

A Tale of Two (Ideally More) Cities



**Impact of San Francisco's Short-term Rental Regulation
on the Airbnb Marketplace**

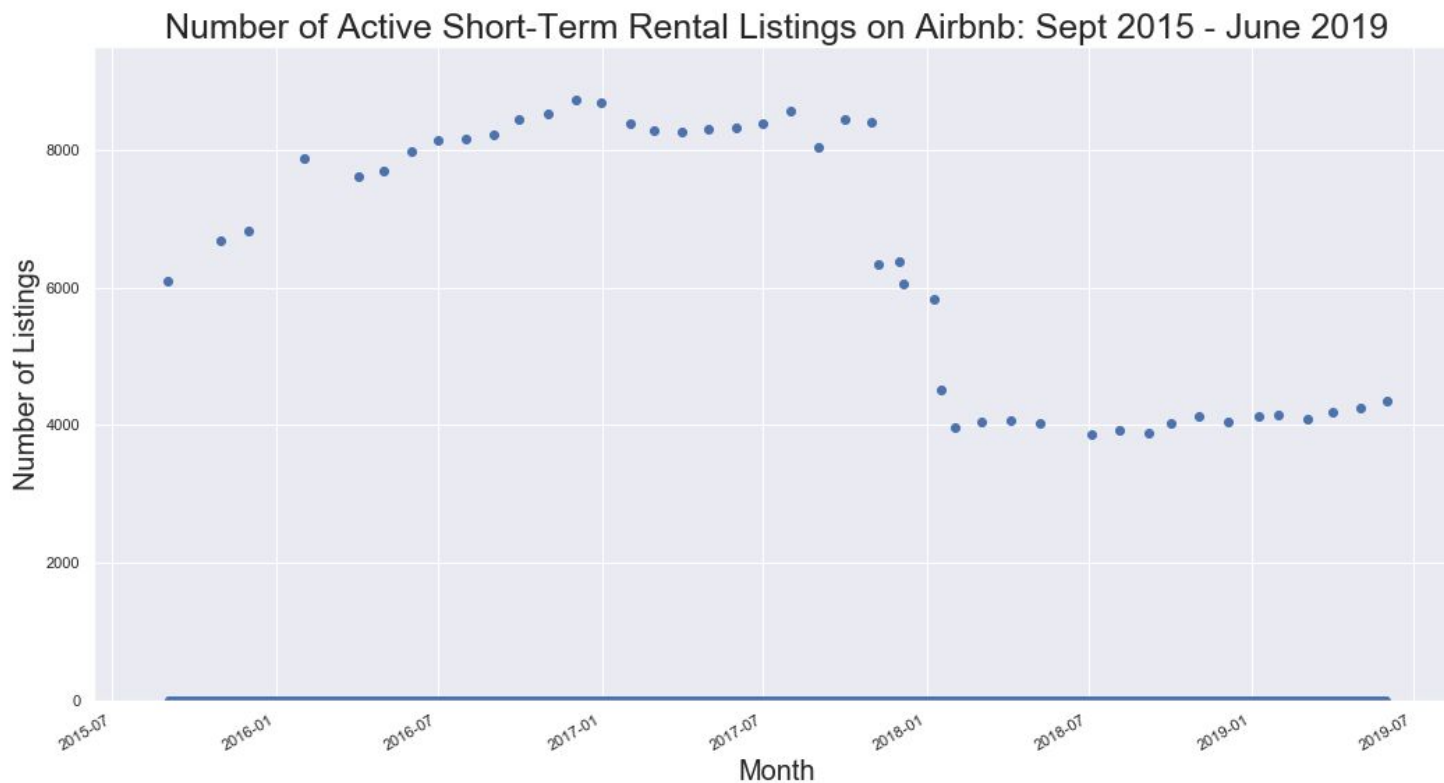
Background

"A short-term residential rental is a rental of all or a portion of one's home for periods of less than 30 nights."

Compliance requirements: business registration and acquiring a certificate (\$\$, valid for 2 years); cap on days.

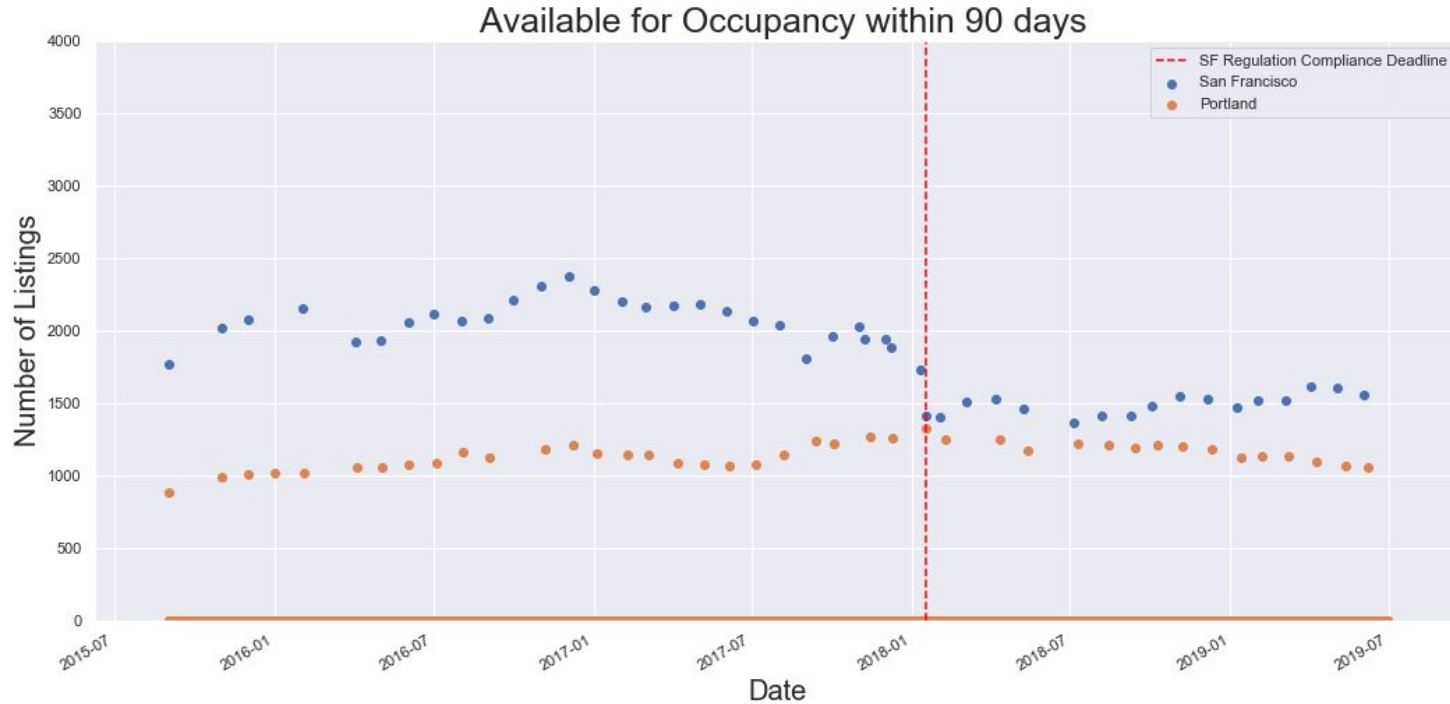
Compliance deadline: midnight Jan 16, 2018

Motivation: What the price would have been without the intervention?

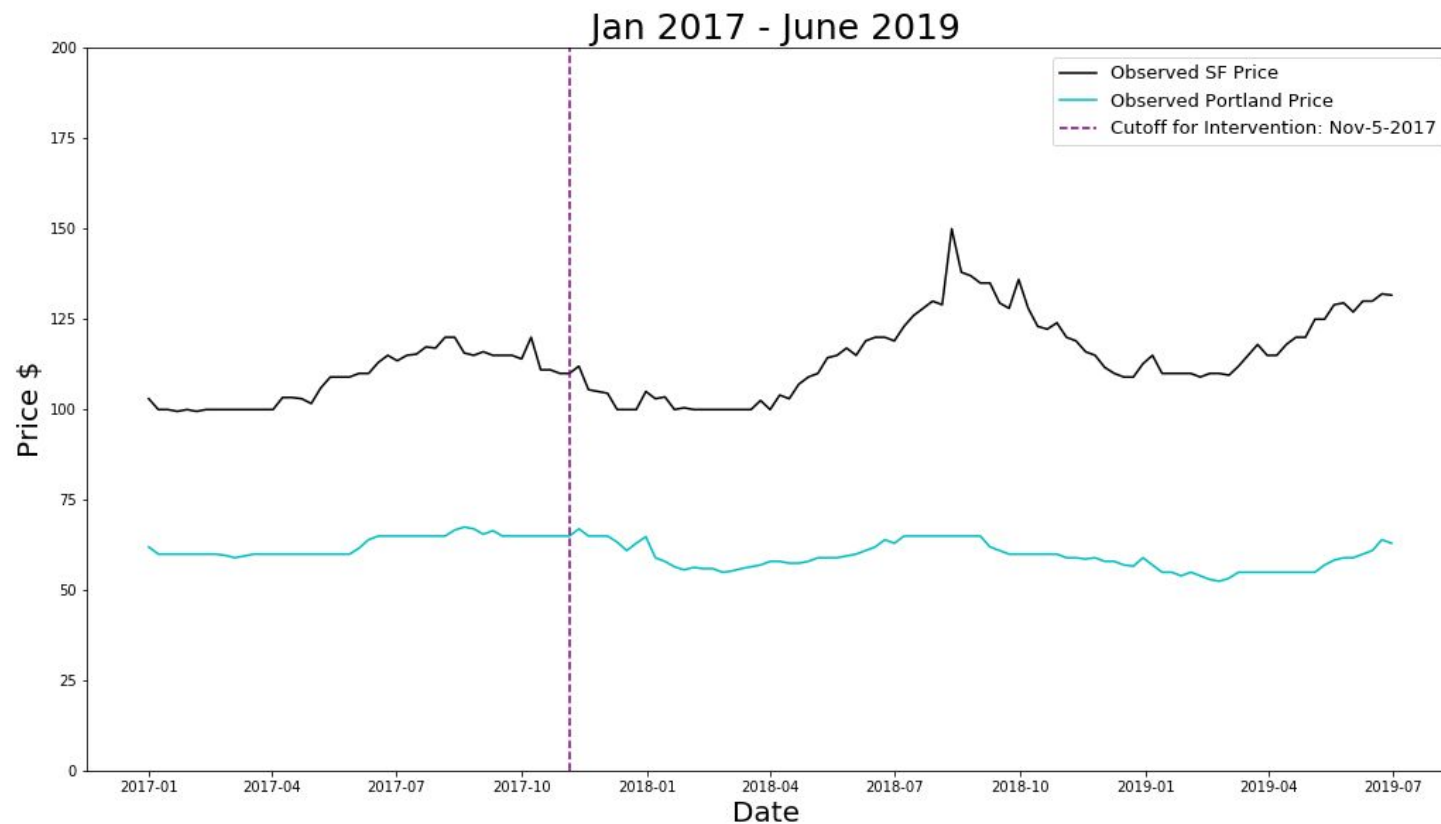


Control Market: Portland

Supply of Short-term Private Rooms in SF vs. Portland: Sept 2015 - June 2019



Weekly Median Price of Private Room Listings: San Francisco vs Portland



The data from Sept-6-2015 to Nov-5-2017 were used for the pre-period.

Causal Effects (post- Nov-5-2017)

Posterior Inference {Causal Impact}

	Average
Actual	115.6
Prediction (s.d.)	103.3 (1.0)
95% CI	[101.4, 105.3]

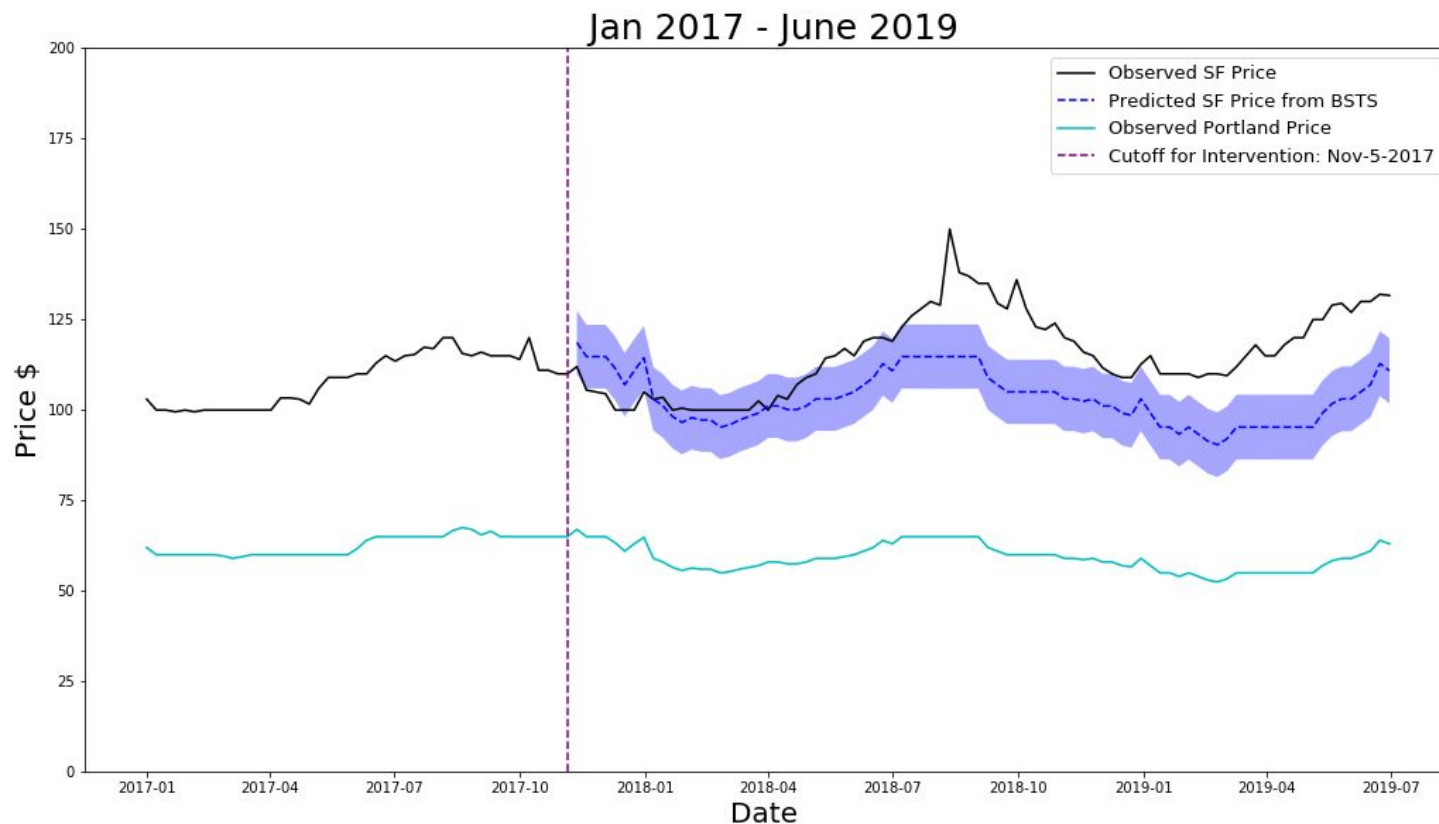
Absolute effect (s.d.)	12.3 (1.0)
95% CI	[10.3, 14.2]

Relative effect (s.d.)	11.9% (1.0%)
95% CI	[10.0%, 13.8%]

Posterior tail-area probability p: 0.0

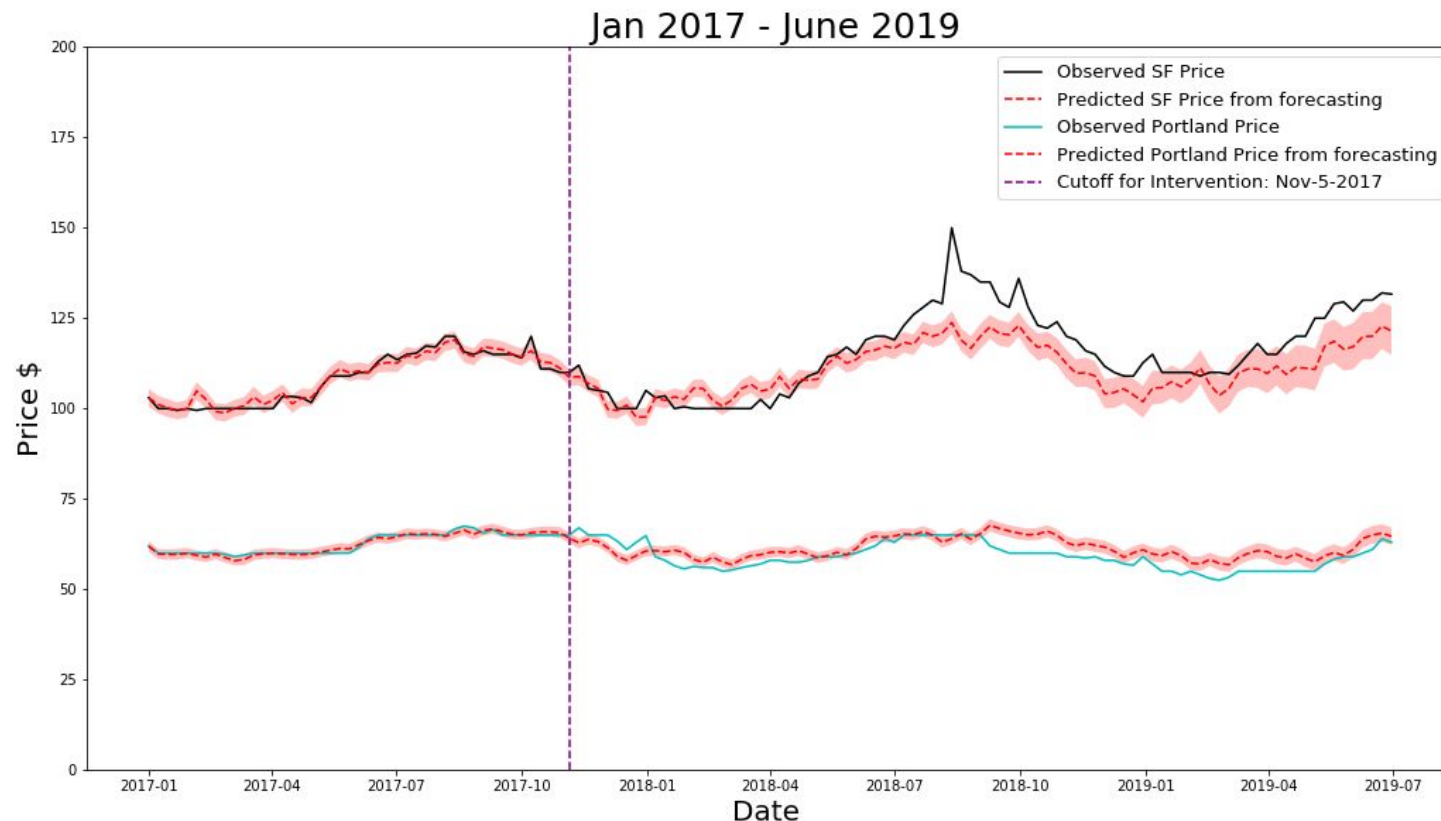
Posterior prob. of a causal effect: 100.00%

Weekly Median Price of Private Room Listings: San Francisco vs Portland



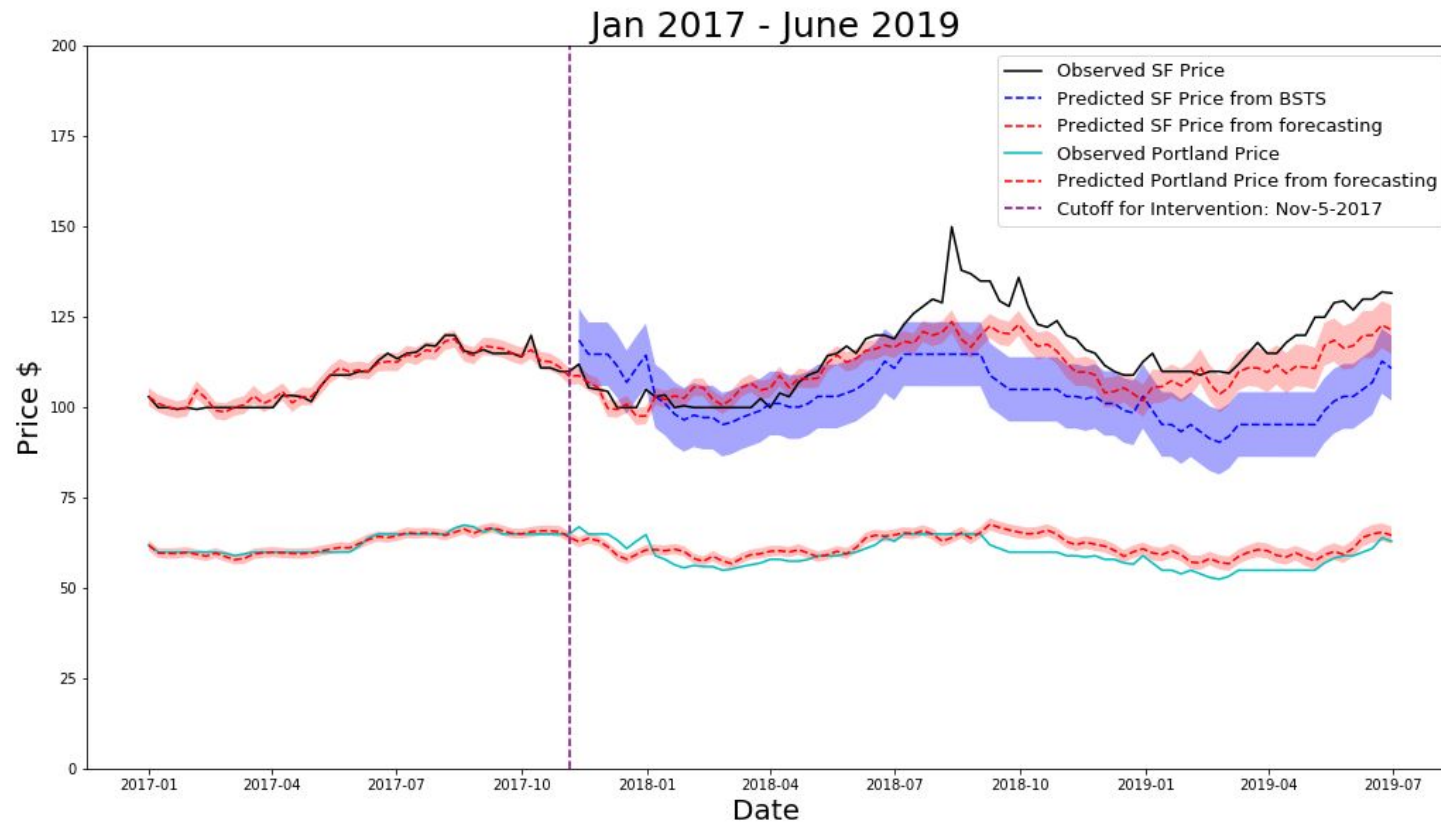
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Weekly Median Price of Private Room Listings: San Francisco vs Portland



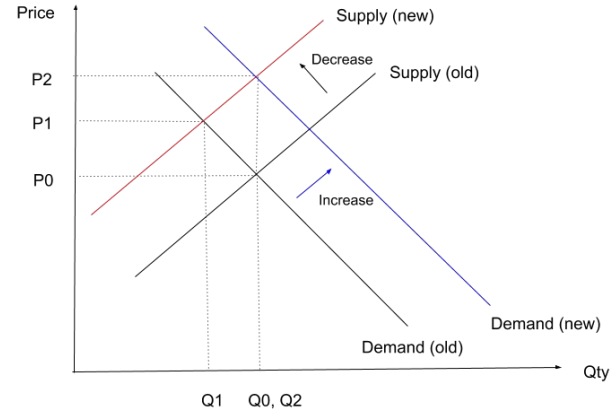
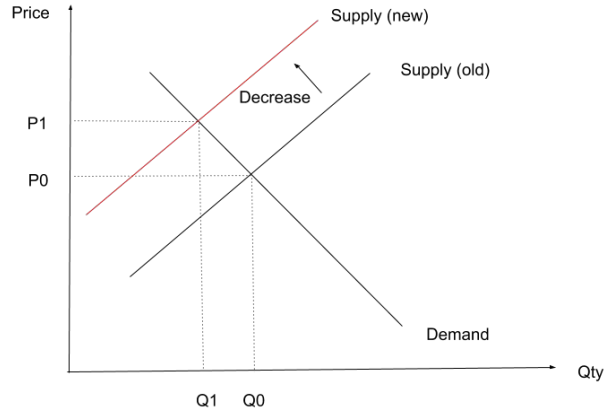
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Weekly Median Price of Private Room Listings: San Francisco vs Portland



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Confounding Factors (e.g. shift of demand schedule)



Takeaways

1. Impact on Airbnb's revenue? (likely a small fraction of a global market).
2. More broad business applications when randomized experiments are unavailable (e.g. launch of a new product, introduction of a new feature, beginning and end of an advertising campaign).

Contacts & Technical Appendix

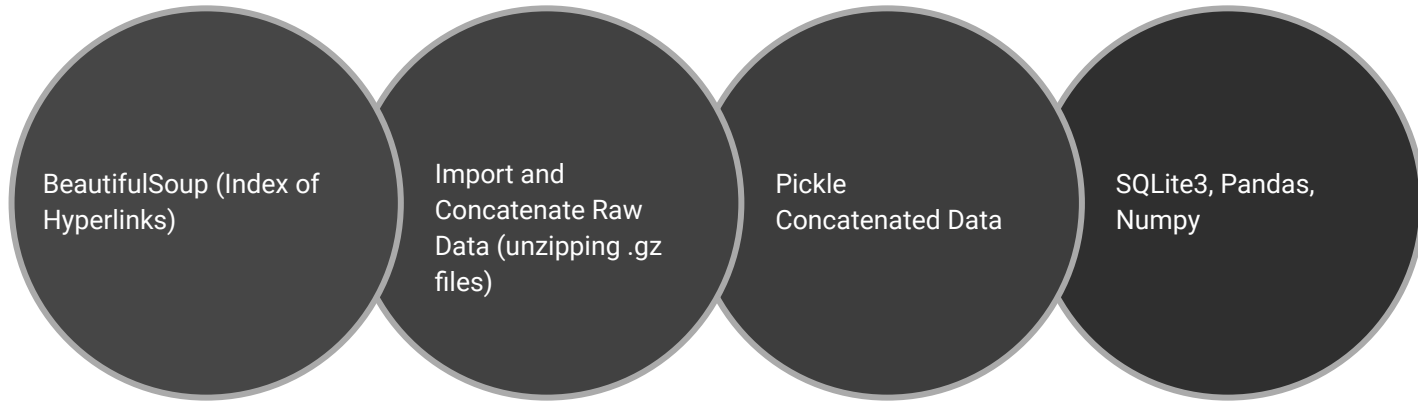
Email: karensheng213@gmail.com

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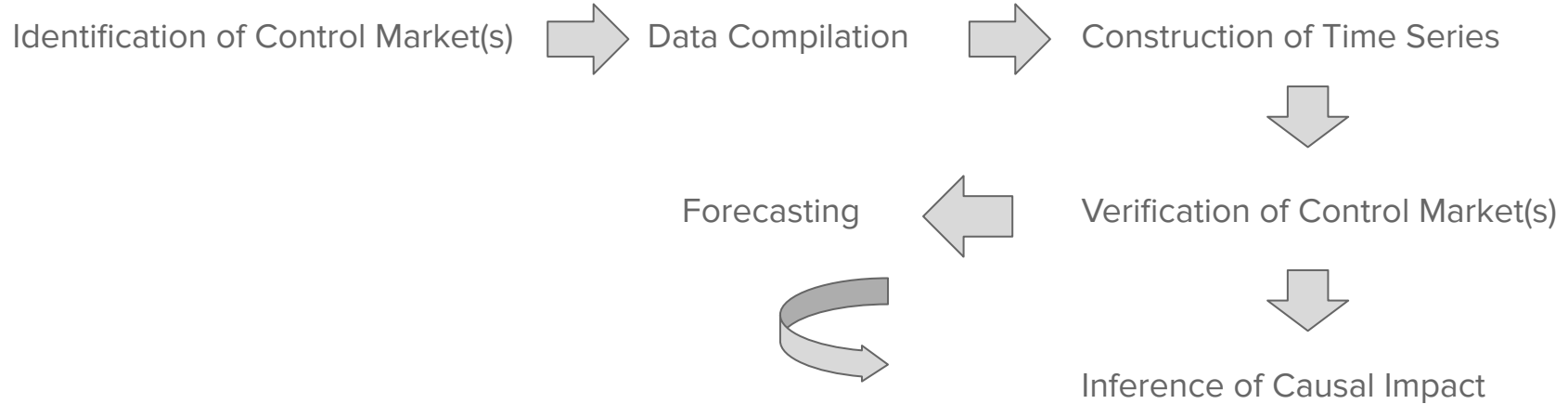
[LinkedIn](#)

[Github](#)

Data Pipeline



Workflow (Causal Impact & Forecasting)



Identification of Control Market(s)

Criteria: Market Size, Geography, Seasonality, Absence of Market Intervention, Availability of Data.

Top candidates: Seattle, Portland (Oregon)

Secondary candidates: LA, Chicago, London

Winner: Portland

Data from Inside Airbnb

	Description	San Francisco	Portland
Listings	Monthly snapshot of available listings.	350K observations	182K observations
Reviews	Occupancy count for a listing within a given time period.	676.6K observations (after removing duplicates)	563K observations (after removing duplicates)
Calendar	Dynamic prices reflecting the lead time.	50.7MM observations (limited to “available” entries)	30.4MM observations (limited to “available” entries)

Correlations between the test and control markets

Metrics: Pearson Correlations ('r') ; DTW (Euclidean Distance)

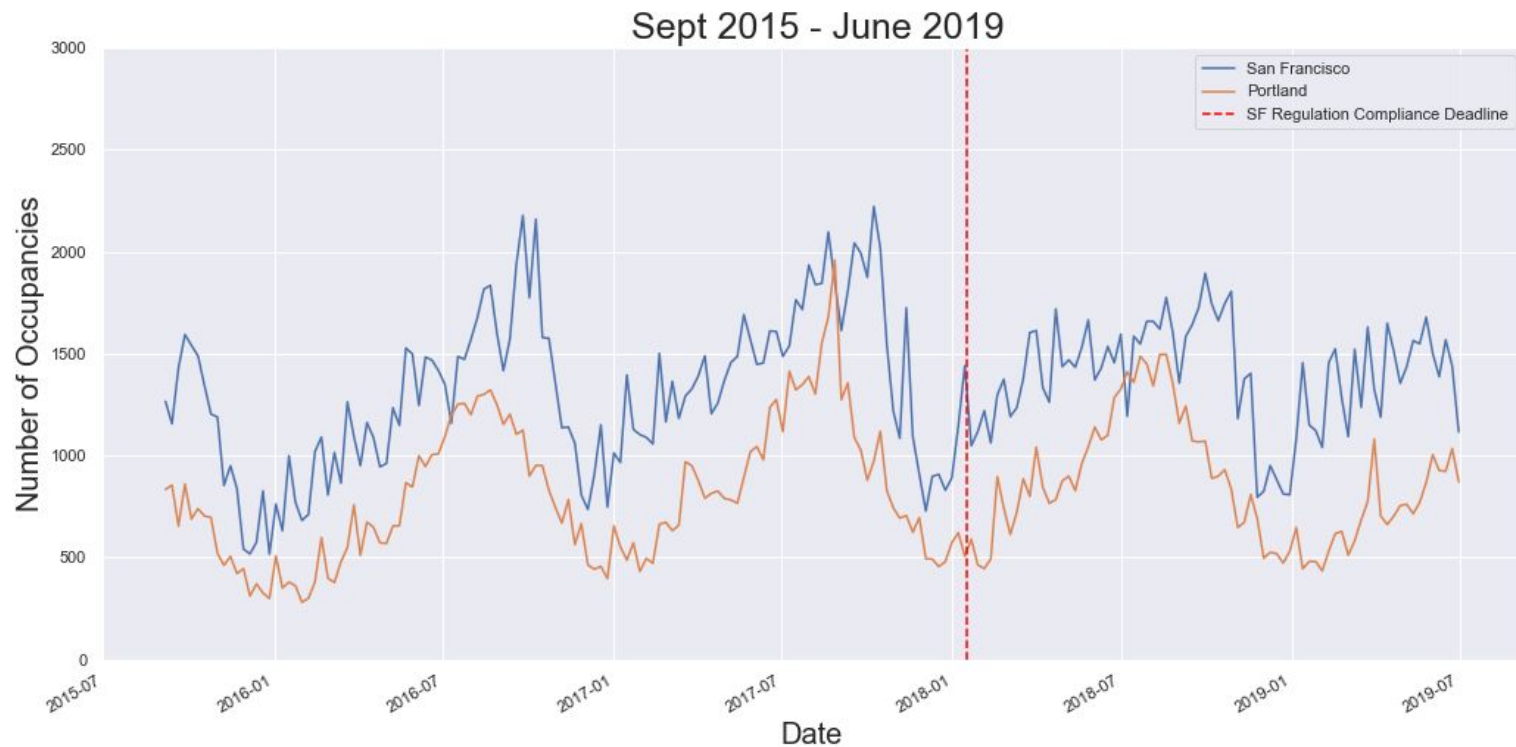
Pre-period supplies: $r = 0.62$ (Nov-5-2017); $r = 0.6$ (Jan-21-2018)

Pre-period qty (demanded at equilibrium): $r = 0.81$ (Nov-5-2017); $r = 0.8$ (Jan-21-2018)

Pre-period price: $r = 0.82$ (Nov-5-2017); $r = 0.79$ (Jan-21-2018)

Time Series (Quantities fulfilled at equilibrium prices)

Weekly Occupancies of Short-term Private Rooms in San Francisco and Portland



Causal Effects (post- Jan-21-2018)

Posterior Inference {Causal Impact}

	Average
Actual	117.2
Prediction (s.d.)	101.1 (1.0)
95% CI	[99.2, 103.2]

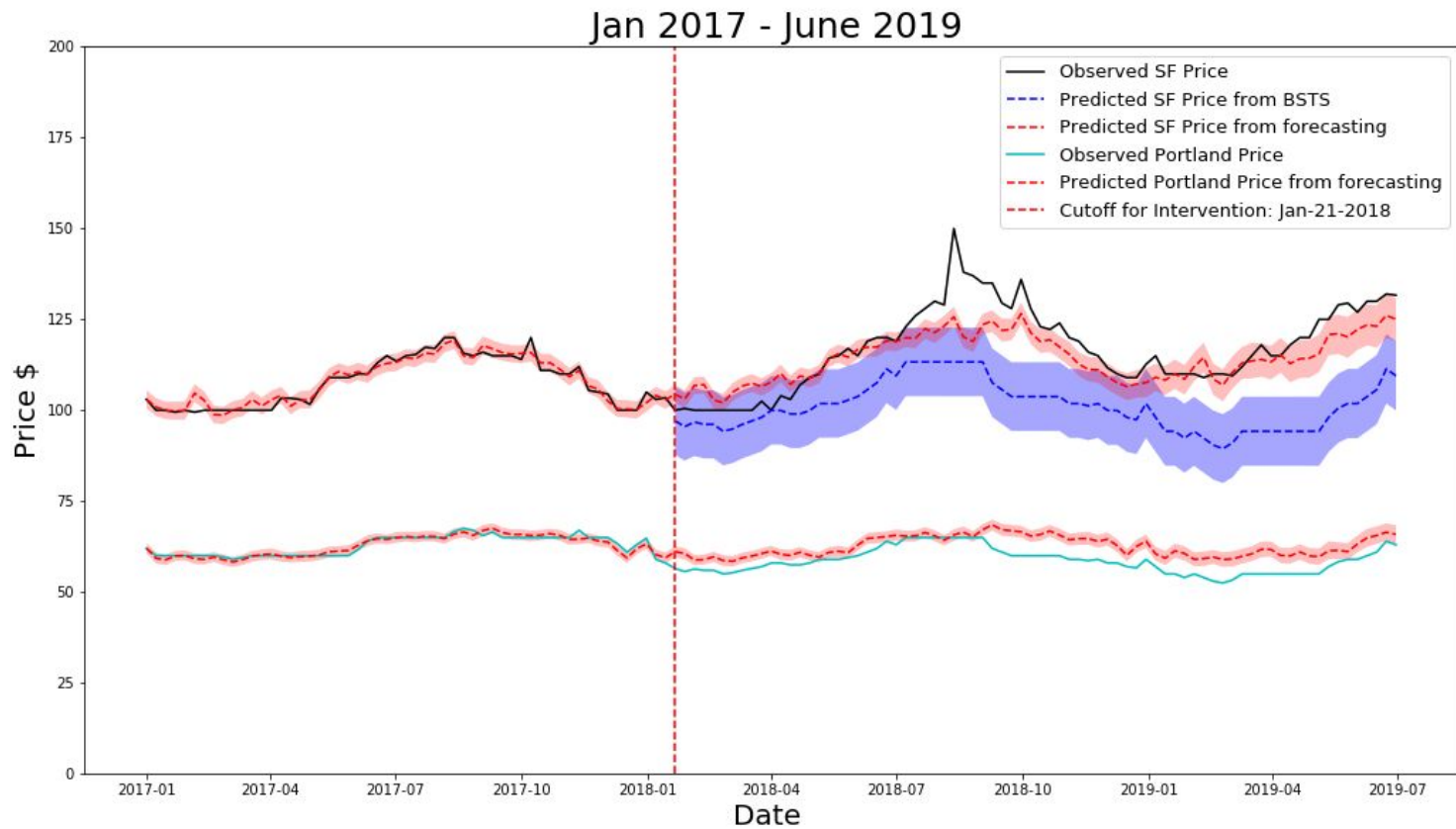
Absolute effect (s.d.)	16.1 (1.0)
95% CI	[13.9, 18.0]

Relative effect (s.d.)	15.9% (1.0%)
95% CI	[13.8%, 17.8%]

Posterior tail-area probability p: 0.0

Posterior prob. of a causal effect: 100.00%

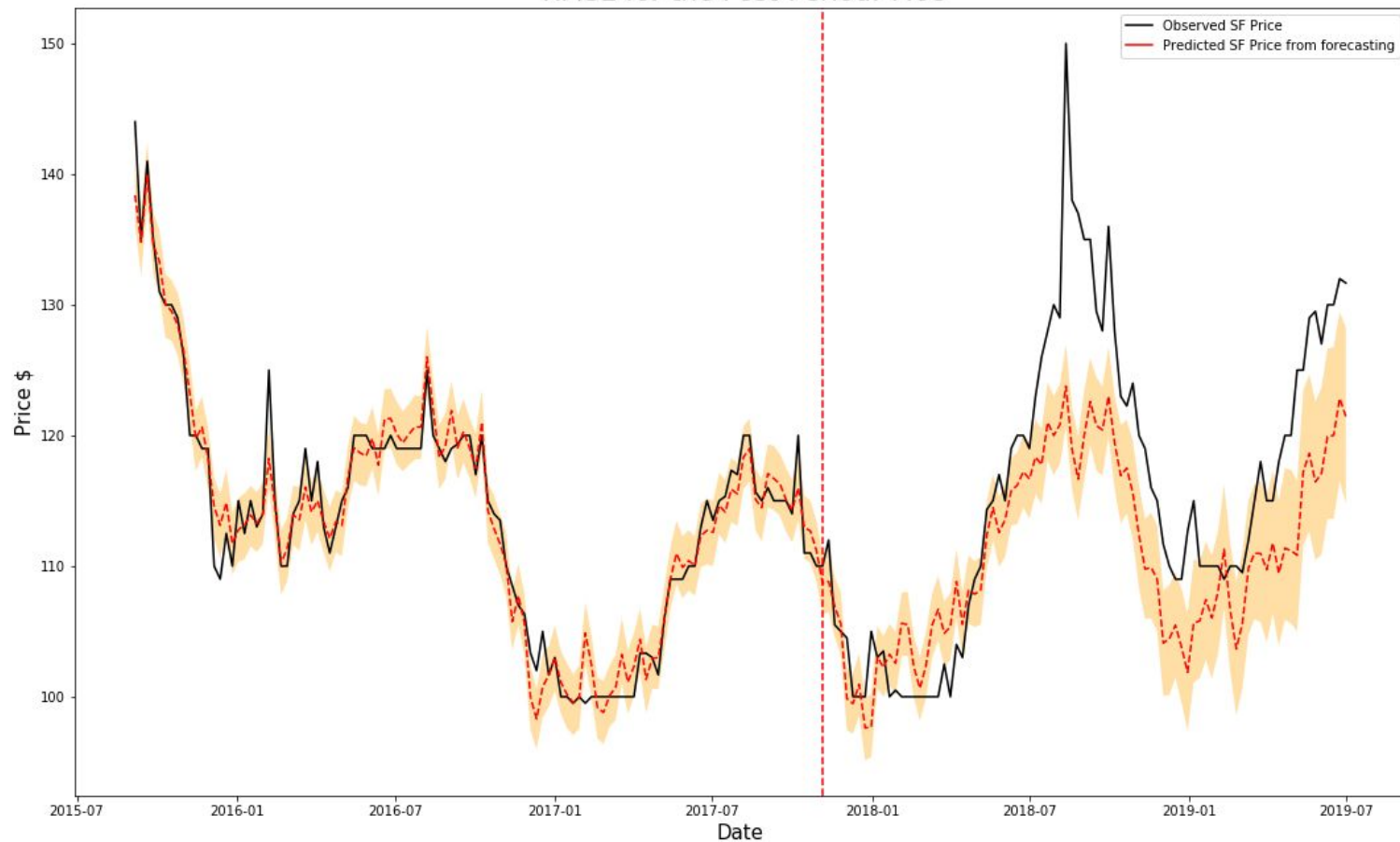
Weekly Median Price of Private Room Listings: San Francisco vs Portland



The data from Sept-6-2015 to Jan-21-2018 were used for the pre-period.

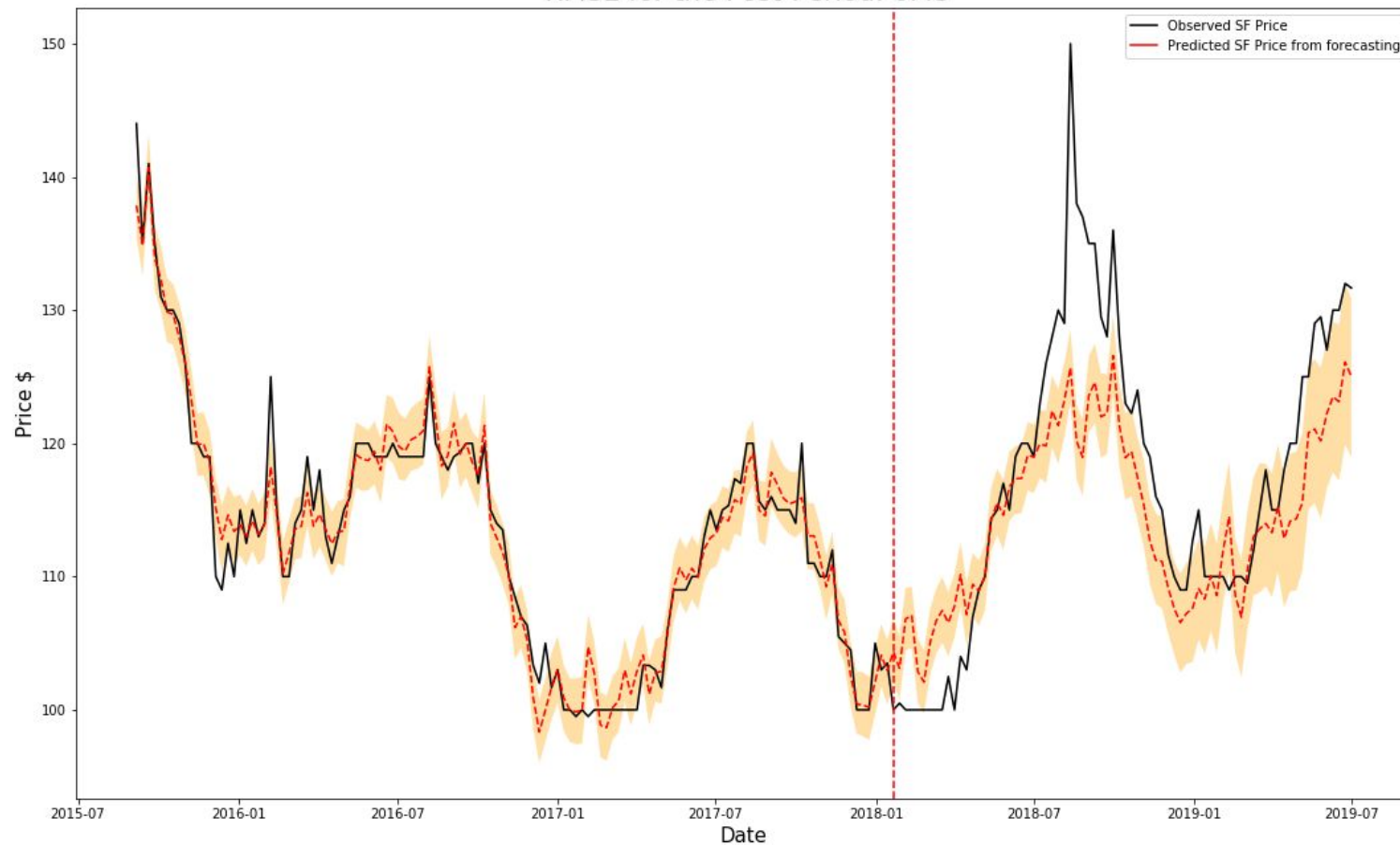
Forecast for the post-period: cutoff on Nov-5-2017

RMSE for the Post-Period: 7.68



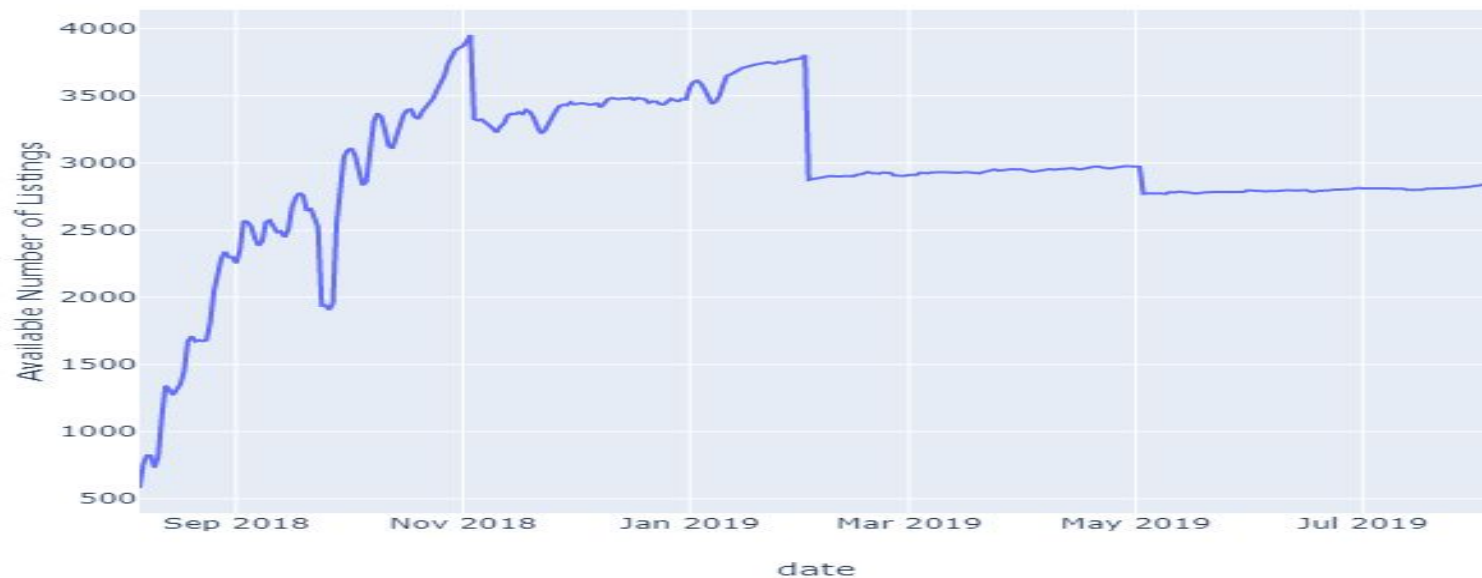
Forecast for the post-period: cutoff on Jan-21-2018

RMSE for the Post-Period: 6.45



Why 90 days lead time?

Number of listings available by date in June 2019



Effects of Dreamforce & Outside Lands

Week	Outside Lands	Dreamforce
2015-09-20	0.00	3.58
2016-08-07	1.39	0.00
2016-10-09	0.00	3.58
2017-08-13	1.39	0.00
2017-11-12	0.00	3.58
2018-08-12	1.39	0.00
2018-09-30	0.00	3.58

Takeaways

1. Domain knowledge is crucial! The actual demand schedule is unknown. Only approximation of demand quantities at the equilibrium. Allocation of the \$ effect in price to the shifts of both supply and demand.
2. Lack of multiple control markets with complete data.