The Causal Effect of Remote Work Share on Housing Prices

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Abstract

The correlation between the housing price changes and the growth of remote work prevalence during Covid-19 pandemic is addressed in this work. Specifically, data before the pandemic period from 2016 to 2019 and during the pandemic period from 2020 to 2022 are studied by two-way fixed effects with difference-in-difference approach. The primary data source is American Community Survey (for state level work from home data) and Zillow research (for house price data). It is observed that the growing remote workforce is closely tied to the escalating housing prices. The main findings of my research highlight that states with high growth in remote work share have experienced a statistically significant additional increase of 2.09 percentage point in property price growth during the pandemic period, compared to states with lower growth in remote work share. Specifically, compare to the year 2019 which is the year before pandemic, there is an additional rise of $18,962 and $27,875 in the states with high remote work share during the pandemic period 2021 and 2022, respectively.

1.Introduction

The transformation of work environments, from traditional office settings to flexible remote work, has significantly impacted living and housing markets globally. This shift, from 4.98% average working from home share[1] in 2016 to 13.78% in 2022, rapidly accelerated by the burst of COVID-19 pandemic in 2020, has not only changed where people choose to live but also how they value and invest in their homes. With the highest working from home share of 25.4%[2] after the burst of pandemic in 2020, some evidence that a significant fraction of current remote work may be permanent (Barrero, Bloom, Davis, and Meyer, 2021)[3] Accordingly, the average house price increased from $210,122 to $340,421[4] with increased in 7.68%[5] in house price growth. The core question of this term paper seeks to answer is: What is the causal effect of growth in working from home share on house prices?

In exploring this question, the paper dig into the broader implications of remote work adoption on house price, providing a clear motivation for why this topic is important for understanding future housing market trends. The paper investigates the dataset combining housing market data and rental market data from Zillow Research[6] with information from American Community Survey[7] on remote work shares across 50 states spanning from 2016 to 2022, offering a state-level view of the

[1] Working from home share = remote work share = $\frac{\text{“ people work at home”}}{\text{“total worker age 16 or older”}}$, terms are defined by American Community Survey

[2] See SUMMARY STATISTICS in Appendix

[3] Also see https://news.gallup.com/poll/355907/remote-work-persisting-trending-permanent.aspx.

[4] See SUMMARY STATISTICS in Appendix

[5] See SUMMARY STATISTICS in Appendix

[6] See https://www.zillow.com/research/data/ Data type: ZHVI ALL HOMES TIMES SERIES RAW, Mid-Tier

[7] See American Community Survey https://data.census.gov/table/ACSDT1Y2022.B99087

pandemic's impact on housing price and its growth. While a positive correlation between house prices and working from home share is anticipated, it is noticed that underlying factors such as demographic shifts, migrations, and policy changes might concurrently exert influence on housing markets. Consequently, disentangling the pure effect of remote work on housing prices is both challenging and essential.

The empirical strategy employs a two-way fixed effect with difference-in-differences approach, leveraging geographic and temporal variations in growth in remote work share to isolate the effect of remote work on housing prices. This methodology allows for a causal interpretation of the change in housing prices over time in states with high increase in remote work share to the change in states with low increase in remote work share, before and after the widespread transition to remote work because of the pandemic. My paper reveal that an additional average 2.09 percentage points increase in the growth of house price for states with high average increase in working from home share compared to the states with low increase in remote work share during the pandemic. Second, I discovered that the growing remote workforce is closely tied to the escalating housing prices. Compared to the year of 2019 which is just before the pandemic, there is an additional rise of $18,962 and $27,875 in the states with high average growth of working from home share during the pandemic period 2021 and 2022, respectively.

If the shift to remote work represents a broad increase in housing prices, then we should expect to see effects on rents as well as prices. I find that the effects of remote work on rents are similar to the effects on house prices within the same sample, consistent with a broad increase in housing prices. This pattern lends credence to the hypothesis that the rise in remote work has exerted upward pressure not only on the value of property ownership but also on the cost-of-living spaces for non-owners. These findings substantiate the notion that remote work has pervasive consequences for the housing market, reinforcing the argument that the increase of remote work share has engendered a reevaluation of residential preferences and valuations.

This paper contributes to the growing body of literature on the economic implications of remote work, offering policymakers and urban planners' valuable insights into how shifts in work patterns may influence housing markets in the coming years. By highlighting the causal impact of remote work on housing prices, the paper provides evidence for understanding the long-term effects of the pandemic on housing policy.

2 Related Literacy

There is a rapidly growing literature on the feasibility and impact of remote work, particularly over the pandemic period. *Bartik, A. W., Z. B. Cullen, E. L. Glaeser, M. Luca, and C. T. Stanton (2020)* found that firms anticipate maintaining a considerable share of their workforce in remote settings even after the pandemic, suggesting a long-term shift in work patterns. Their study emphasizes the role of managerial practices in facilitating remote work and its potential to reshape urban economies. *Dingel, J. I., and B. Neiman (2020)* offers a comprehensive analysis of the potential for remote work across various occupations and highlight that a significant fraction of the workforce in

advanced economies could perform their jobs without the need for physical presence. *Haslag, P. H., and D. Weagley (2021)* focus on the migratory responses triggered by the increased flexibility of remote work. Their research documents a notable trend of workers moving away from traditional economic hubs towards less dense areas, driven by the new remote work policies. This shift, they argue, is likely to have lasting effects on local labor markets and residential real estate. *Althoff, L., F. Eckert, S. Ganapati, and C. Walsh (2021)* link the out-migration from large areas facilitated by remote work to job losses in local non-tradables. *Davis, M. A., A. C. Ghent, and J. M. Gregory (2021)* study the long-run implications of the shift to remote work. Their research indicates that remote work may reduce demand for commercial real estate, lower commuting costs, and redistribute economic activity across regions.

Mondragon J.A. and Wieland J.(2022) provide foundational insights into the nexus between remote work and housing demand. They quantitatively demonstrate that the transition to remote work accounts for a substantial portion of the recent surge in U.S. housing prices. By employing a detailed analysis of housing demand shifts associated with remote work patterns, the authors discovered that the shift to remote work explains over one half of the total national house price increase over the pandemic period. The findings are consistent with my results that the growing remote workforce is closely tied to the escalating housing prices.

Looking back at pre-pandemic analyses, the research by *DeFusco, A. A., C. G. Nathanson, and E. Zwick (2017)* sheds light on the role of credit conditions and investment expectations in fueling house price dynamics. The phenomenon of surging house prices during the pandemic has sparked discussions around the possibility of an emergent housing bubble in the United States, as suggested by *Coulter, J., V. Grossman, E. Mart´ınez-Garc´ıa, P. C. Phillips, and S. Shi (2022)*. These authors analyze the rapid appreciation of house prices and speculate on the potential risks of unsustainable growth akin to those observed prior to the 2008 financial crisis. However, my paper has a different perspective, asserting that the pronounced rise in house prices is a direct consequence of the substantial increase in remote work share. This argument is also supported by the findings from *Mondragon J.A. and Wieland J.(2022)* that the demand for housing has been fundamentally altered by the shift to remote work, thereby changing the landscape of residential real estate valuations.

A study by *Cunha, A., M, and Lobão, J. (2021)* used a Difference-in-difference approach to explore how short-term rentals affected housing prices in Portugal. They focused on municipalities and controlled for factors like population density and salaries. Their analysis checked the parallel trends assumption through graphical methods and employed robust estimation techniques to account for various potential biases. This study can offer insights into the methodological approaches and analytical considerations relevant to remote work on housing prices in my study.

My paper builds on this existing literature by specifically addressing the causal impact of remote work on housing prices through an empirical strategy that leverages recent advancements in data collection and analysis. I contribute to the dialogue by offering an understanding of how remote work influences housing prices and its growth through a two-way fixed effect difference-in-difference model. Moreover, my paper stands at the intersection of labor markets and housing policy, offering fresh insights into one of the economic questions of our time. By drawing on the

robust analytical frameworks and empirical findings of preceding studies, I aim to deepen the understanding of remote work's impacts on housing markets, contributing to informed policy-making and strategic planning in the post-pandemic era.

3.Data

3.1 Data Source

In my paper, I focus on the state level data of the U.S. as our primary units of observation. This allows me to study the patterns and implications of property value fluctuations on a broader, state-wide scale. My examination extends across all states, leveraging their varied economic interconnections and demographic profiles to provide comprehensive insights into the national trends.

For evaluating residential property valuations, I utilize indices from Zillow[8], a leading real estate marketplace, to gauge the baseline house prices. Monthly data on housing prices at the U.S. state level have been obtained for the period between January 2016 to December 2022. I use Zillow Home Value Index, which is a smoothed, seasonally adjusted measure of a typical home value in each state. From the data, an average yearly price for each state spanning from 2016 to 2022 are used to calculate the yearly growth in property price presented in this paper. The growth in house prices is observed in two distinct periods: the pre-pandemic phase from January 2016 to December 2019, and during the pandemic from January 2020 to December 2022. The findings reveal a stark contrast: TABLE 4 the summary statistics in Appendix shows that average house price growth accelerated from 5.7% pre-pandemic to an impressive 11.5% during the pandemic. For rents, I use the monthly data on rents at the U.S. state level spanning from the same period from Zillow and the relevant average rents every year is calculated for each sate as the input data for the paper.

My paper utilizes data from the American Community Survey (“ACS”) collected between 2016 and 2022. The measure of remote work is based on whether an employed individual commutes to work[9]. I use the data set of “Allocation of time arriving at work from home” to obtain the population of working from home and did not work from home respectively, the relevant working from home share is calculated from the ratio of population of “people work at home” to the population of “workers 16 years older” in the dataset. Furthermore, the ACS provides insight into local demographic characteristics. This rich dataset offers state-level information such as gender, age, income, unemployment rate and race. To align with my paper's focus, I use the state level demographic characteristics as control.

[8] See https://www.zillow.com/research/data/ Data type: ZHVI ALL HOMES TIMES SERIES RAW, Mid-Tier

[9] Defined in ACS as “work at home: employed individual that does not commute” https://data.census.gov/table/ACSDT1Y2022.B99087

I defined the treated states as the top 25 states[10] with high average increase in working from home shares pre-pandemic from 2016 to 2019 compared to the average working from home shares during pandemic from 2020 to 2022. The control states are the states with low average increase in working from home shares pre and during pandemic.

3.2 Descriptive Statistics

3.2.1 Remote Work Share

Throughout the sample period, I tracked the share of the workforce engaged in remote work. In my examination of the remote worker share, from TABLE 4 descriptive statistics in Appendix, prior to the pandemic, the average share of remote workers was relatively stable, standing at 5.2%. With the advent of the pandemic, this figure surged to an average of 14.6%, a stark testament to the transformative impact of pandemic on work practices. The standard deviation expanded from a pre-pandemic 0.013 to 0.038 during the pandemic, reflecting a broad dispersion that suggests vastly different rates of adoption across different locales and industries. The remote work share growth, remarkably, soared from 2.9% pre-pandemic to a striking 52.4% during the pandemic, suggesting a seismic shift in work modalities due to the pandemic.

3.2.2 Housing Price

Mirroring the upward trend in the growth of remote worker share, the housing market has also experienced pronounced shifts. Table 4 descriptive statistics in Appendix shows that the average house price pre-pandemic is $227,907 while it boosts to $300,313 during pandemic. The overall house price growth averaged 8.0%, with a slight increase to 8.1% in the weighted mean. The change from the pre-pandemic period's 5.7% to the pandemic period's 11.5% signals a robust response in housing prices coinciding with the onset of the pandemic.

3.2.3 Monthly Rental

Rents response in the patten similar to that of house price, the average rents pre-pandemic is $1,111 and increased to $1,330 during pandemic. Although at a smaller scale, with growth averaging at 5.4% and moving from 3.2% pre-pandemic to 6.9% during the pandemic.

3.2.3 Controlling Variable

The controlling variables including median household income, change in state population, unemployment rate, share of whites, share of population for age over 65 incorporate socioeconomic metrics that offer comprehensive insights. Median household income holds a mean of $68,642, with a substantial increase when weighted by population to $71,588. Population changes swing

[10] Treated states: AL, AZ, CA, CO, CT, FL, GA, ID, IL, IA, ME, MD, MN, MI, NH, NJ, NC, OH, PA, SD, TN, TX, UT, VT, WV

dramatically, showcasing a substantial standard deviation of 12,230, reflecting the dynamic demographic shifts during the study period. Additionally, the racial composition and age distribution highlight demographic diversity.

3.3 Limitation of Data

Due to incomplete county-level data from Zillow[11], I opted for state-level aggregates to maintain the accuracy and integrity of my analysis. This means that my observations are averaged across states, which could mask heterogeneity within states. Over the period from 2016 to 2022, I accumulated 350 observations, if interaction with years is considered, the number of observations would be 2,450 (350*7 years) across 50 states. The observation is my paper preclude a more detailed examination that could be afforded by a fuller individual-level dataset. Besides, the dataset spans a seven-year period, which, while informative, may not fully encapsulate longer-term trends and cyclical economic behaviors that could inform the housing market dynamics, especially in the context of remote work transitions.

My paper substitutes net migration data with overall changes in state population. While this serves as a proxy for migratory movements, it is an imperfect one, as it cannot distinguish between population changes due to migration versus natural increases (births minus deaths). Consequently, the potential for spillover effects, particularly those mediated through inter-state migration, may not be fully captured. This could affect the precision of our estimates concerning the impact of remote work on housing markets.

The ACS relies on household surveys, where respondents self-report on various aspects such as their work status and income. Self-reported data are subject to recall bias, misinterpretation of questions, and intentional misreporting. For instance, respondents may have different interpretations of what constitutes 'remote work', which could affect the accuracy of the 'remote work share'.

4.Methods

I use a two-way fixed effect with difference-in-difference approach to explore the causal relationship between the growth of remote work share and housing prices growth across different states. Simply examining the correlation might overlook factors such as economic growth, policy changes, or other state-specific shocks that could influence housing prices independently of remote work trends. The two-way fixed effect design compares the change in house prices over time in states with high increase in remote work share to the change in states with low increase in remote work share, before and after the widespread transition to remote work because of the pandemic. This helps to control for unobserved variables that could be influencing both remote work and housing prices, assuming these unobserved factors change at a constant rate over time

[11] Some of the country-level data from Zillow are blank without stating the reason.

Key assumptions of the Difference-in-difference design that must hold for my study to accurately capture the causal impact include:

1. Parallel Trends Assumption: In the absence of the shift to remote work, the treated states- states with high growth in remote work share and the control states- states with low growth in remote work share would have experienced similar trends in housing prices over time.
2. No Spillover Effects: The increase in remote work in one state does not affect the housing prices in another state.

$$H_{st} = \alpha + \beta.(WFH_{st}{}^{12}\, X\, post_t) \; + \emptyset_s + \tau_t + \gamma_{st}.C_{st} + \epsilon_{st} \cdots\cdots\cdots Equation\ 1$$

As stated earlier, my data is constructed at the state (s) by year (t), H_{st} measures the house price or the growth of house prices in state s at time t. $WFH_{st}$is a dummy variable where set to 1 for states with high (top 25 states) increase of remote work share between 2016 and 2022, 0 otherwise. $post_t$ is a dummy which equal to 1 indicating the time period during the pandemic period 2020 to 2022, 0 otherwise. $\emptyset_s$ are state fixed effects, capturing time-invariant characteristics. τ_t are time fixed effects, controlling for shocks common to all states at time t. C_{st} represents control variables including state demographic characteristics: change in state population, race, age group, income and unemployment rate. ϵ_{st} is the error term.

The coefficient of interest is β, the difference-in-difference estimate, which measures the average causal impact of the change in remote work ratio on house prices and its growth, assuming that the underlying trends in housing prices would have been parallel across states with different levels of remote work exposure in the absence of the treatment effect.

$$H_{st} = a + b.I_t + \sum_{\substack{y=2016 \\ y\neq 2019}}^{2022} c_y.WFH_{st} + \sum_{\substack{y=2016 \\ y\neq 2019}}^{2022} d_y(WFH_{st}\; X\, I_t) \; + f_{st}.C_{st} + \emptyset_s + \tau_t + \omega_{st} \cdots Equation\ 2$$

Further to the difference-in-difference model setup, the event study model investigates how the treated states evolves over time by comparing the pre-pandemic period to various years during pandemic period. I_t is a set of dummy variables for each year excluding the omitted category, 2019 which is the year just before the burst of pandemic. These coefficient d_y capture the incremental effect of the treated states from 2016 to 2022, relative to the omitted year, 2019. This allows for a more detail analysis of how the treatment's effect unfolds over time, checking for any pre-trends or delayed effects.

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12 In my study, states with high increase of remote work share are: AL, AZ, CA, CO, CT, FL, GA, ID, IL, IA, ME, MD, MN, MI, NH, NJ, NC, OH, PA, SD, TN, TX, UT, VT, WV

5.Result

5.1 Model Assumptions

I use a two-way fixed effect with difference-in-difference approach to recover the effect of increase in remote work share on housing price across U.S. states, using rents as a reference. The fundamental parallel assumption for the research model states that in the absence of the treatment, the increase of remote work share, the treated and control states would have followed similar trends in the outcome variable, the house prices. In other words, any difference in the change of housing prices between the pre-treatment and post-treatment periods can be attributed to the treatment effect rather than to other unobserved differences between the groups that change over time. To assess this assumption, I plot the coefficients of the treated states interacted with years to visualize the pre-treatment trends in the outcome variables. From ***Figure 1: coefficients of house price*** shows that the coefficients before pandemic are not significant away from zero and the graph visualized the pattern. From ***Figure 5: coefficients of house growth for treated states*** , the coefficients of housing price growth before 2020 might not be a visual support for the parallel assumption, however, the p-value[13] of the pre pandemic coefficients for house price growth shows that all of them are statistically insignificant. From ***Figure 2: coefficients of rental for treated states,*** the coefficients are close to zero and are statistically insignificant, this provides support for the parallel trend assumption.

I believe that states are sufficiently economically isolated such that significant economic changes in one state do not directly influence housing market conditions in another. For example, labor and housing markets tend to be localized, and an increase in remote work in California is unlikely to directly affect housing prices in New York. I did concern about spillover due to migration (people moving from treated to control states), I tried to control for this by including change in populations in each state to simulate the interstate migration rates in my model. The coefficients on the change in population variables[14] are not statistically significant which indicating that the inclusion of the control variables does not change the estimated effect of the increase in remote work on housing prices growth. Thus, I assume that the spillover assumption is fulfilled in the paper study.

[13] The p-value of the estimates are 0.143, 0.122 and 0.149 in 2016, 2017 and 2018 respectively.

[14] With growth in house price as the outcome, the coefficient for the control variable change in state level population is approximately zero. Refer to *Figure 6: coefficients of house growth for treated states with controls*

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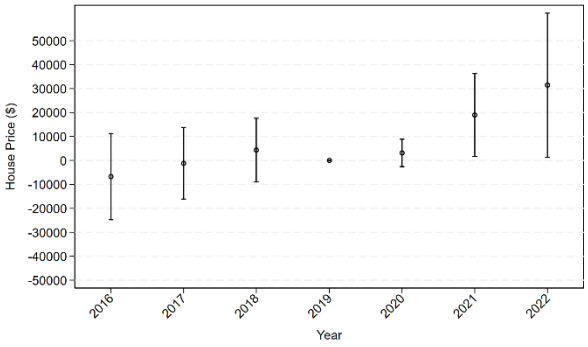


Figure 1: coefficients of house price for treated states

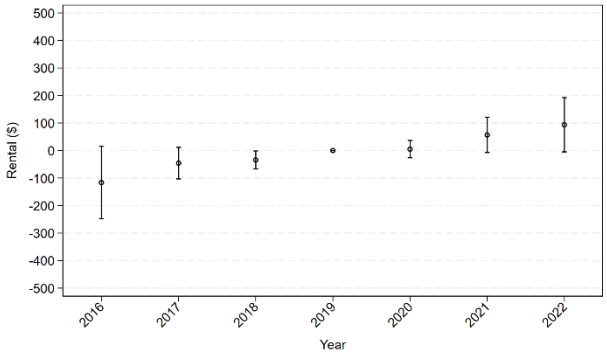


Figure 2: coefficients of rental for treated states

5.2 House Price and Market Rental

I initiate the examination by estimating the impact of increase in working from home share, delineated by the pandemic period, on the housing market, specifically on average house prices across different states. Referring to figure 3 and 4 below, I find that the states designated as treated states—those with highest average growth in working from home shares by the pandemic shifts—exhibit significant alterations in average house prices when compared to control states. The magnitude of the changes documented within my focused dataset surpasses the general market alterations, signaling that the delineation of treated states has isolates the influence of the growth in working from home shares because of the pandemic.

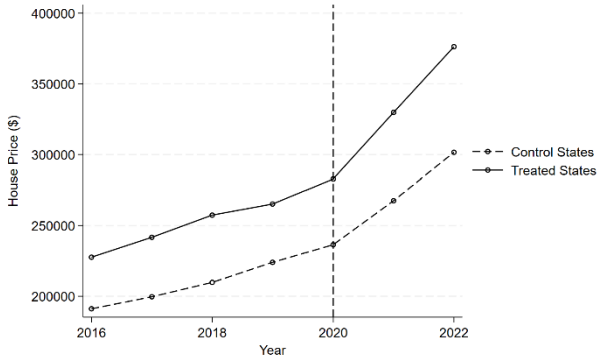


Figure 3: Housing Price trend from 2018 to 2022 for treated and control states

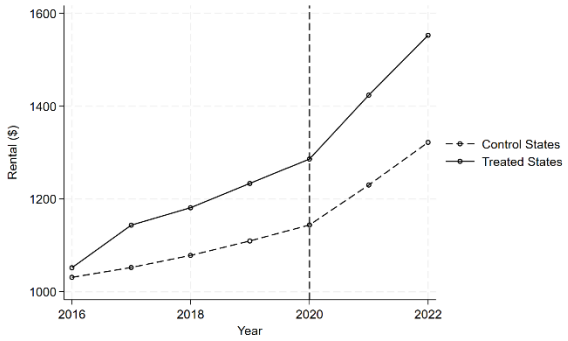


Figure 4: Average Monthly Rental trend from 2018 to 2022 for treated and control states

[15] Figures 1 and 2 present the estimated coefficients of interest d_y from the analysis modeled in $Equation\ 2$, exploring the impact of increase in remote work share on the growth in housing prices across U.S. states. The results draw from data spanning the years 2016 to 2022, with 2019 which is the year before pandemic as the omitted year. The table reflecting variations in the house price with the increased remote work shares

To further elucidate the relationship between remote work share and housing prices, I analyze the change of house prices through the changes of the remote work share across states by the pandemic's catalyzing effect. Refer to TABLE 1, I gauge the growth in working from home shares because of the pandemic effect on housing prices by assessing the coefficients for the 'Treated States X Pandemic' interaction term. In the difference-in-difference model, this interaction term suggests that in the pandemic period, the average house prices in the treated states have seen an additional increase of $19,268.4—indicative of the pandemic's pronounced impact on the housing market. However, the result is not statistically significant to stand for the effect of growth in working from home shares because of pandemic on house price.

I further analyze the coefficients of the treated states interreacted with each year and compare them with coefficient in the year just before the pandemic, 2019. This year works as the omitted year to allow a direct comparison of the house price during pandemic period for treated states to the year just before the pandemic. For the event study approach, the coefficients in TABLE 1 captures the interaction effect between a particular year and the treated states. Essentially, these coefficients measure the differential change in house prices for the treated states, relative to the control states, from the omitted year 2019 where the pandemic occurred. Focusing on the yearly coefficients without any control variables, Column (1) in TABLE 1, the coefficients for the year 2020 show an increase in housing prices compared to the omitted year of 2019, suggesting an early impact of the pandemic. The model estimates range from $3,128 to $8,006, indicating a varying but positive shift in housing prices during the first year of the pandemic. The standard errors are relatively large, and this coefficient is not statistically significant.

However, the coefficient of interest in 2021 show a substantial increase in house prices amounting to $18,962.1 with a standard error of 8,624.9, indicating that the house prices in treated states experienced an average increase of approximately $18,962.1. This effect is statistically significant at the 5% level. This implies a strong causal effect where the growth in working from home share is associated with a considerable increase in house prices for the year 2021. In other columns, the coefficients are slightly higher, reinforcing the consistency of this effect across different control variables. In 2022, the coefficients are even more significant, with values from 27,874.9 to 31,968.8 after controlling for the demographic characteristics. These figures indicates that the effects are statistically significant at least at the 5% level. This underlines the strong upward trajectory in housing prices.

The year-specific coefficients offer insights into the temporal dynamics of the housing market, reflecting both immediate reactions and adjustments to the growth in working from home share due to pandemic. The incremental growth rates for the years 2020 through 2022 suggest a cumulative and escalating effect on housing prices, a trend that is likely sustained by both the direct consequences of the pandemic and the subsequent responses aimed at recovery.

TABLE 2 presents coefficients from a difference-in-difference model estimating the impact of the pandemic on rents, with 2019 as the reference year. I use rents as outcome to further support the result of house price. The difference-in-difference coefficient “Treated States × Pandemic” aggregate post years for the treated states during the pandemic period is 104.1, but with a relatively

large standard error, suggesting that while there is a positive effect of the pandemic on rents in treated states, this effect is not statistically significant. The coefficients in 2020 turn positive but are not statistically significant, implying an increase in monthly rents compared to 2019, but not robust enough to be distinguished from random variation within the model's confidence levels. There's a noticeable increase in monthly rents, with coefficients ranging from 45.19 to 63.80. In model (3), this effect is statistically significant, indicating a potential post-pandemic recovery or adjustment in rental markets. The coefficients for 2022 show a further increase in monthly rental, with amounts ranging from 79.17 to 95.58 across different model specifications. However, none of these coefficients are statistically significant.

The trend in monthly rents as captured by the working from home share supports the findings regarding house prices. In both cases, there appears to be an upward trend post-pandemic, which may reflect increased demand for space, as more people work from home, the demand for larger living spaces that can accommodate home offices could drive both rental and house prices up. Moreover, the real estate market might be adjusting to the longer-term implications of the pandemic, reflecting expectations of a permanent increase in working from home share arrangements. Besides, the limited housing supply, due to factors such as slower construction rates during the pandemic, could have contributed to increases in both rents and house prices.

TABLE 1: EFFECT OF GROWTH IN WORKING FROM HOME SHARE ON HOUSE PRICE DURING PANDENMIC

DIFFERENCE-in-DIFFERENCE ESTIMATES

	(1)	(2)	(3)	(4)	(5)	(6)
Difference-in-difference Model						
Treated States X Pandemic	19,268.4 (24,578.2)	18,478.9 (24,381.2)	18,619.4 (24,395.0)	9,010.4 (18,707.2)	6,092.6 (17,668.2)	5,729.4 (17,828.6)
Treated States## Years						
2016	-6756.0 (8943.8)	-6417.9 (8690.7)	-6440.0 (8737.8)	1337.4 (7179.1)	-762.1 (7419.4)	-662.7 (7481.2)
2017	-1,204.4 (7443.3)	-721.6 (7141.7)	-792.9 (7202.6)	5,378.3 (6426.3)	3,333.9 (6532.6)	3,399.7 (6558.8)
2018	4,342.3 (6613.8)	4,765.3 (6548.1)	5,875.9 (6994.0)	9,055.2 (7849.8)	9,213.4 (7947.0)	10,066.7 (8301.4)
2019(omitted)	0	0	0	0	0	0
2020	3,127.7 (2837.8)	1,427.3 (3579.7)	1,682.6 (3429.0)	7,366.4 (4035.5)	7,968.0 (4116.1)	8,006.1 (4092.3)
2021	18,962.1* (8624.9)	20,105.9* (9333.8)	20,829.1* (9123.1)	16,186.6 (9896.4)	18,493.2 (9691.8)	18,544.2 (9671.9)
2022	31,443.6* (14983.2)	31,775.5* (15133.5)	31,968.8* (15060.2)	2,7874.9 (15301.4)	30,234.2* (14839.3)	30,304.8* (14832.4)
Change in Pop		Yes	Yes	Yes	Yes	Yes
Unemployed Rate			Yes	Yes	Yes	Yes
Median Income				Yes	Yes	Yes
Share White					Yes	Yes
Share age > 65						Yes
N	350	350	350	350	350	350

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TABLE 2: EFFECT OF GROWTH IN WORKING FROM HOME SHARE ON AVERAGE MONTHLY RENTAL DURING PANDENMIC

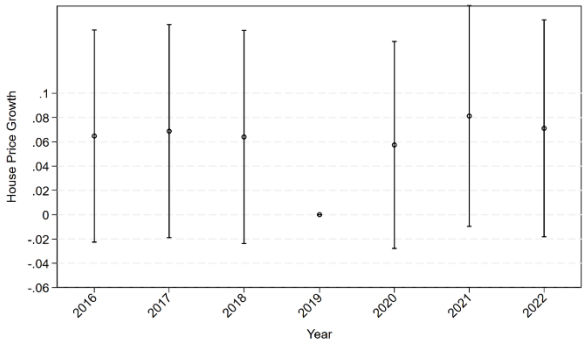
DIFFERENCE-in-DIFFERENCE ESTIMATES

	(1)	(2)	(3)	(4)	(5)	(6)
Difference-in-difference Model						
Treated States X Pandemic	104.1	106.6	107.6	81.7	72.7	67.6
	(73.78)	(73.71)	(73.27)	(59.76)	(56.30)	(56.93)
2016	-116.4	-116.2	-116.4	-85.21	-88.82	-89.50
	(65.44)	(65.70)	(64.86)	(70.04)	(70.22)	(70.56)
2017	-45.81	-45.45	-46.07	-21.34	-24.86	-25.30
	(28.62)	(28.72)	(27.31)	(22.83)	(22.57)	(22.76)
2018	-34.27*	-33.96*	-24.20	-11.45	-11.18	-17.00
	(16.24)	(16.22)	(13.59)	(16.93)	(17.36)	(19.26)
2019 (omitted)	0	0	0	0	0	0
2020	4.976	3.692	5.934	28.71*	29.75*	29.49*
	(15.64)	(16.56)	(15.44)	(13.24)	(13.34)	(13.44)
2021	56.58	57.44	63.80*	45.19	49.16	48.81
	(31.81)	(31.88)	(30.67)	(26.14)	(26.59)	(26.54)
2022	93.63	93.88	95.58	79.17	83.23	82.75
	(49.10)	(49.18)	(48.99)	(42.27)	(41.90)	(41.89)
Change in Pop		Yes	Yes	Yes	Yes	Yes
Unemployed Rate			Yes	Yes	Yes	Yes
Median Income				Yes	Yes	Yes
Share White					Yes	Yes
Share age > 65						Yes
N	350	350	350	350	350	350

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.3 House Price Growth

[16]Refer to TABLE 3, the Difference-in-difference estimator is 0.0209 which statistically significant at 5% level, this coefficient represents the differential effect of the treated states after the onset of the pandemic: The states with high growth in remote work share experienced an additional 2.09 percentage point higher growth rate in house prices compared to the states with low growth of in remote work share during pandemic.



[17]

Figure 5: coefficients of house growth for treated states

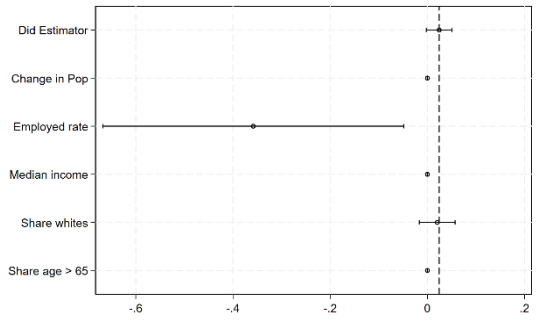


Figure 6: coefficients of house growth for treated states with controls

Further dig into the effect in each year compare to the year just before pandemic, the coefficient of 0.0936 indicates that in treated states, where there was high increase in the share of remote workers, house price growth was 9.36 percentage points higher in 2021 compared to the control states in the omitted year (2019), after controlling for other variables in the model. Similarly, for 2022, the coefficient of 0.0863 suggests an additional 8.63 percentage points increase in house price growth in treated states relative to the 2019. This confirms that the effect observed in 2021 was not a one-time event but continued into the following year.

The significance of the Difference-in-difference estimators, indicates that this is a robust finding and not due to random variation. The continuation of the positive effect into 2022 also suggests a sustained increase for house price in areas with increased remote work, possibly due to ongoing changes in work habits and preferences for living spaces as the pandemic continues to influence behaviors.

The consistent positive coefficients for both 2021 and 2022 imply that there may be a longer-term structural shift in housing markets due to increased remote work. It suggests that as more people

[16] Figures 5 present the estimated coefficients of interest d_y from the analysis modeled in $Equation\ 2$, exploring the impact of increase in remote work share on the growth in housing prices across U.S. states. The results draw from data spanning the years 2016 to 2022, with 2019 which is the year before pandemic as the omitted year. The table reflecting variations in the house price growth with the increased remote work shares

[17] Figures 6 present the estimated coefficients of the difference-in-difference regression in $Equation\ 1$ with all the control variables

work remotely, their preferences for where they live change, perhaps valuing more space or different locations, which in turn increases demand and drives up house prices.

These findings highlight the importance of considering remote work as a significant factor influencing housing markets during and possibly beyond the pandemic era. The fact that these effects are significant over consecutive years points to a persistent shift rather than a temporary reaction to the initial outbreak of the pandemic.

TABLE 3: EFFECT OF GROWTH IN WORKING FROM HOME SHARE ON HOUSE PRICE GROWTH DURING PANDENMIC

DIFFERENCE-in-DIFFERENCE ESTIMATES

	(1)	(2)	(3)	(4)	(5)	(6)
Difference-in-difference Model						
Treated States X Pandemic	0.0209*	0.0238*	0.0236*	0.0237*	0.0239*	0.0243
	(0.0098)	(0.0088)	(0.0086)	(0.0089)	(0.0099)	(0.0102)
Treated States## Years						
2016	0.0648	0.0639	0.0641	0.0370	0.0344	0.0340
	(0.0435)	(0.0435)	(0.0427)	(0.0227)	(0.0240)	(0.0241)
2017	0.0687	0.0676	0.0680	0.0465	0.0439	0.0437
	(0.0437)	(0.0437)	(0.0429)	(0.0233)	(0.0239)	(0.0240)
2018	0.0640	0.0630	0.0572	0.0462	0.0464	0.0436
	(0.0437)	(0.0437)	(0.0371)	(0.0252)	(0.0252)	(0.0251)
2019 (omitted)	0	0	0	0	0	0
2020	0.0574	0.0615	0.0602	0.0404	0.0412	0.0411
	(0.0424)	(0.0428)	(0.0412)	(0.0211)	(0.0213)	(0.0213)
2021	0.0812*	0.0785*	0.0747*	0.0909*	0.0938*	0.0936*
	(0.0352)	(0.0352)	(0.0328)	(0.0431)	(0.0441)	(0.0443)
2022	0.0711*	0.0703*	0.0693*	0.0835*	0.0865*	0.0863*
	(0.0345)	(0.0345)	(0.0335)	(0.0402)	(0.0416)	(0.0417)
Control Variables						
Change in Pop		Yes	Yes	Yes	Yes	Yes
Unemployed Rate			Yes	Yes	Yes	Yes
Median Income				Yes	Yes	Yes
Share White					Yes	Yes
Share age>65						Yes
N	350	350	350	350	350	350

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6.Conclusion

The paper has probed the essential question: How does the rise in remote work influence house price and its growth across the states in United States? This topic holds considerable weight as it impacts economic policy, labor markets, urban planning, and individuals' housing decisions in a post-pandemic landscape where remote work has become increasingly prevalent.

The main findings of my research highlight that states with a high growth in remote work share have experienced a statistically significant additional increase of 2.09 percentage point in property price growth during the pandemic period, compared to states with lower remote work share. This differential effect not only highlights the direct repercussions of increased remote work on housing markets but also signals a fundamental market adjustment in response to changing work lifestyles.

Analyze deeper into the annual impacts, Specifically, the treated states have seen an additional average increase of $18,962 and $27,875 in the pandemic period 2021 and 2022 respectively, compared to the year 2019, the year before the pandemic. Additionally, the year 2021 saw an 9.36 percentage point surge in house price growth in states with significant rises in remote work relative to the baseline year of 2019 after controlling the demographic characteristics. This trend persisted into 2022, with an 8.63 percentage point increase, reaffirming that the influence of remote work on housing markets was not merely a transient pandemic-era anomaly but rather a sustained shift.

The robustness of these findings, indicated by the statistical significance of the difference-in-differences estimators, confirms that the observed effects are not attributable to random fluctuations. Instead, they likely reflect a deep-seated transformation within housing markets—an evolution driven by ongoing changes in work arrangements and living space preferences among the workforce. The consistent positive impacts across consecutive years suggest a structural shift in housing demand, propelled by a workforce increasingly untethered from traditional office locations and seeking residences that better suit their new remote work lifestyles.

However, there are limitations in my study. One of the key challenges in asserting causality is the potential violation of the parallel trend assumption inherent in the difference-in-difference methodology. If trends before pandemic in the growth of property prices between the treated and control states were diverging, this could bias my results. Additionally, my analysis may not fully account for other concurrent policy changes or economic factors that could influence house prices independent of remote work trends.

The ideal analysis, with the luxury of more time or richer data, would involve accessing individual-level data over a longer time span, allowing for a more sophisticated analysis of the relationship between remote work and housing markets. With such data, I could use instrumental variables that could mitigate any remaining endogeneity concerns. Moreover, a longer time series could provide the opportunity to examine the long-term equilibrium effects of remote work on the housing market, beyond the initial adjustments observed during the pandemic.

7.Appendix

Table 4 SUMMARY STATISTICS

	Mean	Weighted Mean	SD	Min	Max	N
Remote Worker Share	0.093	0.100	0.060	0.022	0.254	350
Remote Worker Share Pre-Pandemic	0.052	0.055	0.013	0.022	0.091	100
Remote Worker Share Pandemic	0.146	0.162	0.038	0.055	0.254	250
Remote Worker Share Growth	0.242	0.241	0.650	-0.269	3.073	350
Remote Share Growth Pre-Pandemic	0.029	0.030	0.052	-0.246	0.233	100
Remote Share Growth Pandemic	0.524	0.581	0.900	-0.269	3.073	250
House Price	258,938	285,473	116,380	107,943	831,601	350
House Price Pre-Pandemic	227,907	251,527	94,894	107,943	613,684	100
House Price Pandemic	300,313	330,113	129,159	120,221	831,601	250
House Price Growth	0.080	0.081	0.061	-0.405	0.878	350
House Price Growth Pre-Pandemic	0.057	0.055	0.056	-0.405	0.878	100
House Price Growth Pandemic	0.115	0.115	0.051	0.026	0.333	250
Rental	1,205	1,188	352	650	2,814	350
Rental Pre-Pandemic	1,111	1,198	295	650	2,208	100
Rental Pandemic	1,330	1,276	384	811	2,814	250
Rental Growth	0.050	0.056	0.049	-0.229	0.397	350
Rental Growth Pre-Pandemic	0.035	0.036	0.047	-0.229	0.196	100
Rental Growth Pandemic	0.069	0.070	0.044	-0.055	0.397	250
Controlling Variables						
Median Household Income	68,642	71,588	12,230	43,469	101,548	350
Change in State Population	33,911	34,607	105,765	-360,439	892,499	350
Unemployment Rate	0.049	0.051	0.014	0.022	0.097	350
Share White	0.781	0.741	0.120	0.411	0.964	350
Share of age over 65	0.235	0.294	0.230	0.114	0.838	350

Notes: weighted means is weighted by average state level population.

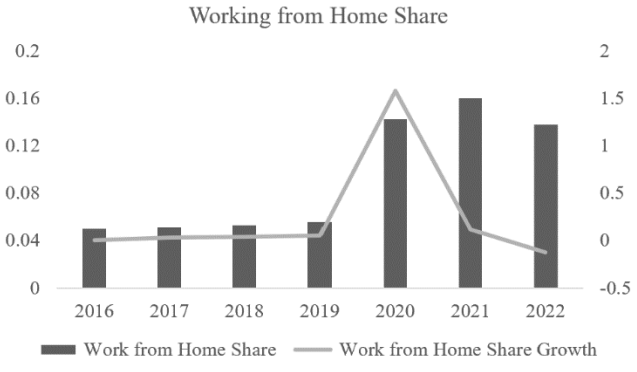


Figure 7: Working from Home Share and its growth from 2016 to 2022

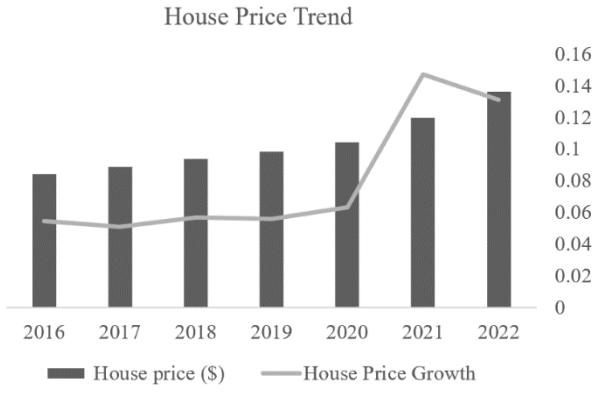


Figure 8: House Price and its growth from 2016 to 2022

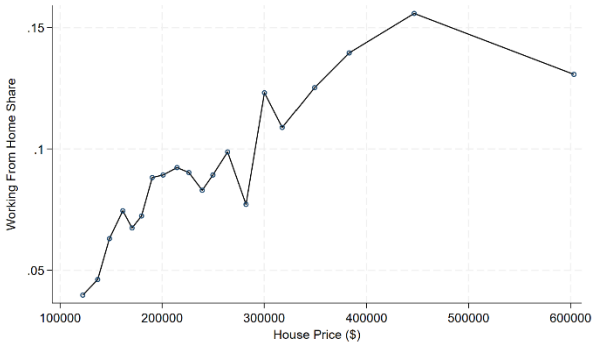


Figure 9: Working from Home Share and house price ($)

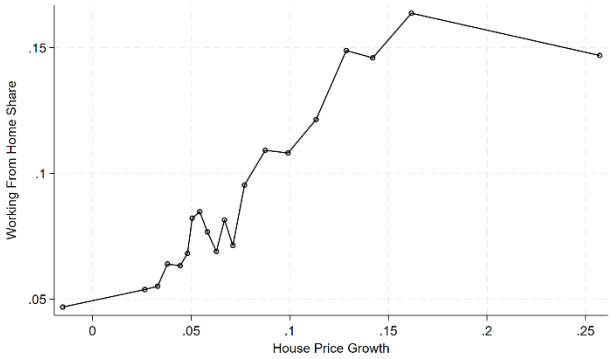


Figure 10: Working from Home Share and house price growth

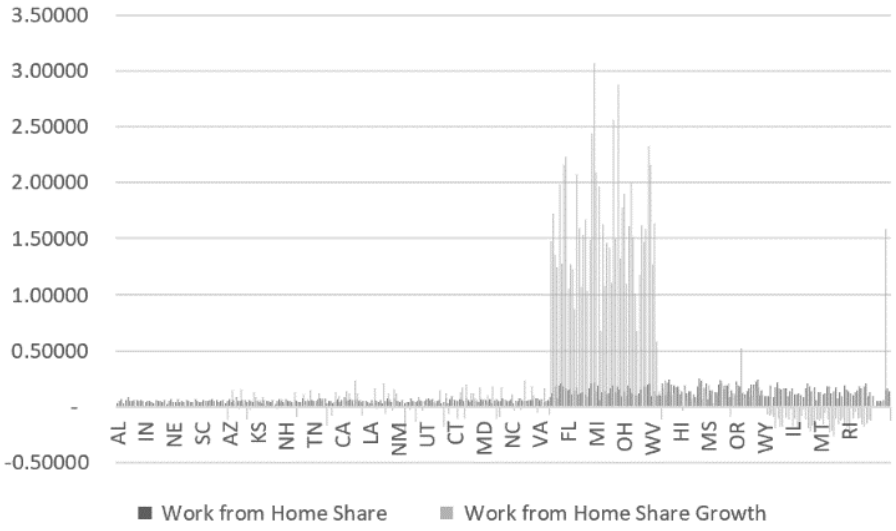


Figure 11: State view of Working from Home Share and growth

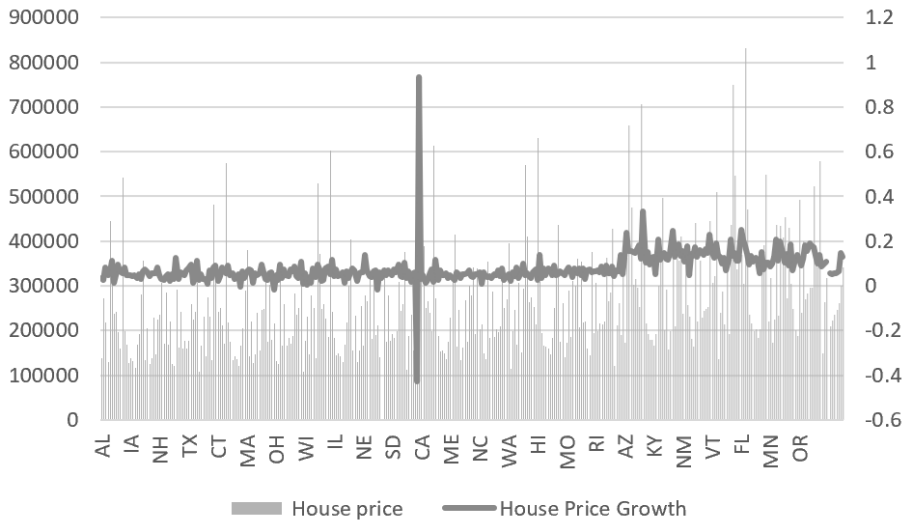


Figure 12: State view of House Price and growth

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