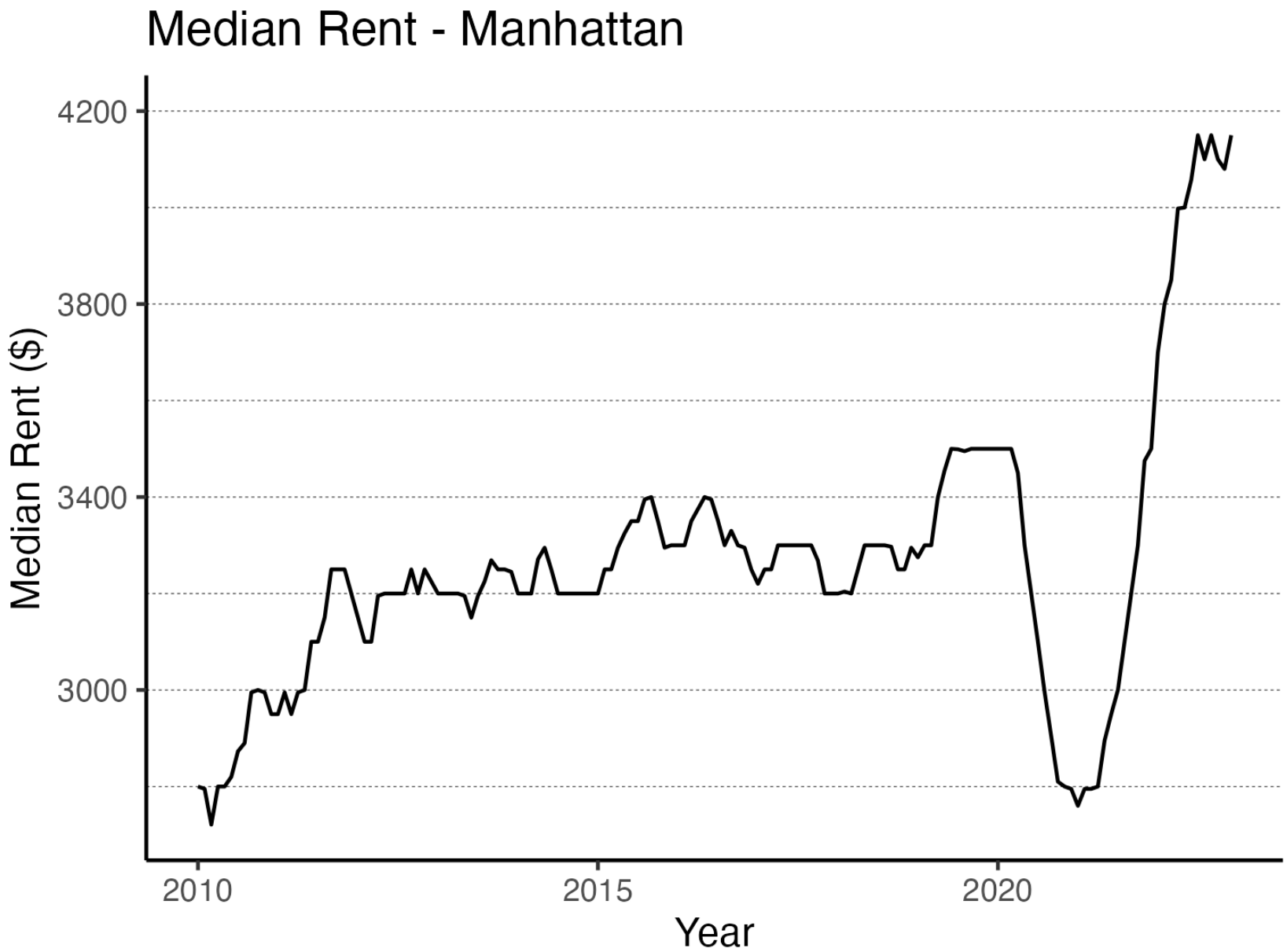
# Introduction

- The onset of COVID-19 led to a pronounced urban flight, especially in New York City - the largest rental market in the United States (Whitaker, 2021; Coven et al., 2022)
- This rapid shift precipitated "COVID discounts" on rent...
- ... followed by a rebound period of returning residents and swift increase in rents
- We explore COVID's intertwined effects on NYC rent and rental inventory

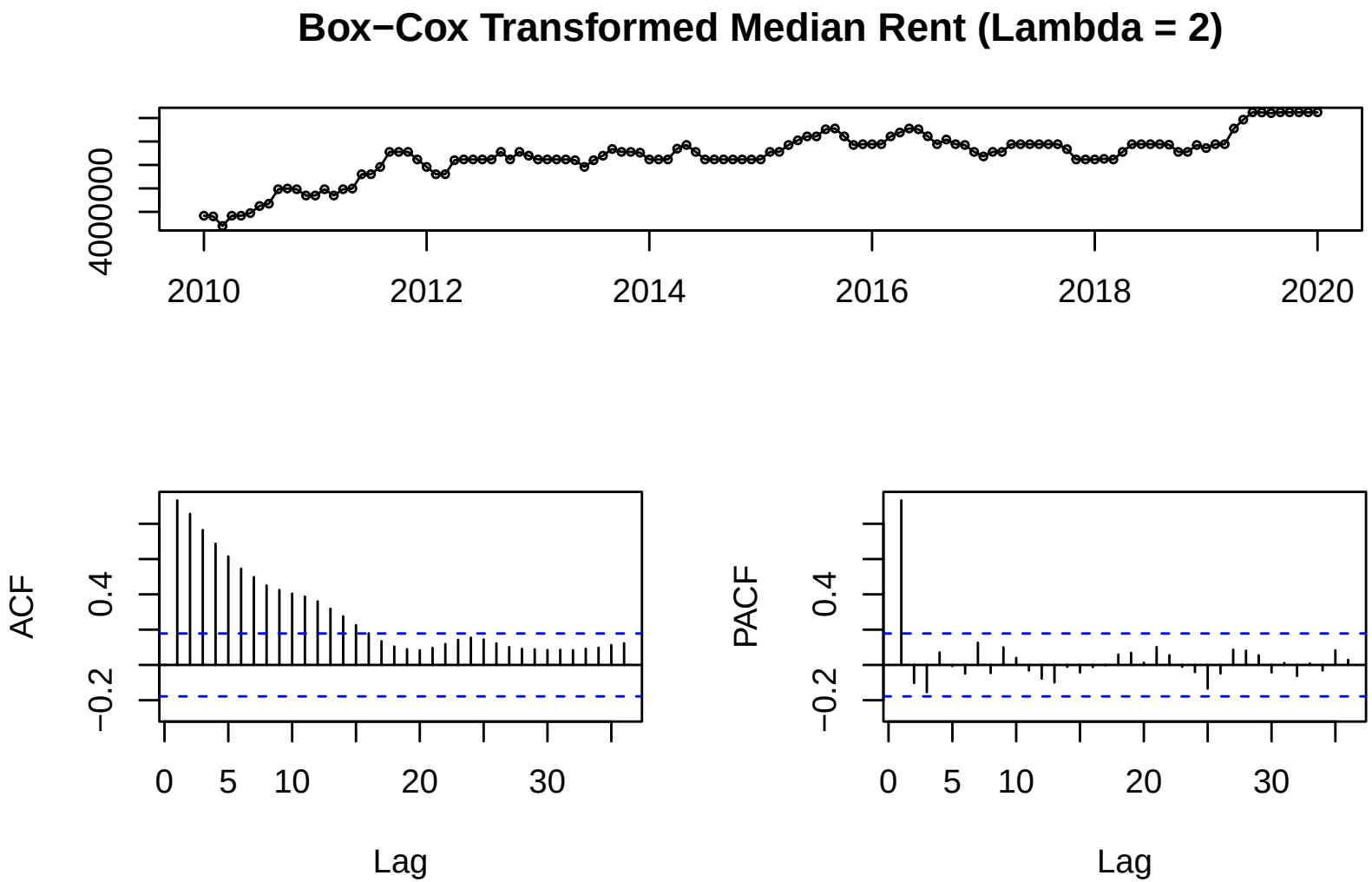
# Data

- Data from StreetEasy, a NYC Zillow subsidiary
- StreetEasy publishes monthly series for a number of sale and rental indicators based on its thousands of listings
- To narrow scope, we specifically look at Manhattan monthly median asking rent and rental inventory
- We use January 2010 - January 2020 as training data and in a cross-validation approach to assess in-sample model performance
- We also estimate the effect of COVID in the February 2020 - December 2022 period

# Median Rent Data



# Box-Cox Transformed Median Rent



# Models

We fit 4 different models:

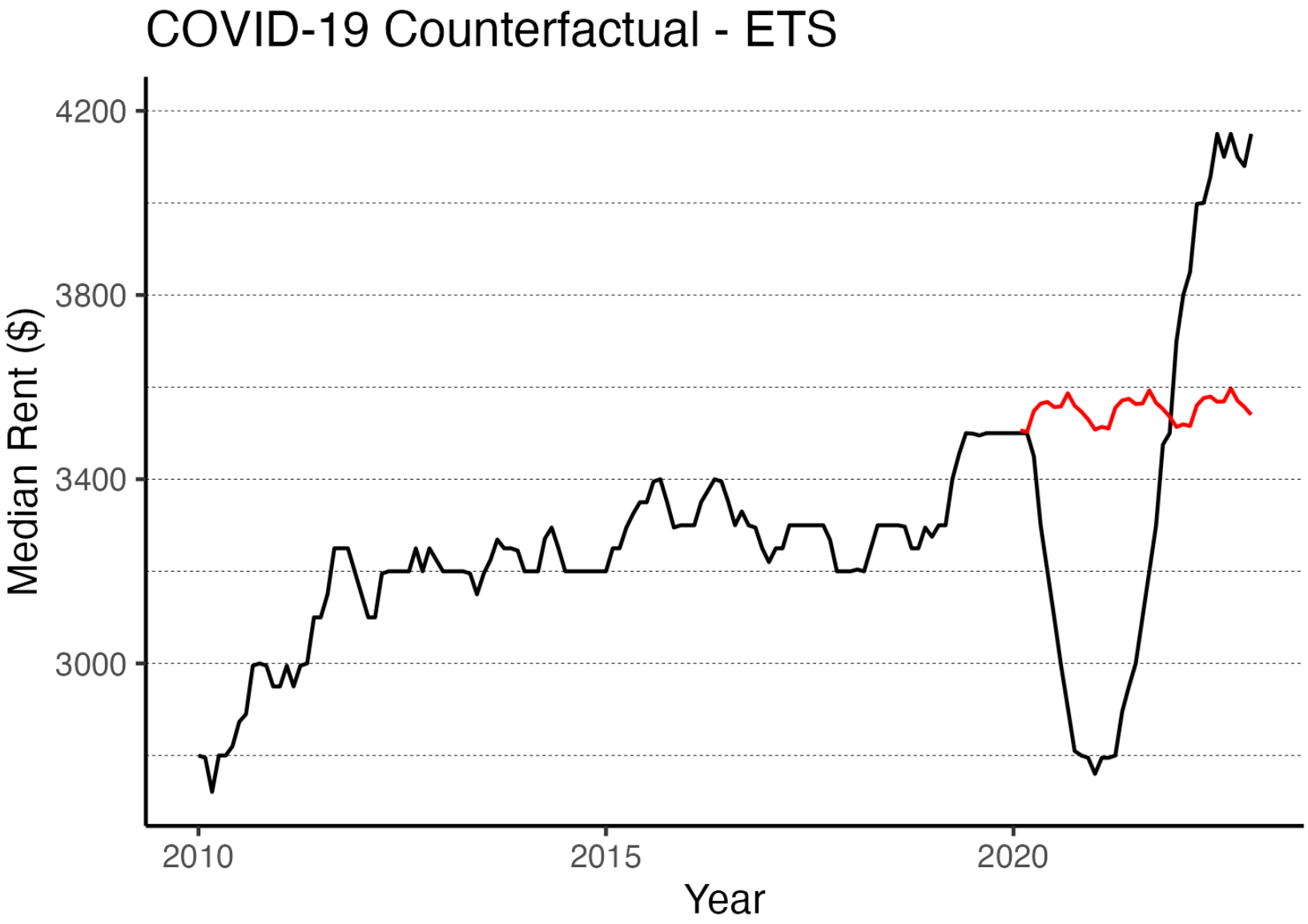
1. Seasonal Exponential Smoothing (ETS)
2. Seasonal Autoregressive Integrated Moving Average (sARIMA)
3. Vector Autoregression (VAR)
4. Regression with ARMA errors

- Each model is evaluated on in-sample performance and COVID-period analysis
- Seasonality is annual for all models

# Exponential Smoothing and sARIMA

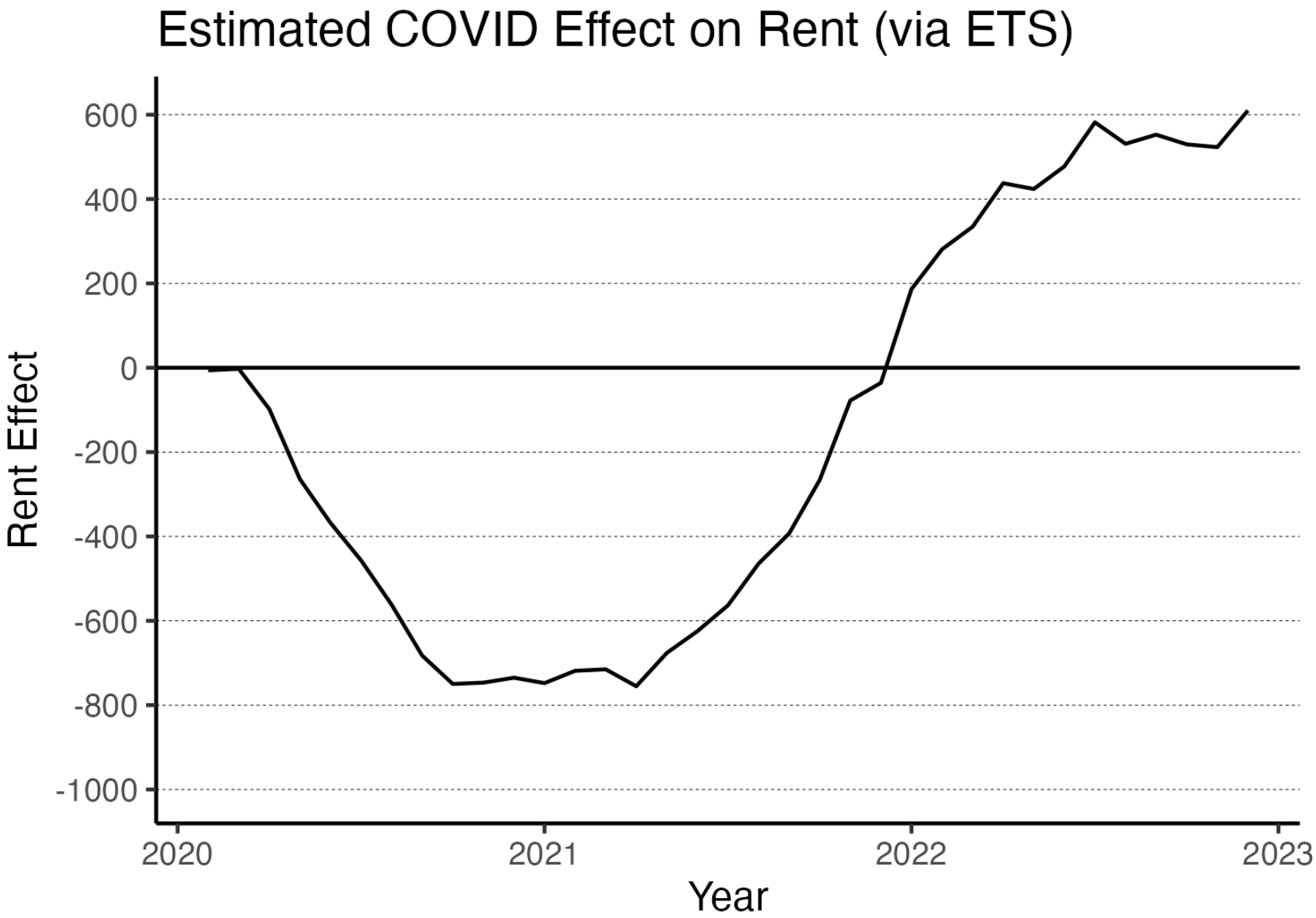
- Minimum-AICc ETS model is damped additive, and dominated by error term: AAA with $\alpha \approx 1$, $\beta \approx \gamma \approx 2 * 10^{-4}$, $\phi = 0.97$
- Minimum-AICc model is $ARIMA(0,1,0),(2,0,0)_{12}$: nonseasonal component is just first difference, while seasonal component is $AR(2)$; no drift needed
- Both approaches produce white noise residuals as verified by Ljung-Box test

# Rent Counterfactual (ETS)



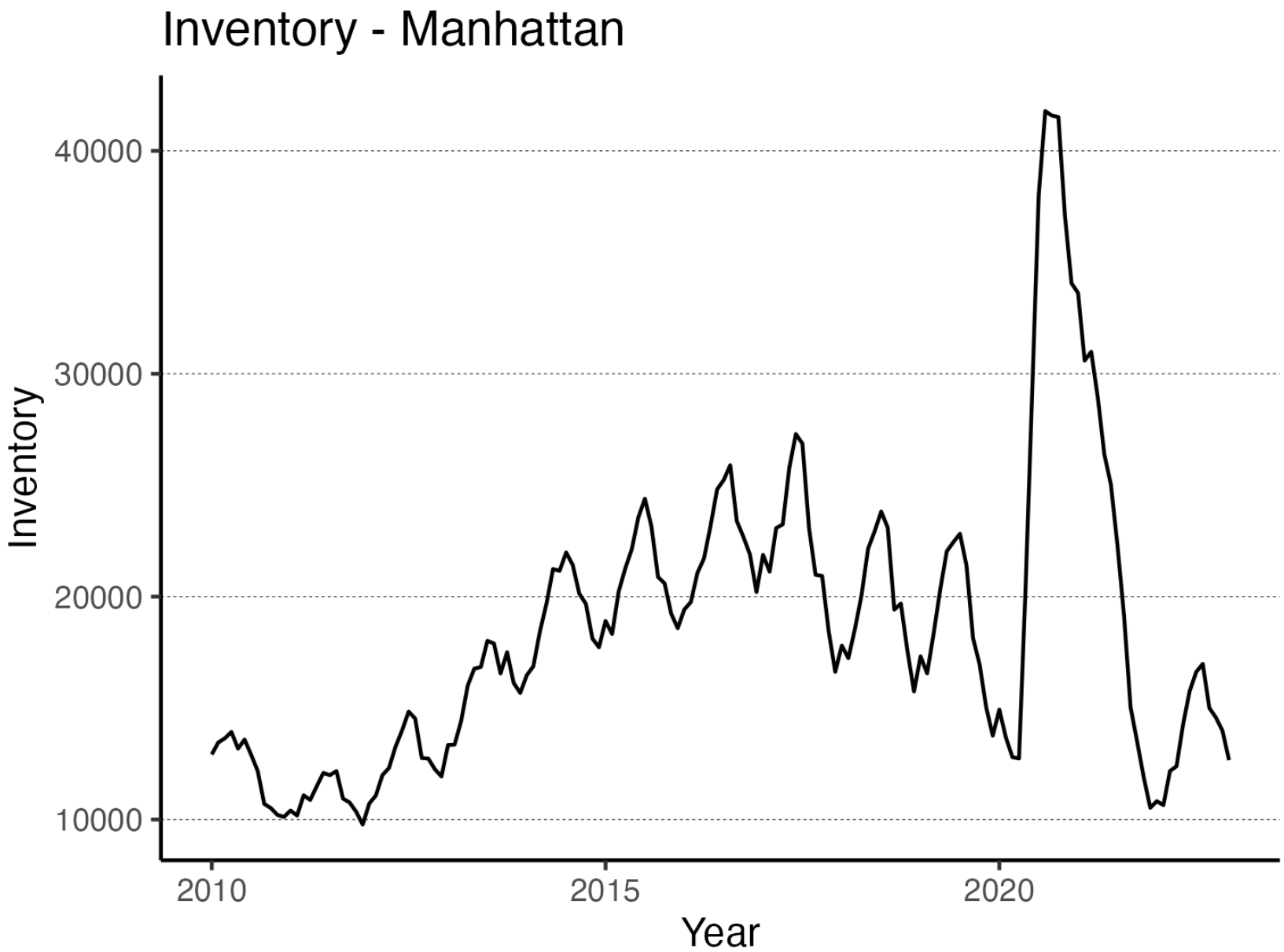

Forecasted values of ETS(A,Ad,A) in red.

# Effect of COVID on Rent

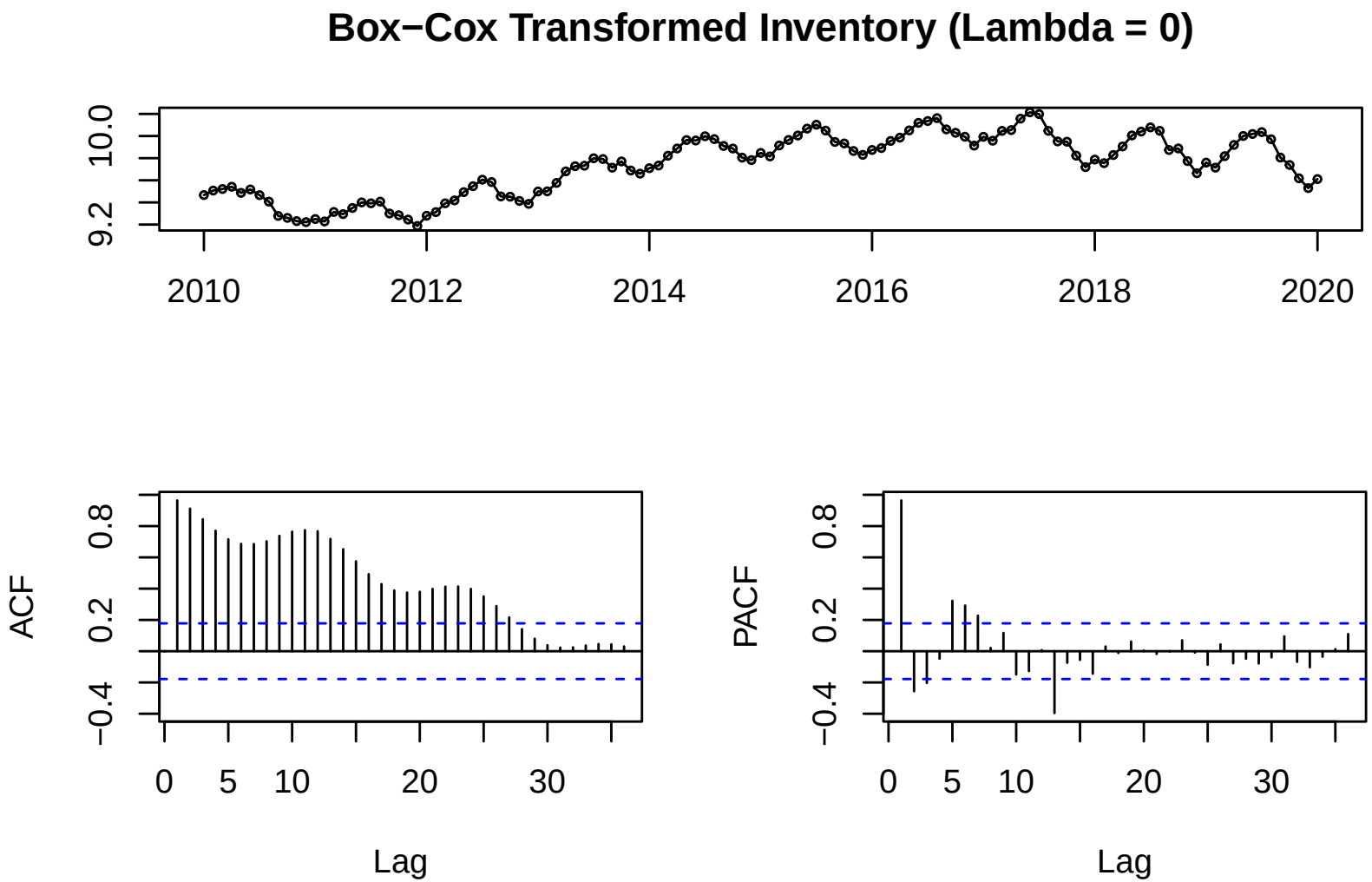



Effect in relation to pre-COVID model predictions.

# Listing Inventory Data



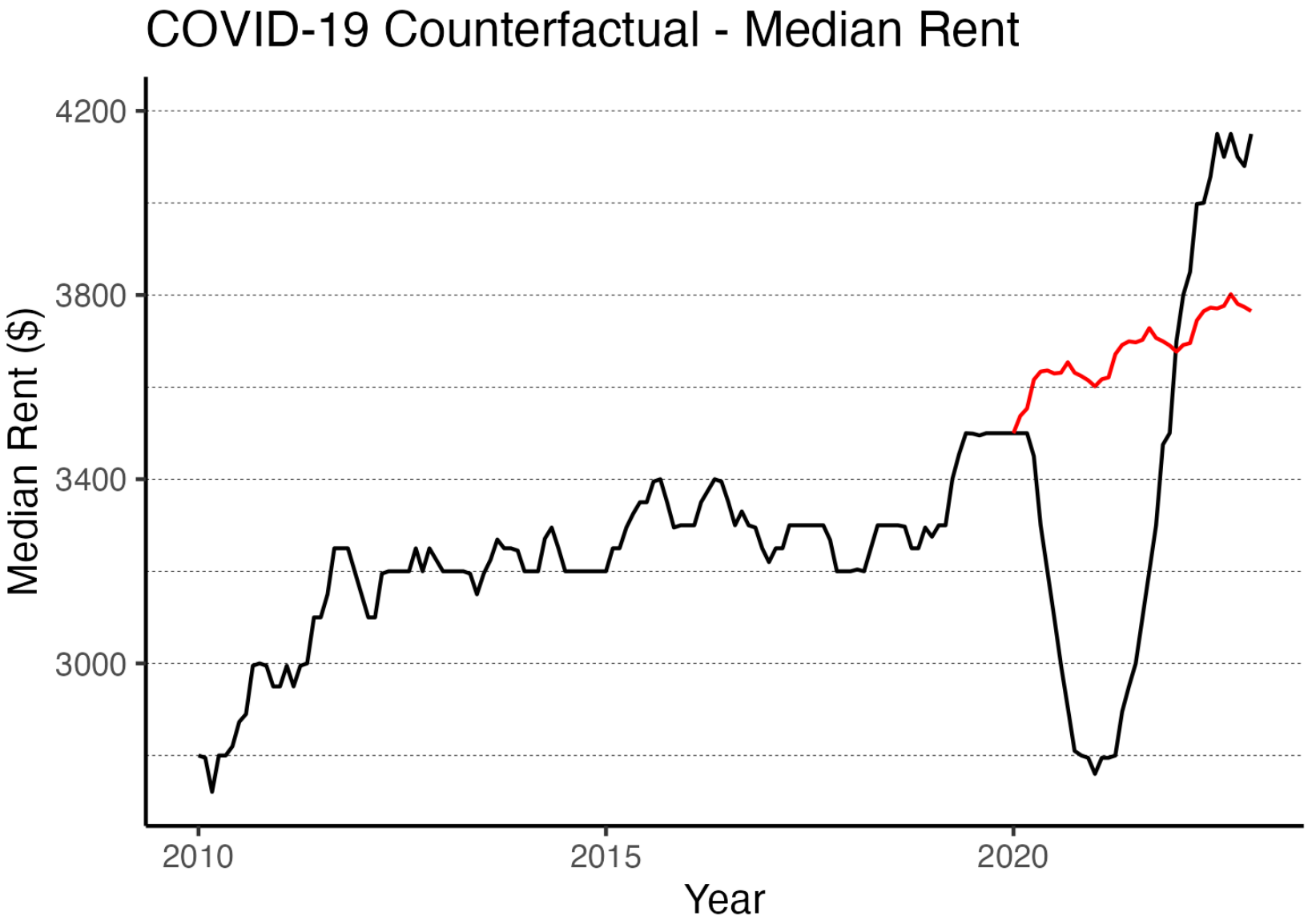
# Box-Cox Transformed Listing Inventory



# VAR

- We test the hypothesis that listing inventory and rent are **endogenous** with a $VAR(5)$ model
- Surprisingly, there is largely no significant predictive relationship between the two
- Select lags of inventory are significant in median rent, but not lags of rent are significant in inventory
- Though intervention analysis is more complex in the multivariable case, this provides us with a "COVID counterfactual"— what if COVID-19 never happened?

# Rent Counterfactual (VAR)

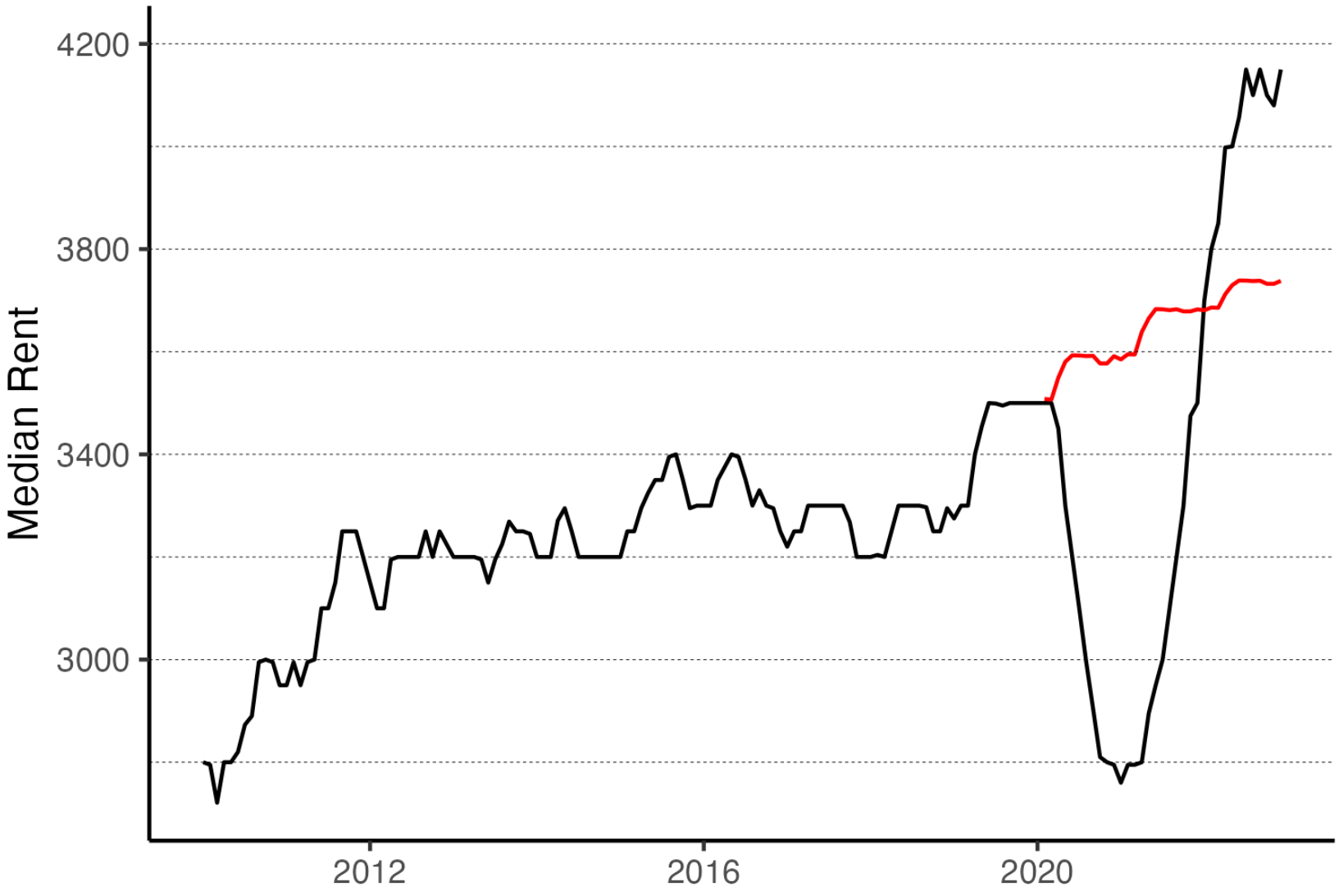



Forecasted values of VAR(5) model in red.

# Regression with ARIMA Errors

- Interpretable way to factor in the relationship of an independent variable
- OLS estimation, while allowing for standard errors to follow ARIMA process
- Using listing inventory as a covariate, but now determined **exogenously**
- Inventory forecasted using $ARIMA(0,1,0)(0,1,1)_{12}$ with $\lambda = 0$

# Rent Counterfactual (Regression w/ ARIMA Errors)




Forecasted values of Regression with Arma Errors model in red.

# In-Sample Cross-Validation on Median Rent

# Conclusion

- Multiple basic approaches produce solid, fairly equivalent models of Manhattan rent in the pre-COVID period
- COVID's onset marked a major departure from stationarity; intervention analysis methods show it has had a lasting impact on rent (despite a return to baseline of rental inventory)
- Rental inventory has limited use as a predictor of future rents, but not vice versa

# Future Work

- Continued impact of COVID: With more time will rent slowly return to "steady state" level and trend?
- Would data from a more comprehensive sample of rental units yield different results? Does StreetEasy have an upward/downward bias in rental price or inventory?
- What is the interaction between rents (and inventory) in different neighborhoods, or even different cities? Can we estimate spillover effects?
- Is inventory too aggregated of a variable? It represents equilibrium effects—would showing more demand/supply side variables of the rental market be more advantageous?

# References

Coven, J., Gupta, A., Yao, I. (2022). JUE Insight: Urban Flight Seeded the COVID-19 Pandemic Across the United States. Journal of Urban Economics, 103489.

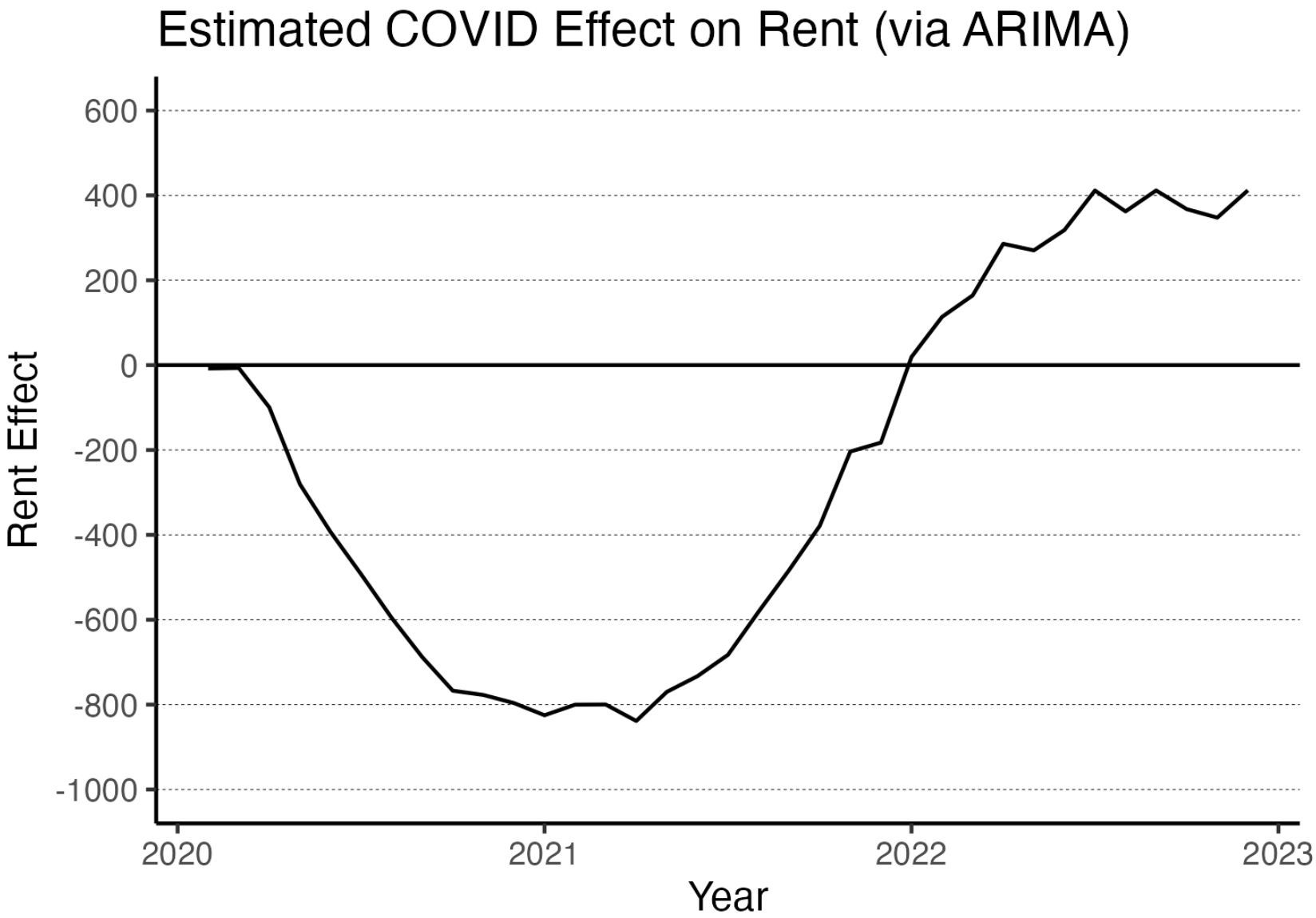
Whitaker, Stephan D. 2021. "Did the COVID-19 Pandemic Cause an Urban Exodus?" Federal Reserve Bank of Cleveland, Cleveland Fed District Data Brief . https://doi.org/10.26509/frbc-ddb-20210205

# Appendix

# Individual Contributions

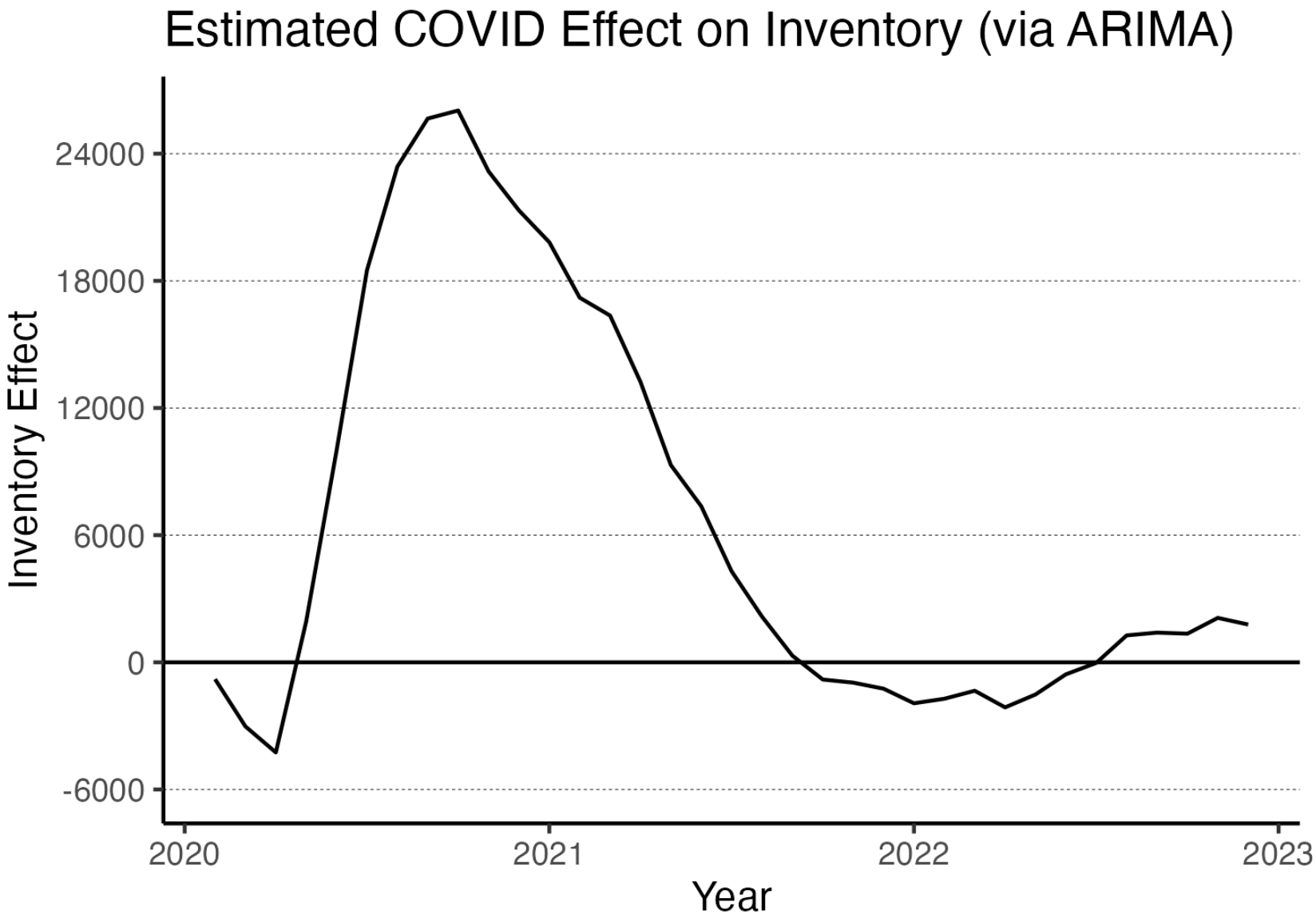
- Wesley: Quality control on modeling, futile attempt at sVARIMA model, slide creation logistics
- Drew: Dataset finding, sARIMA and ETS modeling, base cross-validation script
- Sergio: VAR modeling, slide editing
- Michael: Regression with ARIMA Errors modeling, slide editing

# COVID-19 Effect on Median Rent



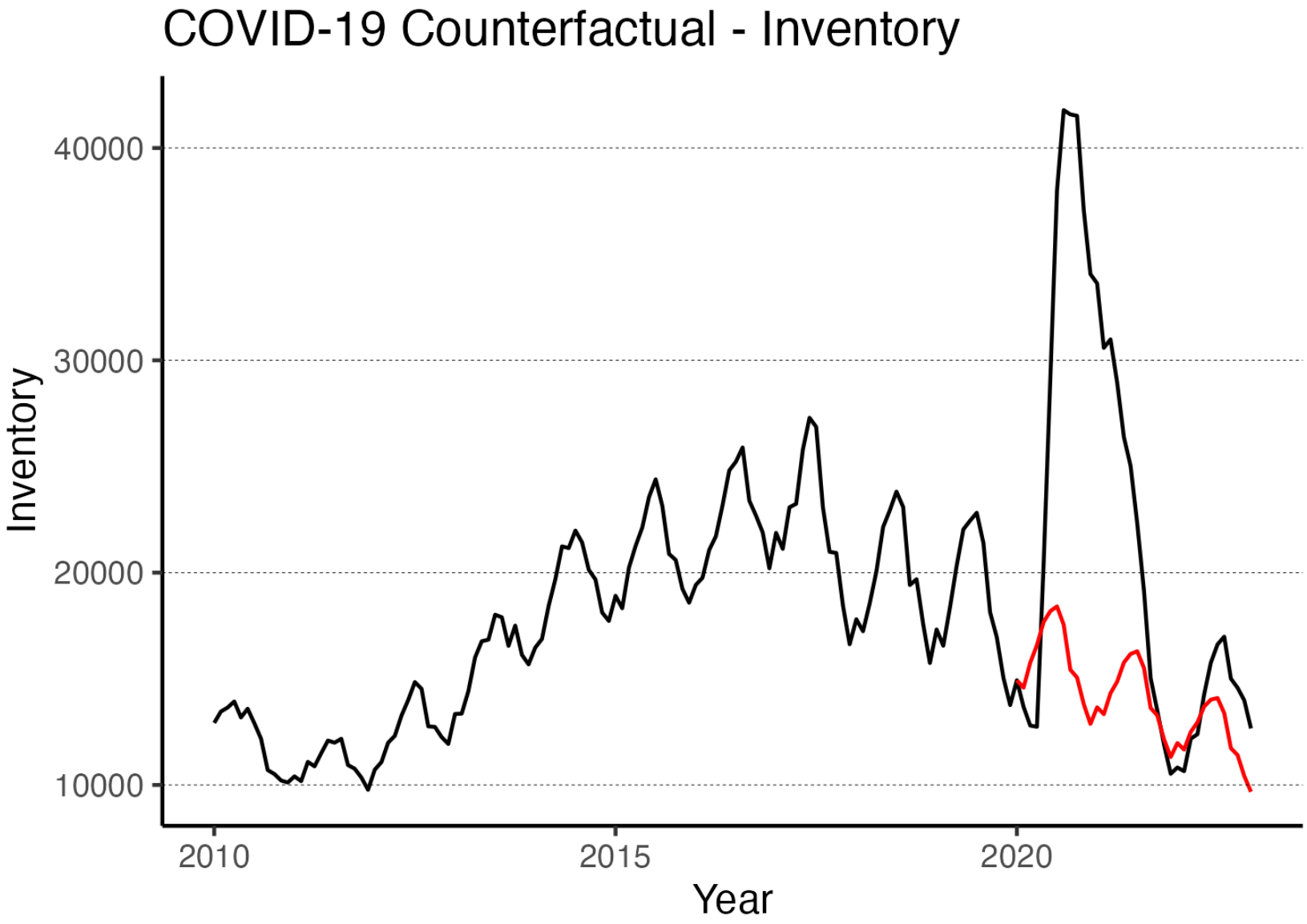

Effect in relation to pre-COVID model predictions.

# COVID-19 Effect on Inventory



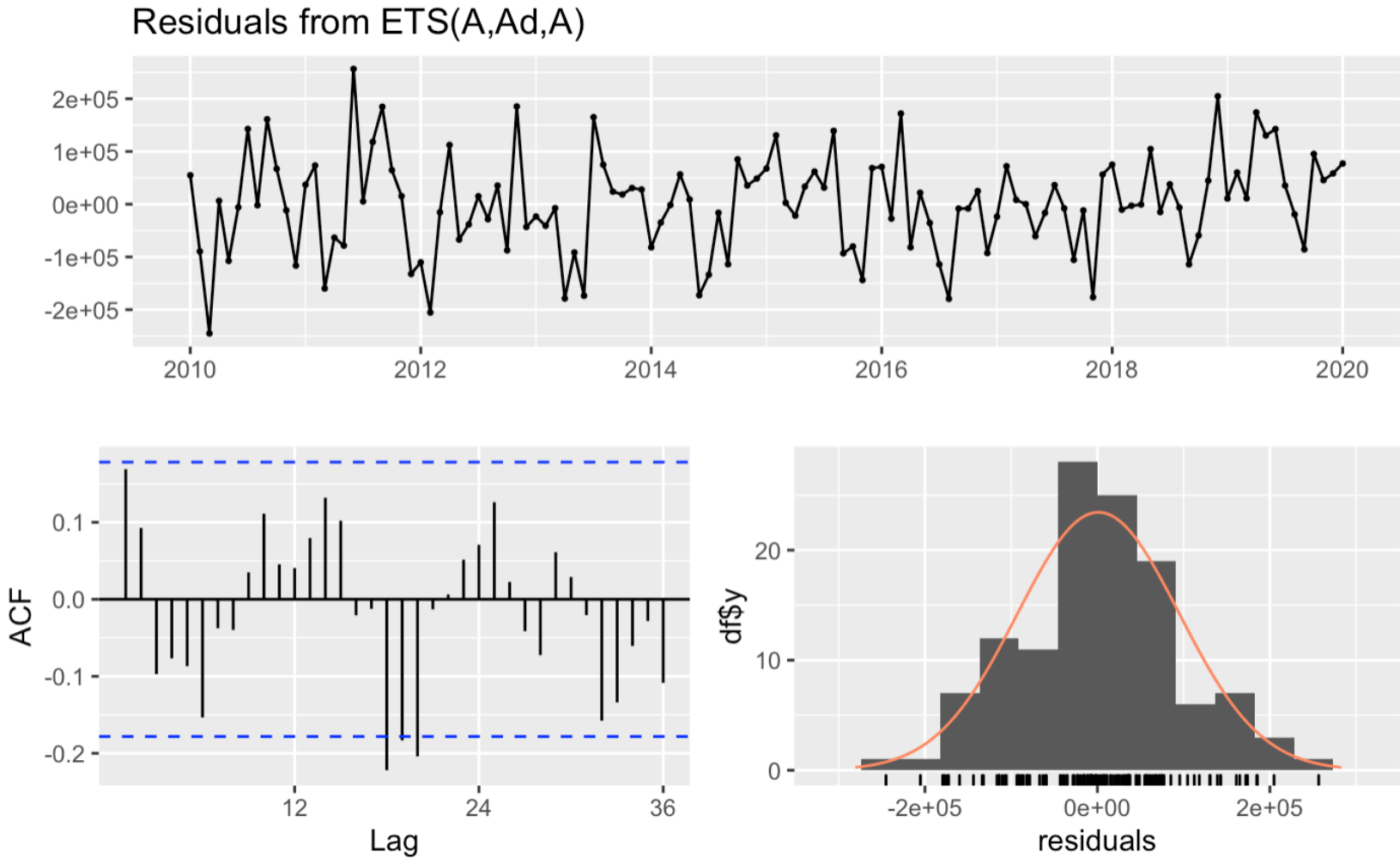

Effect in relation to pre-COVID model predictions.

# Inventory Counterfactual (VAR)

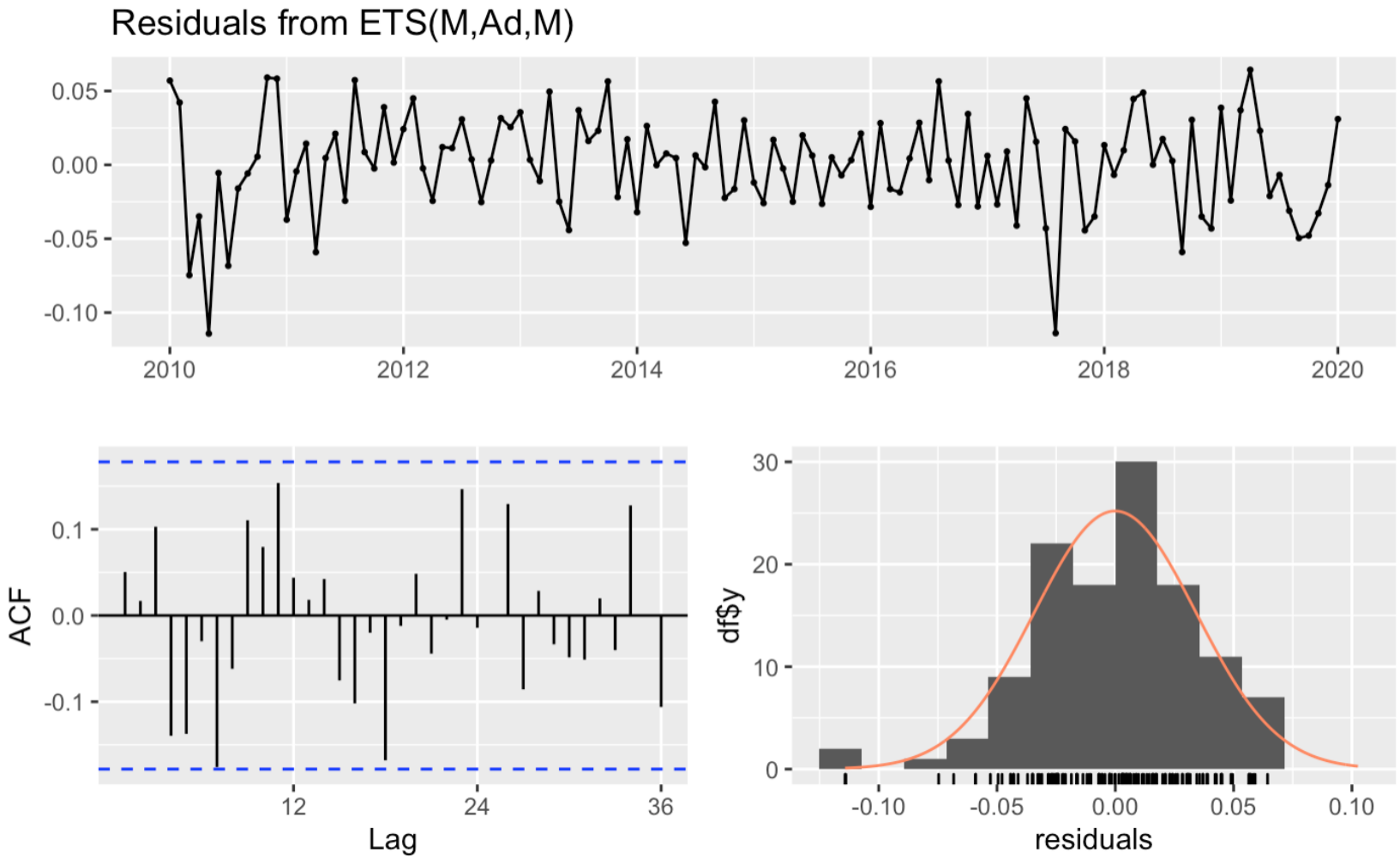



Forecasted values of VAR(5) model in red.

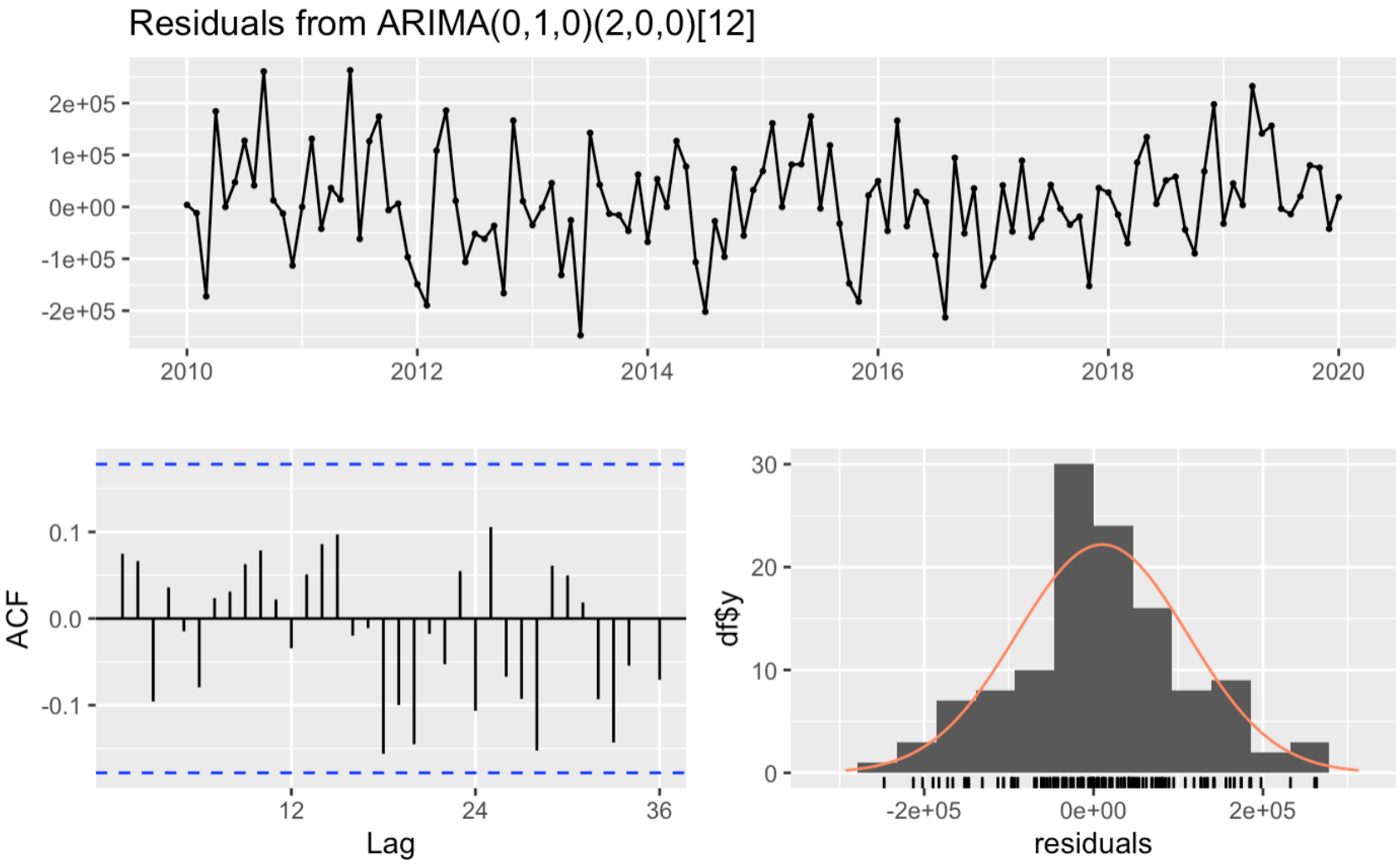
# ETS Model Residuals (Median Rent)



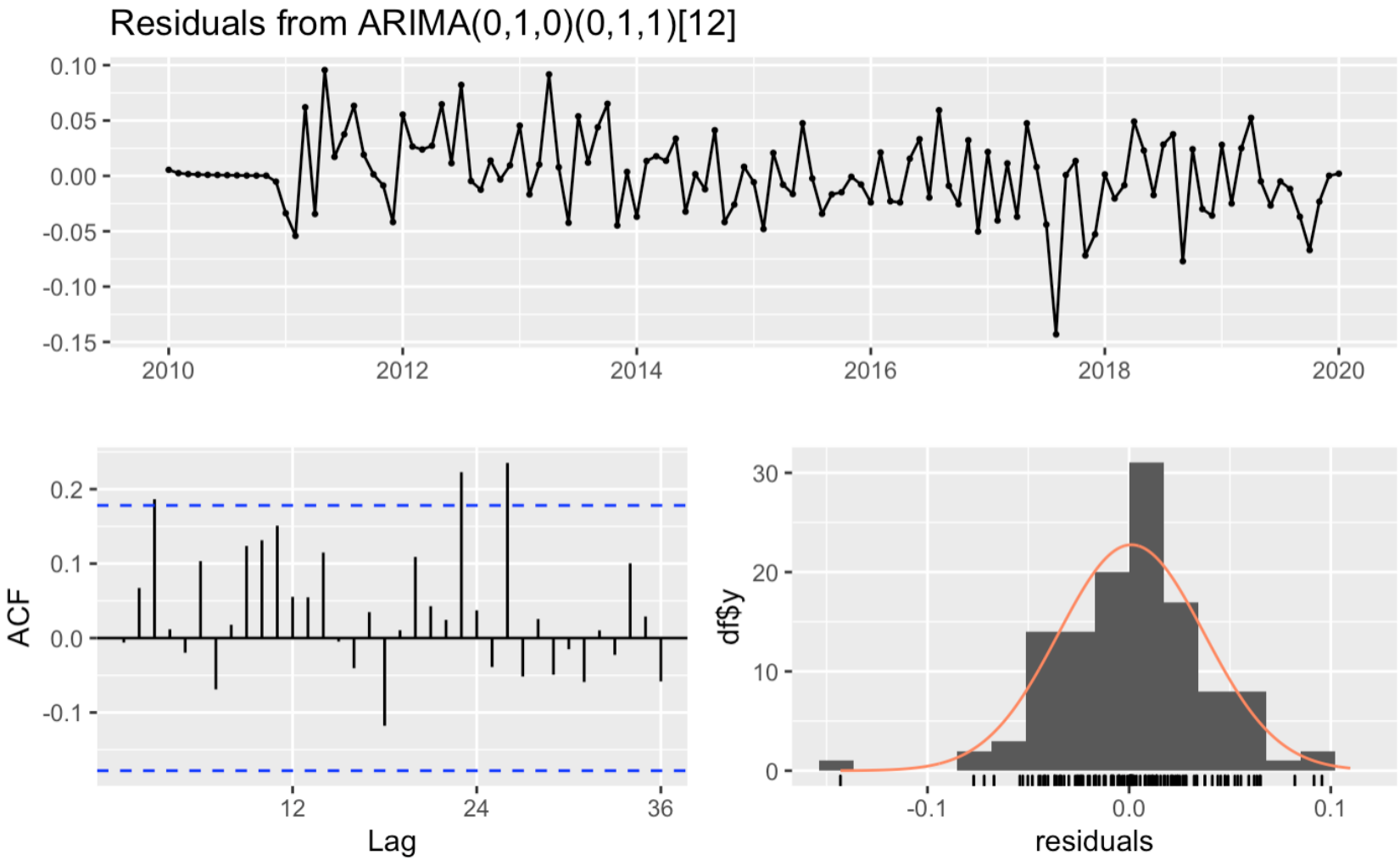
# ETS Model Residuals (Listing Inventory)



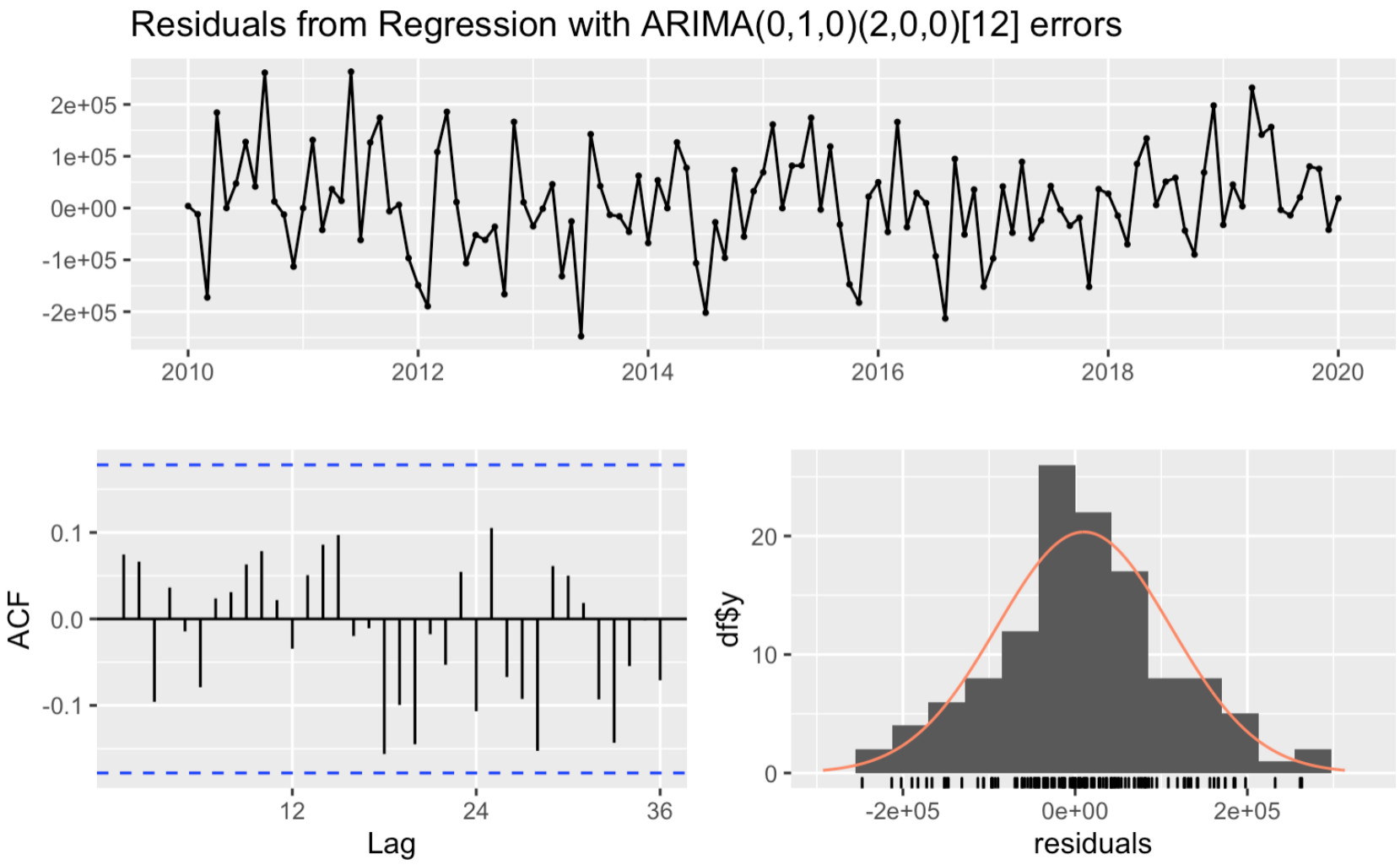
# sARIMA Model Residuals (Median Rent)



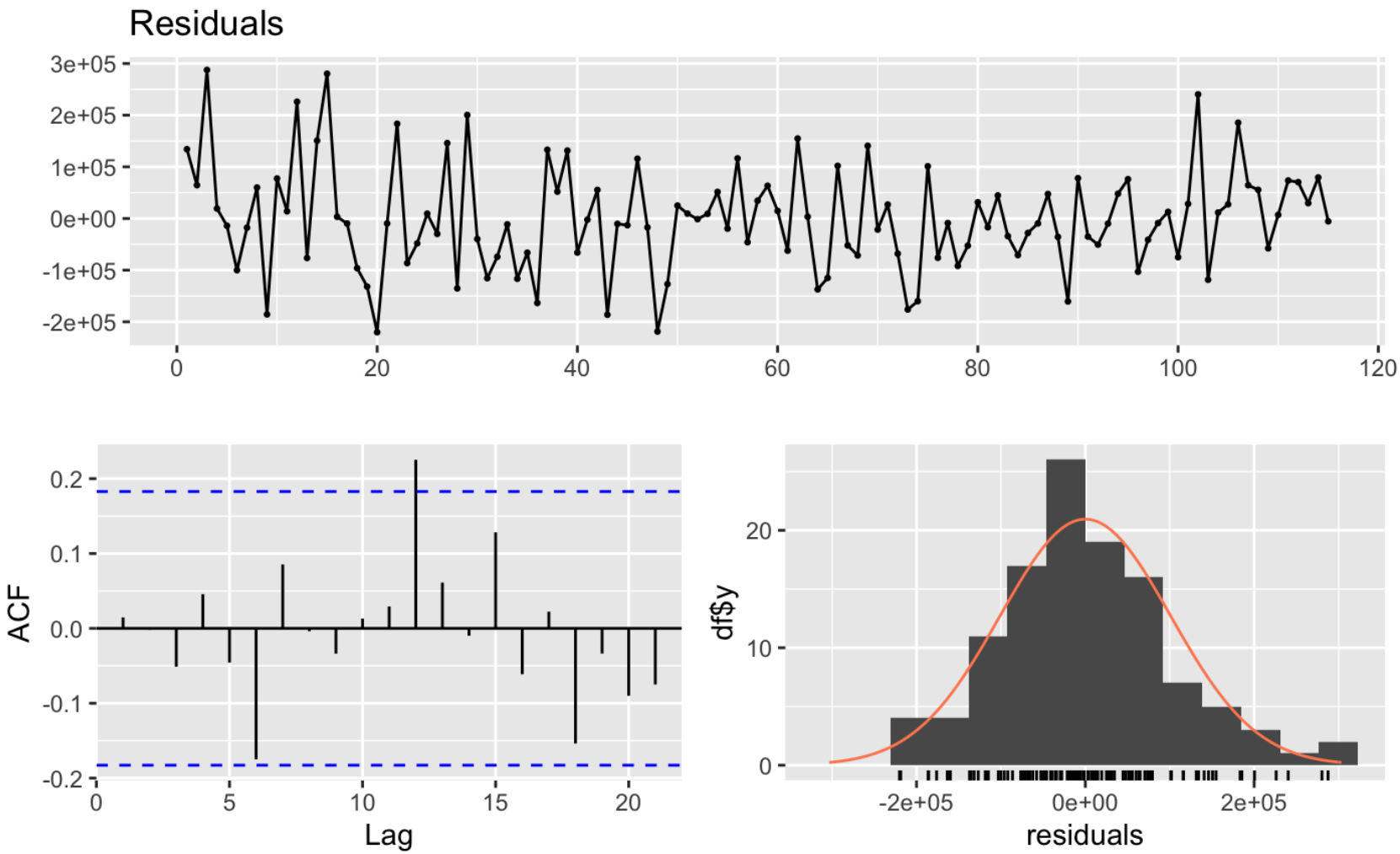
# sARIMA Model Residuals (Listing Inventory)



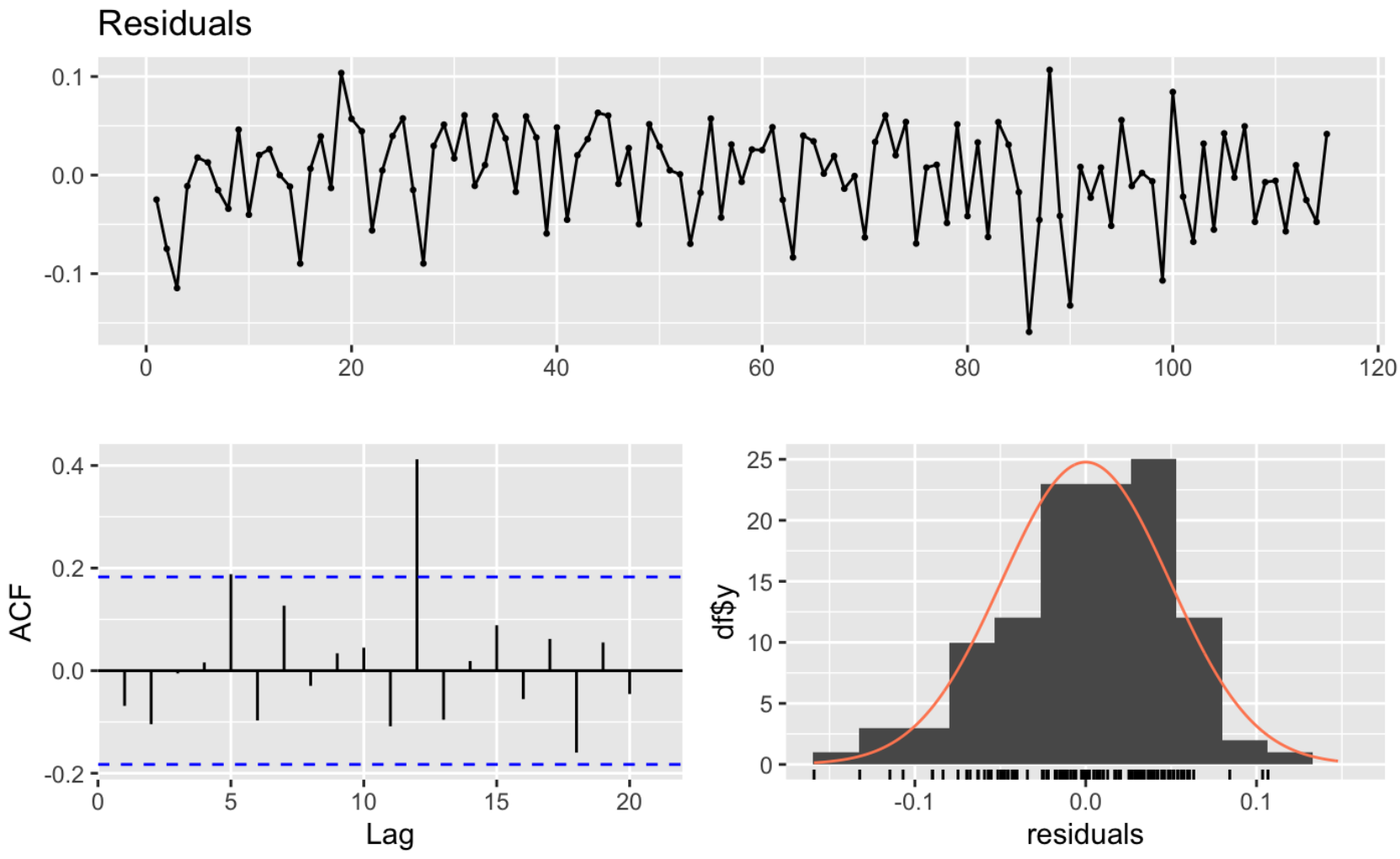
# Regression with ARIMA Errors Residuals



# VAR(5) Model Residuals (Median Rent)



# VAR(5) Model Residuals (Listing Inventory)



# VAR(5) Model CCF of Residuals