The Change in Remote Worker Population During/After the COVID-19-19 Pandemic and Its Effect on Urban Housing Prices in the US

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December 2023

Abstract

We present a linear regression analysis of median sale price of houses in U.S. states on various explanatory factors to study the effect that the COVID-19 pandemic had on housing prices. With COVID-19 making it difficult for the work population to continue business as usual, the remote worker population increased significantly during the peak of the pandemic around 2021. We use data from 2019 and 2021 to provide a comparison between pre-pandemic and peak-pandemic conditions. In our linear regression model we include variables that capture the remote worker percentage, median household income, COVID-19 case count, and governor political party for the majority of U.S. states. The governor political party of each state is included in the regression because stay-at-home orders were issued on a statewide basis during the pandemic and the policy implemented, which was likely influenced by the governor's political party, probably affected the percentage of the population at home. From our model, we estimate that for every 1% increase in the remote worker percentage of a state's workforce, the median sale price of houses in the state increase by \$20,000 pre-pandemic and by \$2,400 peak-pandemic. The decrease in rate of change corresponding to remote worker percentage is likely due to the popularization of remote work combined with the need to maintain some normalcy of housing prices. It should also be noted that the decrease is accompanied by a decrease in the standard error for the estimate, meaning the estimate is more precise, and a significant decrease in the model constant, indicating that there are much fewer unobserved factors influencing median sale price. The model estimate that we provide and discuss is based on a linear ordinary least squares (OLS) regression model.

Keywords: COVID-19; Remote Work; Housing Prices

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1 Introduction

Because of the COVID-19 pandemic that struck the U.S. at the start of 2020, many Americans had to change their lifestyles due to the stay-at-home mandate. One of the most significant impacts of the pandemic was the increase in the remote worker percentage. According to Brynjolfsson et al., from January 2020 to May 2020, 35.2% of workers had switched from commuting to work to working from home. Furthermore, 15.0% of workers reported that they were already working remotely before the pandemic, which means that 50.2% of the American workforce was working from home in 2020.

Additionally, this increase in remote worker percentage during the COVID-19 pandemic has indefinitely changed the workforce's attitude towards working from home. In 2021, the U.S. Survey of Working Arrangements and Attitudes (SWAA) conducted a survey targeted to U.S. residents aged between 20 and 64 that asked workers how much they would like to work after the pandemic Barrero et al. (2021). Of the surveyed participants who worked remotely during the pandemic, 80% answered they would want to work at home at least one day a week while 30% reported they would prefer to work at home every day. The general attitude of the American workforce towards remote work has shifted from "noninteractive and boring" to "convenient and efficient" within a few years.

This paper aims to examine the effects of the increased remote worker percentage on housing prices across the U.S. With more people working from home, the demand for housing, especially in urban areas, decreased as less people commuted to work. Consequently, less workers sought to find housing in urban areas because they did not have to worry about commute time or beating traffic. In this paper, we utilize panel data from the U.S. Census Bureau to observe the differences in the remote worker percentage in most American states and territories between 2019 and 2020. To compare the housing prices before and after the pandemic, we used Housing Data from Zillow Research, which revealed the median house sale price in hundreds of cities in the U.S. In addition to the remote worker percentage, we also decided to observe the effects of median household income, COVID-19 case count, and governor political party on median house sale price. Of course, the change in remote worker percentage alone cannot fully explain the changes in the median house sale price between 2019 and 2021. Thus, we implemented three additional variables into the regression to not only explain the changes in the dependent variable more accurately, but also to decrease the error term in the regression equation.

Our paper contributes to the studies done on the impact of remote worker percentage on housing prices in the U.S. Most of the studies conducted in 2021 and 2022 have concluded that the shift to remote work had led to an increase in housing prices. For example, Mondragon and Wieland suggest that the shift to remote work raised aggregate U.S. house prices by 15.1 percent. Similarly, Kmetz et al. found that the remote worker percentage rose housing prices by 15% and that it accounted for more than 60 percent of the overall increase in

housing prices. Our study in this paper works to confirm the results found by others who also analyzed this relationship. But also, by implementing median household income, COVID-19 case count, and governor political party into our regression, we are able to present a different perspective on the changes in housing price between 2019 and 2021. We decided to add median household income into the equation because of its significant impact on housing prices. Without this variable, we might have attributed too much of the housing price increase to the increase in remote worker percentage. Also, since states with different political parties most likely had different stay-at-home and work-from-home mandates. We wanted to observe how a state's political party would affect the housing prices. With four explanatory variables we were able to observe the changes in the dependent variable while minimizing the error term and bias.

2 Econometric Model and Estimation Method

2.1 Empirical Model Specification

Our empirical analysis aims to assess the impact of the rise in remote work on housing prices in major urban areas, considering the context of the COVID-19 pandemic. We propose an Ordinary Least Squares (OLS) regression model to estimate this relationship. The model is specified as follows:

$$\begin{aligned}\text{Median Sale Price}_{i,t} = \beta_0 + \beta_1 \times \text{Remote Worker Percentage}_{i,t} + \beta_2 \times \\ \text{Median Household Income}_{i,t} + \beta_3 \times \text{COVID-19 Case Count}_{i,t} + \beta_4 \times \\ \text{Governor Political Party}_{i,t} + \epsilon_{i,t} \end{aligned} \tag{1}$$

Where:

- Median Sale Price$_{it}$ is the dependent variable representing the median sale price of homes in state i at time t.
- Remote Worker Percentage$_{it}$ captures the proportion of the workforce engaged in remote work in state i at time t.
- Median Household Income$_{it}$ reflects the median household income in state i at time t.
- COVID-19 Case Count$_{it}$ denotes the number of reported COVID-19 cases in state i at time t.
- Governor Political Party$_{it}$ is a categorical variable indicating the political affiliation of the state governor in state i at time t.
- ϵ_{it} is the error term.

2.2 Estimation Method

The estimation of the above model will be carried out using Ordinary Least Squares (OLS). OLS is chosen for its simplicity and efficiency under the classical linear regression model assumptions. It minimizes the sum of squared differences between the observed and predicted values of the dependent variable, providing unbiased, consistent, and efficient estimates of the parameters in the presence of normally distributed error terms.

2.3 Considerations and Assumptions

- The model assumes that the relationship between the dependent and independent variables is linear.
- It also assumes no multicollinearity among independent variables, homoskedasticity of residuals, and no autocorrelation.
- The COVID-19 case count for 2019 is considered to be zero, as the pandemic had not begun in that year.
- The Governor Political Party variable is treated categorically, with values indicating political affiliations (Democrat, Republican, Independent).

2.4 Limitations

- The model does not capture potential non-linear relationships or interactions between variables.
- External factors influencing housing prices, not included in the model, may lead to omitted variable bias.

Through this empirical framework, we aim to provide insights into how shifts in remote work culture and pandemic-related factors have influenced housing market dynamics.

3 Data Description

3.1 Data Sources and Variable Definitions

The analysis utilizes data from various sources, covering the period from 2019 to 2021, to capture the effects of the COVID-19 pandemic on housing markets and remote work trends. The data sources include:

1. **Zillow Housing Data**: Provides information on median sale prices.
2. **U.S. Census Bureau**: Offers data on the percentage of home-based workers.
3. **Worldometers**: For COVID-19 case counts.
4. **Federal Reserve Bank of St. Louis**: Supplies data on median household income.

Our sample comprises state-level data across the United States, focusing on key economic and pandemic-related indicators. The variables included in the analysis are:

- **Median Sale Price**: The median price at which homes are sold in a given state.
- **Remote Worker Percentage**: The proportion of the workforce engaged in remote work in each state.
- **Median Household Income**: The median income of households in each state.
- **COVID-19 Cases**: The number of reported COVID-19 cases in each state.
- **Governor Political Party**: Categorical variable indicating the political affiliation of the state governor (0 for Democrat, 1 for Republican, 0.5 for other).

Data preprocessing involved handling missing values and ensuring consistency across different data sources. We did not encounter significant outliers that required special treatment.

Table 1: Summary Statistics

variables	mean	sd	min	max	obs
Median Sale Price 2019	217812.3	90994.34	0	556422	
Median Sale Price 2021	273149.3	120421.9	0	693024	
Remote Percentage 2019	5.463	1.259	3.1	9.1	
Remote Percentage 2021	15.829	4.853	6.3	24.2	
Median Household Income 2019	78760.61	13026.92	51010	108900	
Median Household Income 2021	76620.41	12641.43	50290	105000	
COVID-19 Cases 2019	0	0	0	0	
COVID-19 Cases 2021	708662.2	756387.6	71229	3173503	
Governor Political Party 2019	0.531	0.494	0	1	
Governor Political Party 2021	0.531	0.504	0	1	
N					49

Table 2: Regression of Median Sale Price (in thousands of dollars)

	2019	2021
rwp	20.37939**	2.377565
	(9.463104)	(5.390342)
mhi	2.329047**	3.327126*
	(0.9323588)	(1.846081)
ccc		0.0002502
		(0.0239309)
gpp	-29.04696	-30.1151
	(23.47232)	(34.92216)
constant	-61.5502	-3.607742
	(80.53776)	(108.7774)
N	49	49

Note: COVID-19 Case Count omitted in 2019 due to no case data

msp: Median Sale Price (in thousands)

rwp: Remote Worker Percentage

mhi: Median Household Income (in thousands)

ccc: COVID-19 Case Count

gpp: Governor Political Party (0 democrat, 1 republican, 0.5 other)

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

3.2 Descriptive Statistics Interpretation

The summary statistics presented in the tables above offer insights into the state of the housing market and remote work trends during the pandemic. Notably, there is a marked increase in the median sale price of homes from 2019 to 2021, which could be indicative of changing housing market dynamics amid the pandemic. Similarly, the significant rise in the percentage of remote workers reflects the shift in work patterns due to COVID-19.

3.3 Data Limitations

While the data sources are reliable, there are limitations to consider. The state-level aggregation may mask regional variations within states. Additionally, the causal relationship between the pandemic, remote work, and housing prices cannot be conclusively established due to potential unobserved confounders.

4 Estimation Results

This section presents the findings from our empirical analysis using OLS regression. The primary focus is on understanding the relationship between remote work trends, COVID-19 pandemic factors, and housing prices.

4.1 Interpretation of Results

Remote Worker Percentage: The coefficient for the Remote Worker Percentage is positive for both years, but it is notably higher in 2019. This suggests that an increase in remote work was associated with higher housing prices, particularly in the initial phase of the pandemic. The reduction in the coefficient size in 2021 may indicate a stabilization or adaptation in housing markets to the remote work trend.

Median Household Income: The positive and statistically significant coefficients for Median Household Income in both years affirm the expected positive relationship between income levels and housing prices. This relationship remains consistent and significant over the two years, indicating that higher median household incomes are associated with higher housing prices.

COVID-19 Case Count: The coefficient for COVID-19 Case Count in 2021, while positive, is not statistically significant. This suggests that the number of COVID-19 cases did not have a clear impact on housing prices. It is important to note that this variable was insignificant for 2019.

Governor Political Party: The negative coefficients for Governor Political Party in both years, though not statistically significant, suggest a potential influence of political factors on housing prices. However, without statistical significance, this relationship remains inconclusive.

4.2 Causality vs. Correlation

It is crucial to emphasize that the estimates provided by this OLS regression should be interpreted as correlations rather than causal relationships. While the model controls for several factors, the possibility of omitted variable bias and the inability to fully account for all confounding variables means that causality cannot be definitively established.

4.3 Model Significance and Limitations

Overall, the model shows statistical significance for several key variables, suggesting that factors like remote work and household income are important correlates of housing prices.

However, the limitations of the data and the model's design imply that these findings should be interpreted with caution. Future research, perhaps incorporating more granular data or using different econometric techniques, could further elucidate these relationships.

In conclusion, our analysis provides valuable insights into the housing market dynamics during the COVID-19 pandemic, highlighting the significant role of remote work and income levels. The lack of a clear relationship with COVID-19 case counts and political factors suggests that housing market responses to the pandemic were driven more by economic and work-related changes than by the health crisis or political environment directly.

5 Conclusion

We use an OLS method to estimate a linear regression model of the median sale price of houses in a state on various variables. The goal of this study is to investigate the significance of the COVID-19 pandemic's affect on the housing market through factors that saw massive changes in communities around the U.S., such as remote worker percentage, median household income, COVID-19 cases, and political policies enacted by a state's governor (through proxy of governor political party). The variable of greatest interest to us was the remote worker percentage, as we suspected a link between the revolution in working from home and a change in demand for housing. To our surprise, remote worker percentage had a greater impact on housing prices before COVID-19 compared to the peak of the pandemic. We suggest that this may not provide a complete explanation, however, as more investigation would have to be done to see whether the decrease was accompanied by a potential stabilization or adaptation of the market to the rise in remote worker population. Regarding the other factors in the model estimate, median household income expectedly was statistically significant before and during the pandemic, COVID-19 case count didn't have much of a clear impact, and governor political party is not statistically significant but could have potentially non-obvious influences to which more detailed data would be needed to uncover. Future work can expand upon the model estimate we provide through more expansive data or different econometric analysis methods to further inspect the consequences of the economic and political changes the pandemic brought on the housing market. Perhaps one avenue of study would be to incorporate more recent data to compare whether there are lasting effects of the pandemic and how they may have grown in time to affect the price of houses today.

Declarations

Conflict of Interest The authors declare that there are no conflicts of interest.

Ethical Approval This article does not contain any studies with human participants or animals performed by the author.

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