



# The Recurring American Dream? Understanding the Effect of Remote Work on Suburban Housing Prices

**Data Science Live 2023**

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**Is work from home—induced by a COVID-19 policy shock—associated with a revival of American suburbanization?**



# Research Design: Housing Prices Across Space and Time

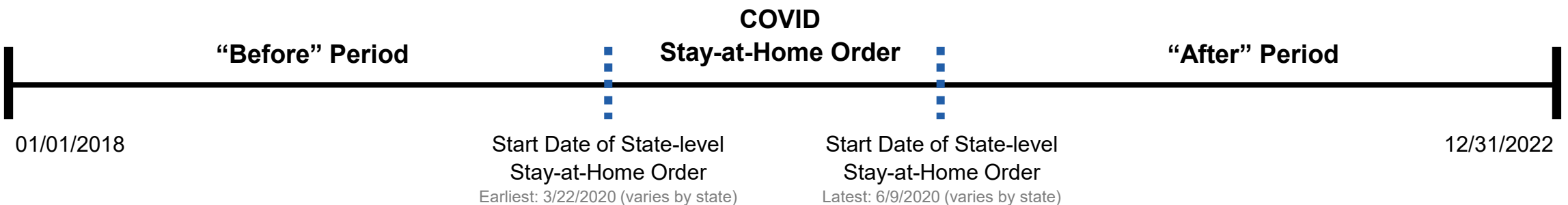
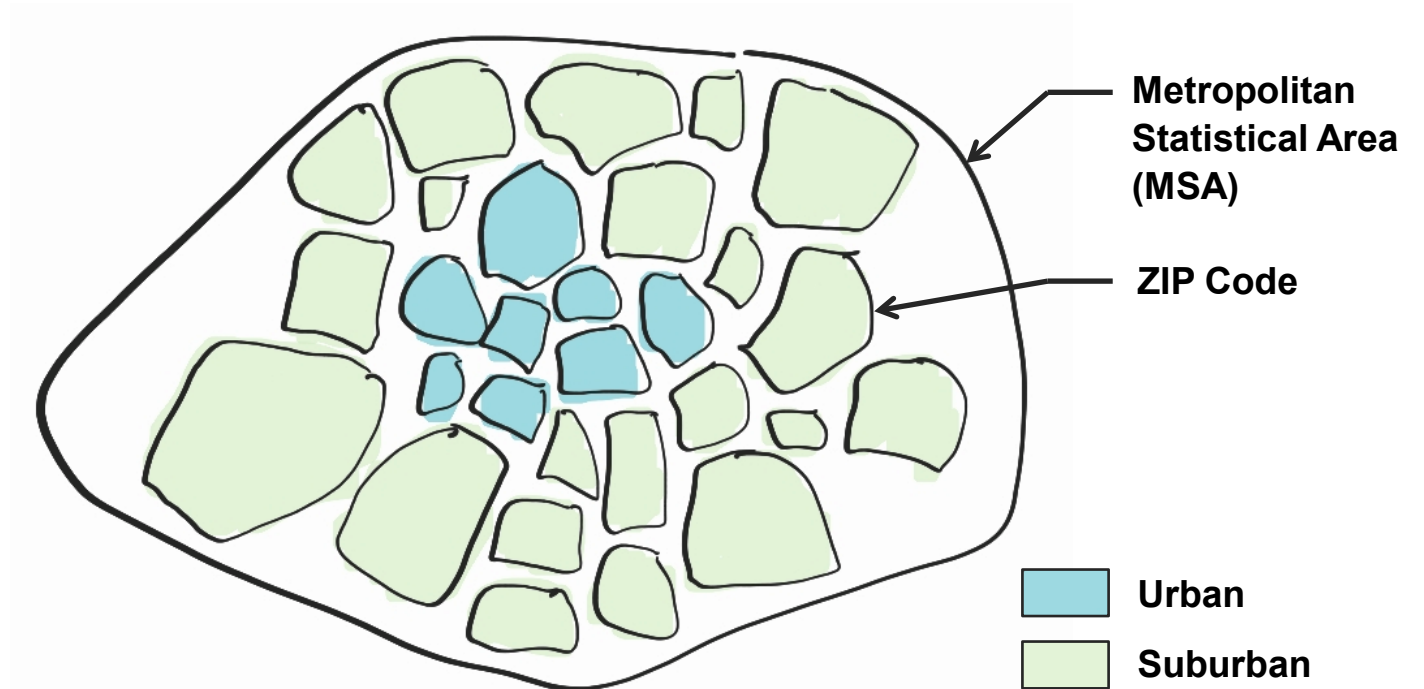
**Unit of Analysis:** ZIP Code

## Dependent Variable

- Log Median Home Value

## Predictors

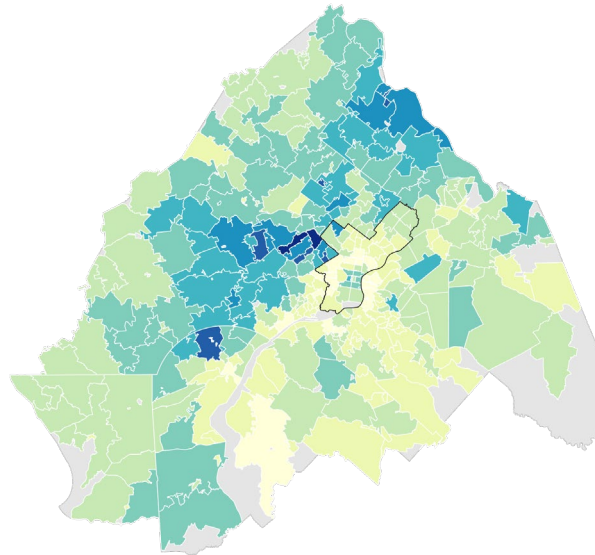
- Percent WFH
- State
- Urban or Suburban
- Percent Age 65 or Older
- Percent White
- Percent College Education or Higher
- Log Median Household Income



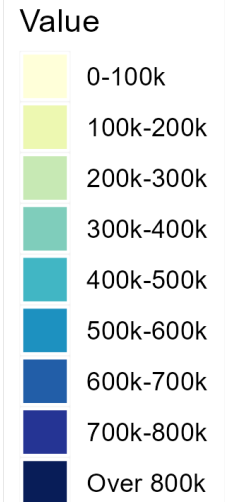
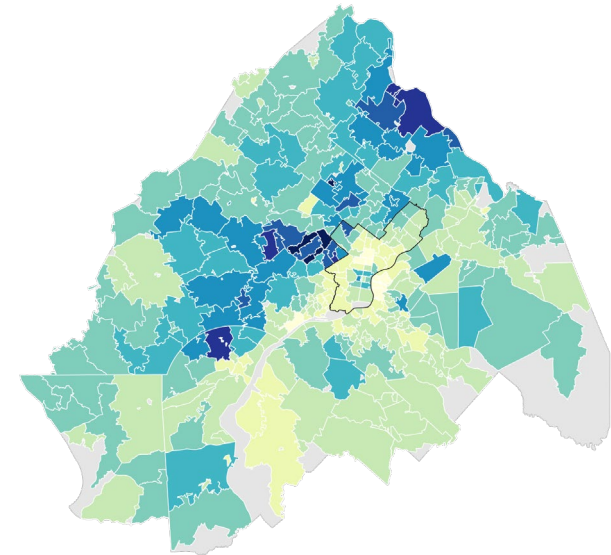
# EDA: Philadelphia MSA

Median Home Value for  
Single Family Home

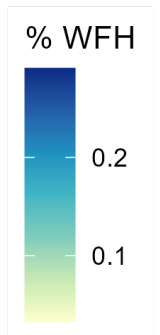
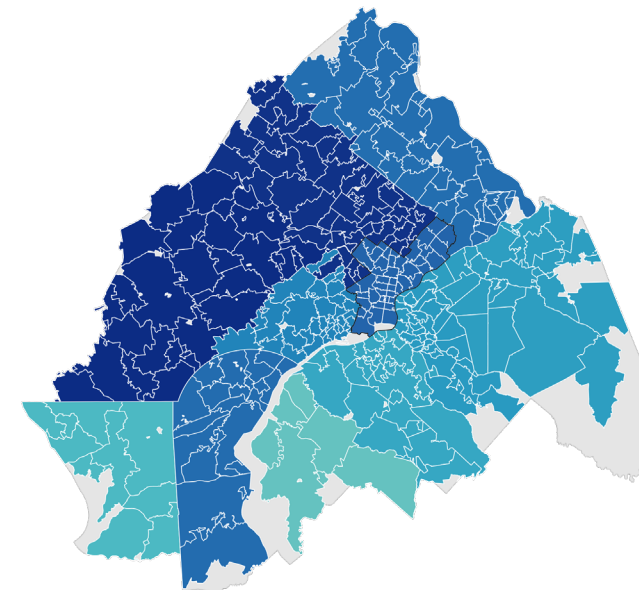
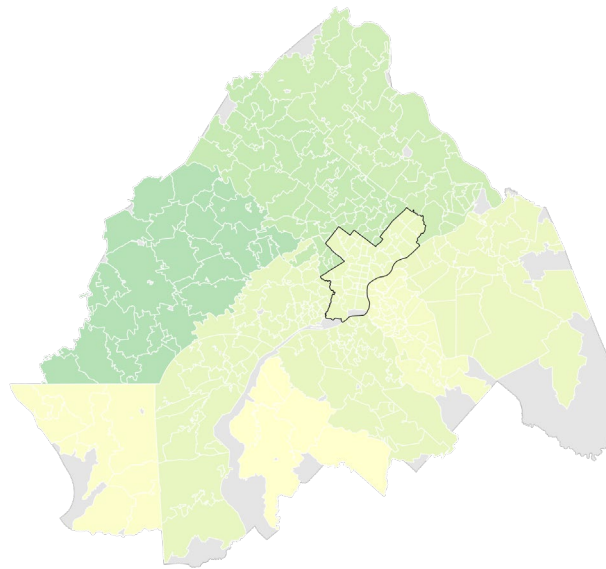
“Before” COVID Policy



“After” COVID Policy



Percent Population  
Working from Home



Not to Scale

# Dataset: ACS, Zillow, & COVID Policy Intervention

Variables		Before		After	
Dependent Variable (DV)	housing price	average monthly median home value Zillow Home Value Index   SFR, 2018-2022	ZIP	average monthly median home value Zillow Home Value Index   SFR, 2018-2022	ZIP
	Independent Variables (IVs)	age	average % aged 65 and above ACS 1-Year Estimates   DP05, 2018 - 2019	county ↓ ZIP	% aged 65 and above ACS 1-Year Estimates   DP05, 2021
race		average % white ACS 1-Year Estimates   DP05, 2018 - 2019	county ↓ ZIP	% white ACS 1-Year Estimates   DP05, 2021	county ↓ ZIP
education		average % bachelors and above ACS 1-Year Estimates   S1501, 2018 - 2019	county ↓ ZIP	% bachelors and above ACS 1-Year Estimates   S1501, 2021	county ↓ ZIP
income		average median household income ACS 1-Year Estimates   S1901, 2018 - 2019	county ↓ ZIP	median household income ACS 1-Year Estimates   S1901, 2021	county ↓ ZIP
WFH		average % work from home ACS 1-Year Estimates   DP03, 2018 - 2019	county ↓ ZIP	average % work from home ACS 1-Year Estimates   DP03, 2021	county ↓ ZIP
state		DE, GA, MD, NJ, PA			state ↓ ZIP
urban / suburban		1: ZIP codes within city limits of Atlanta / Philadelphia 0: other ZIP codes			ZIP

# Methods: OLS, LASSO, & Single Tree Regression

Methods		Before	After
Statistical / Theory-Based	OLS	<p><b>All IVs included plus interaction</b></p> <pre>logAveValueBefore ~ State + SeniorBefore + WhiteBefore + HigherEduBefore + WFHBefore + Urban + logMedHHIncBefore + WFHBefore*Urban</pre>	<p><b>All IVs included plus interaction</b></p> <pre>logAveValueAfter ~ State + SeniorAfter + WhiteAfter + HigherEduAfter + WFHAfter + Urban + logMedHHIncAfter + WFHAfter*Urban</pre>
	Force-in LASSO	<p><b>Force-in LASSO shows all IVs important</b></p> <pre>logAveValueBefore ~ State + SeniorBefore + WhiteBefore + HigherEduBefore + WFHBefore + Urban + logMedHHIncBefore + WFHBefore*Urban</pre> <p><i>Same model</i></p>	<p><b>Force-in LASSO shows only 4 IVs important</b></p> <pre>logAveValueAfter ~ State + SeniorAfter + WhiteAfter + HigherEduAfter + WFHAfter + Urban + logMedHHIncAfter + WFHAfter*Urban</pre> <p><i>Parsimonious model</i></p>
Machine Learning / Non-Theory-Based	Single Tree	<p><b>3 IVs of interest</b></p> <p>logAveValueBefore can be predicted by</p> <pre>WhiteBefore HigherEduBefore logMedHHIncBefore</pre>	<p><b>3 Different IVs of interest</b></p> <p>logAveValueAfter can be predicted by</p> <pre>logMedHHIncAfter State WFHAfter</pre>

# Results: Model Comparison

Methods		Before	After
Statistical / Theory-Based	OLS	MSE = 28.44	MSE = 21.86
	Force-in LASSO	MSE = 28.44	MSE = 22.22
Machine Learning / Non-Theory-Based	Single Tree	MSE = 28.68	MSE = 23.08

# Discussion

## Key Findings

- WFH after the COVID policy shock is associated with an increase in average home values in suburban areas
- WFH is not statistically significant in the “after” period, but theory and practice indicates a trend toward WFH and suburban housing prices
- WFH demographics shifted in the “after” period and became colinear with college education
- WFH impacted housing prices differently depending on state
- OLS performed best on both “before” and “after” models

## Limitations

- Housing markets take time to reflect macro level shocks, so analysis was limited by time
- “After” period only includes 2021, so does not reflect housing demand in 2022
- Different data granularity limits the analysis
  - Monthly, ZIP code level housing price data
  - Annual, county level WFH data and demographics
  - State level COVID policy intervention data

## Research Directions

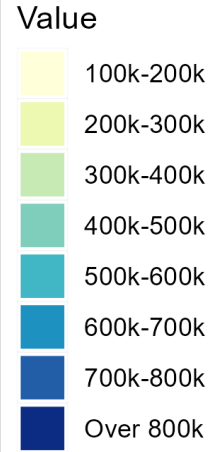
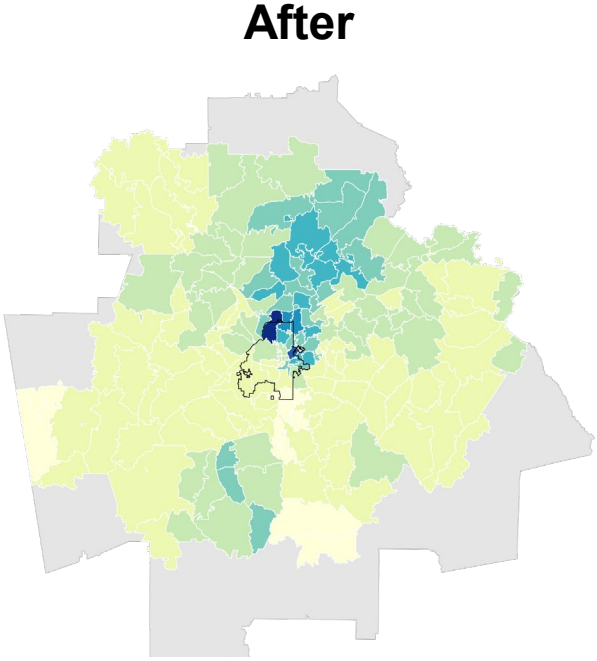
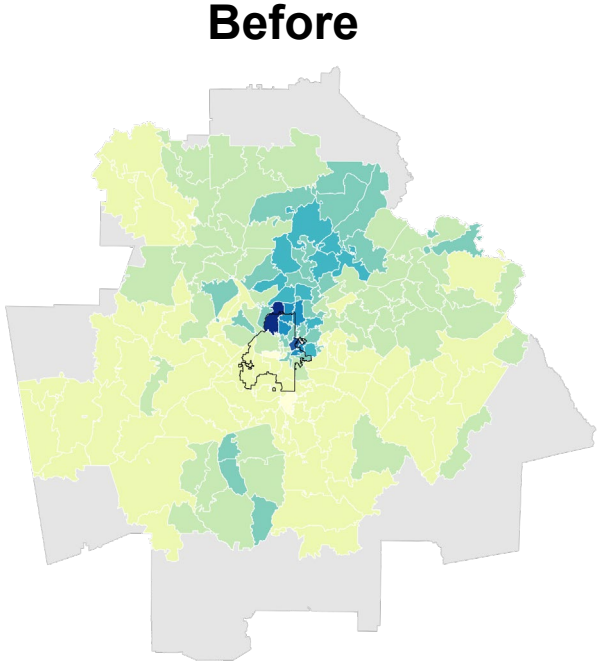
- Study contributes a pre and post (non-causal) approach to future data analytics on remote work and other trends associated with policy interventions
- Future research could include more MSAs for larger sample
- Future research on housing prices could include more granular data on WFH
- Need to watch future trends in suburban housing prices



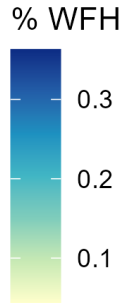
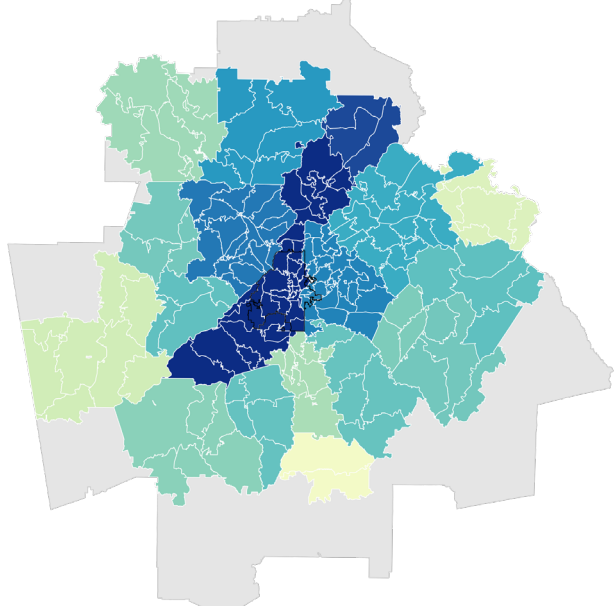
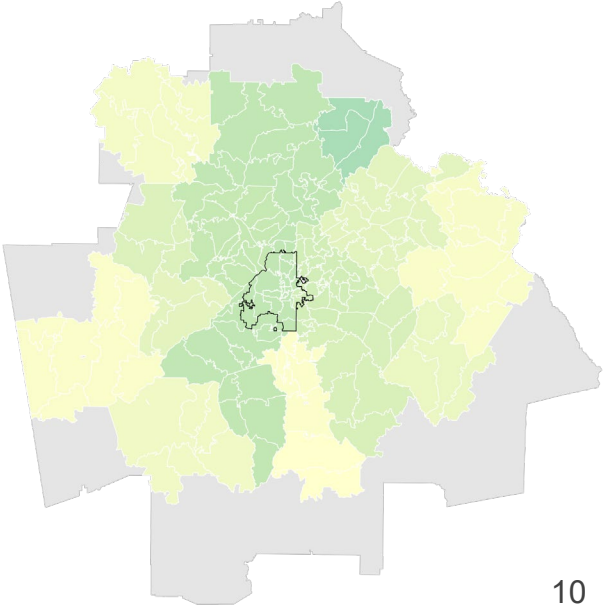
# Appendix

# EDA: Atlanta MSA

Median Home Value for  
Single Family Home



Percent Population  
Working from Home



Not to Scale

# Results: OLS Regression

## Findings

- State of NJ and median household income are statistically significant both “before” and “after”
- Before, log median home values **decreased by 18.1 percentage points in urban areas compared to 8.7 in suburban areas**
- After, log median home values **decreased by 1.5 percentage points in urban areas and increased by 0.1 percentage points in suburban areas**
- After, more work from home was still associated with lower home values in urban areas (though less so), but **became associated with higher home values in suburban areas**
- After, WFH and Urban interaction is not statistically significant, but both “before” and “after” models passed the F-test

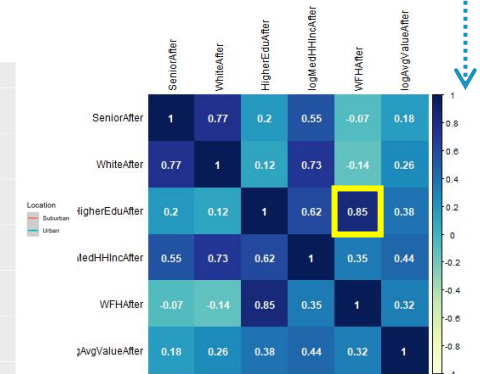
## Before

	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	-6.561	4.605	-1.42	0.15491	
StateGA	0.276	0.159	1.73	0.08398	.
StateMD	-0.102	0.169	-0.61	0.54401	
StateNJ	-0.499	0.113	-4.42	1.20E-05	***
StatePA	-0.136	0.111	-1.22	0.2236	
SeniorBefore	2.142	1.806	1.19	0.23629	
WhiteBefore	-0.105	0.337	-0.31	0.75539	
HigherEduBefore	0.973	0.525	1.85	0.06443	.
WFHBefore	-8.663	4.272	-2.03	0.04311	*
Urban1	0.917	0.334	2.75	0.00626	**
logMedHHIncBefore	1.67	0.433	3.85	0.00013	***
WFHBefore:Urban1	-9.454	3.776	-2.5	0.01262	*

## After

	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	-1.8295	2.6596	-0.69	0.49184	
StateGA	0.06	0.1007	0.6	0.55159	
StateMD	0.0622	0.1415	0.44	0.66059	
StateNJ	-0.3709	0.1026	-3.62	3.30E-04	***
StatePA	-0.0601	0.0907	-0.66	0.50786	
SeniorAfter	2.0616	1.5438	1.34	0.18237	
WhiteAfter	-0.3126	0.25	-1.25	0.21167	
<i>HigherEduAfter is dropped due to high collinearity with WFHAfter.</i>					
WFHAfter	0.0559	0.6082	0.09	0.92677	
Urban1	0.5311	0.3596	1.48	0.14028	
logMedHHIncAfter	1.2721	0.2587	4.92	1.20E-06	***
WFHAfter:Urban1	-1.5432	1.1531	-1.34	0.18141	

*WFH \* Urban added because of interaction effect*



# Results: LASSO Regression

## Findings

- “Before” LASSO model is identical to the “Before” OLS model, meaning that all IVs are considered important
- “After” LASSO model reduced the number of IVs to four: state, WFH, urban, and household income
- WFH was included in both models

## Before

	Estimate	Std. Error	t value	Pr(> t )	
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## After

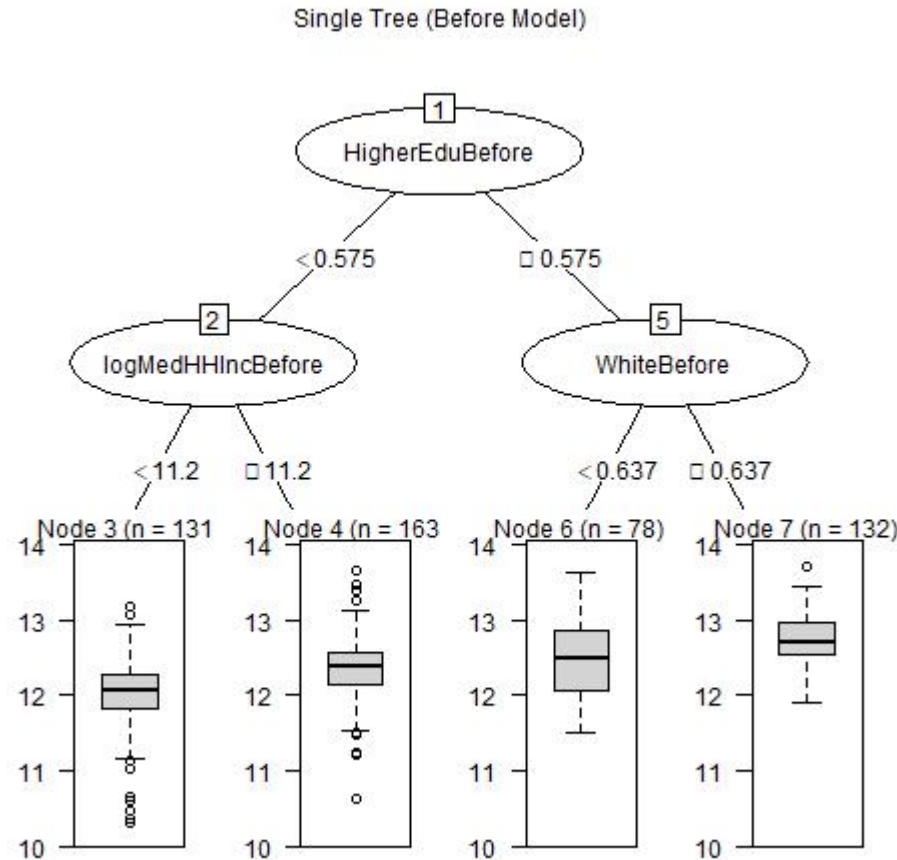
	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	0.9241	1.5118	0.61	0.5413	
StateGA	0.025	0.0838	0.3	0.76583	
StateMD	0.0132	0.1382	0.1	0.9242	
StateNJ	-0.337	0.0957	-3.52	0.00047	***
StatePA	-0.0145	0.0865	-0.17	0.86661	
WFHAfter	0.2977	0.4352	0.68	0.49428	
Urban1	0.0398	0.0793	0.5	0.61549	
logMedHHIncAfter	1.0341	0.141	7.34	9.10E-13	***

# Results: Single Tree Regression

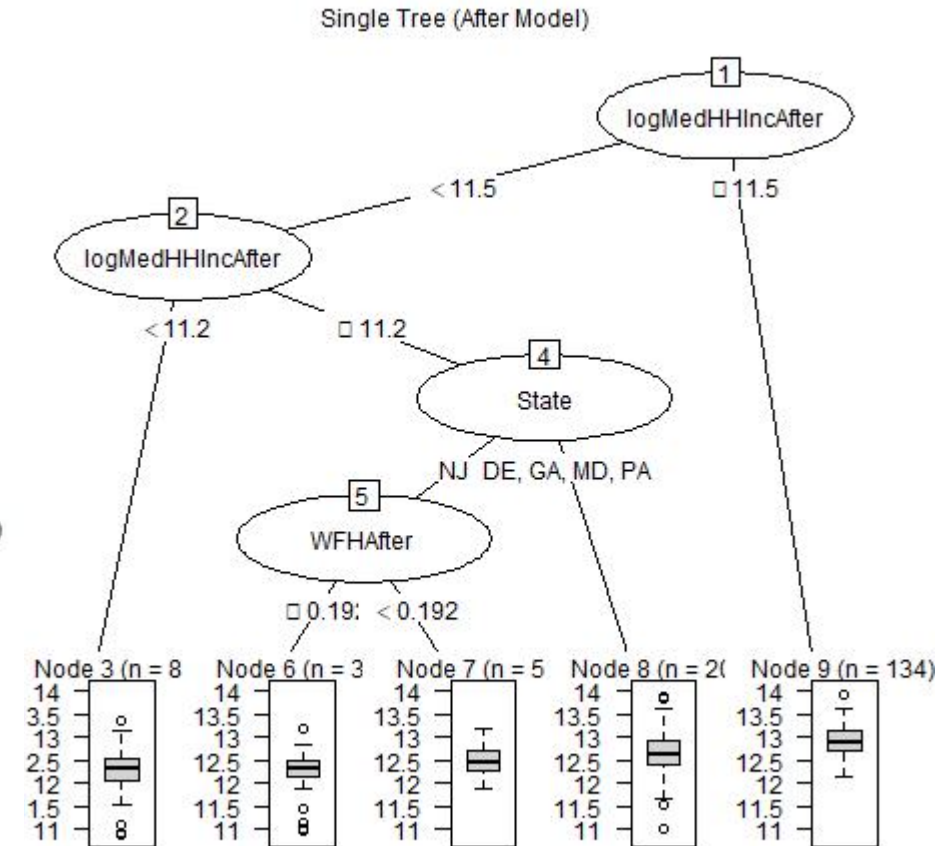
## Findings

- Before, housing prices explained by college education, household income, and white population
- After, housing prices associated with household income, state, and WFH

## Before



## After



# Remote Work and the Future of Cities

## Policy Implications

- Metropolitan areas are likely to expand beyond existing boundaries
- Car reliance is likely to increase
- Urban areas are likely to lose population density
- Housing prices are likely to increase in both urban and suburban areas
- People are likely to move to the suburbs of affordable cities

## Policy Recommendations

- Manage urban expansion with growth controls and regional planning
- Strengthen transit to and within suburban areas
- Attract retail and entertainment industries to urban areas to increase population density
- Build more housing in urban areas to increase housing affordability