

Affordable Housing and Workforce Participation

Abstract

This paper investigates the relationship between housing affordability and labor force participation in the United States using county-level data from the 2023 American Community Survey. Despite widespread policy interest in the link between housing costs and employment outcomes, the analysis finds no statistically significant effect of affordability or its interaction with population density on labor force participation. These findings highlight the need for a more holistic policy approach, combining affordable housing initiatives with investments in transportation and childcare access, job quality and educational support.

Gabrielle Dominique

Applied Econometrics

Professor Zabel

1. Introduction

Access to affordable housing plays a crucial role in economic stability and workforce participation. Many economists have researched the link between affordable housing and labor force participation, and the results are indisputable. For instance, the National Governors Association (NGA) has identified housing access as a widespread barrier to workforce participation, particularly for middle-income workers who are ineligible for subsidized housing but struggle to afford homes near their workplaces in the U.S. New home affordability continues to drop with just 10% of new homes selling for less than \$300,000 in the last quarter of 2022, down from 41% in the fourth quarter of 2019 (NGA 2024). This trend prevents lower and middle class individuals and families from securing stable housing, which in turn limits their ability to participate fully in the workforce and contribute to economic growth.

The affordable housing shortage is both a social and economic issue as it directly impacts businesses' ability to attract and retain skilled workers. When workforce demand and housing needs aren't aligned workers must often choose between inadequate housing, long commutes to work or leaving the workforce altogether. As for employers, they are faced with challenges related to filling job openings. If many employees cannot afford living in or near metropolitan areas where job demands are high and long commutes to work cannot be justified, many jobs are left unfilled. This dynamic underscores the importance of addressing housing affordability as a key component of workforce development strategies.

Governors around the United States are increasingly recognizing the link between housing affordability and workforce challenges and are choosing to implement policies to help bridge this gap. In California, Governor Gavin Newsome has introduced legislation to streamline the building of new homes and ensure local zoning laws do not prohibit denser development through the launching of the Housing Accountability Unit (HAU) in 2021. In Connecticut Governor Ned Lamont advocated for \$100 million annually for workforce development housing to create 2,000 units for households with an income of 60% - 120% area median income (AMI) in addition to \$50 million annually for the Time-To-Own program, which provides forgivable down-payment assistance targeted at households making less than 80% AMI (NGA 2024).

Even in states where metropolitan areas are smaller in population in comparison to California and Connecticut, Governors are making strides to address the lack of affordable

housing. In Montana, Governor Greg Gianforte has proposed legislation to pass several housing regulation reforms including SB323 allowing for duplex, triplex, and fourplex housing in city zoning and SB528, which would revise zoning laws to allow for accessory dwelling units. Additionally, Governor Gianforte has also invested in the construction workforce, which requires continued development and upskilling to ensure staffing is not a barrier to housing development (NGA 2024). In Wisconsin, Governor Tony Evers' highlighted housing initiatives such as \$150 million investment to continue the Neighborhood Investment Fund Grant Program, which provides grants to local and Tribal governments to invest in solutions to bolster the workforce for the future, including building affordable housing (NGA 2024).

Initiatives such as these reflect the growing understanding that housing affordability is a critical economic priority as well as a social issue. Based on the U.S Government Accountability Office, at the federal level, policies like the Housing Choice Voucher Program, emergency rental assistance, and support for manufactured housing have sought to address affordability challenges. However, despite these efforts demand for affordable housing continues to outpace supply, particularly in metropolitan areas where workforce participation is heavily concentrated. This gap highlights the need to better research the causal relationship between housing affordability and workforce outcomes.

The goal of this research paper is to examine the relationship between access to affordable housing and workforce participation, with a focus on how housing affordability impacts economic stability and workforce success. In conjunction with analyzing both state and federal policies, this paper aims to understand how affordable housing impacts individuals' ability to gain and maintain employment. Through exploring this causal relationship, this paper will provide evidence to help policymakers implement more effective housing and workforce success strategies.

This paper begins by reviewing relevant literature and describing the data and methodology used. The empirical results from county level data using the 2023 American Community Survey data then follows. While the results show there is no strong statistically significant relationship between affordability and workforce participation, it highlights the significance of other factors such as level of education and state fixed effects. Lastly, this paper concludes with policy implications and suggestions for a more holistic approach to workforce engagement.

2. Literature Review

Extensive research has been conducted on housing and its effects of labor market participation, income and human capital investment. Prior studies highlight both the potential benefits and drawbacks of housing subsidies, particularly its influence on labor supply incentives. Dauth et al. (2024) contribute to this literature by exploiting exogenous variation in the timing of admission to affordable housing. By utilizing administrative data from 465 subsidized rental housing projects in five major Bavarian cities, they track individuals' labor market trajectories over nearly two decades. Their empirical strategy uses the nonparametric event study difference-in-differences estimator first employed by Borusyak et al. (2024) (BJS). Unlike two-way fixed effects, this method does not suffer from overly restrictive assumptions on effect heterogeneity and offers a more flexible estimation of long term effects. In their study Dauth et al. exclude observations one year prior to receiving affordable housing to account for potential anticipation effects, as individuals may be aware of their upcoming move months in advance. This strategy includes a fixed-effects specification controlling for individual characteristics, city-specific effects, nationality, and sex, ensuring robust estimation of counterfactual labor outcomes. Their findings indicate that access to affordable housing leads to increased labor income and job quality, and reduced likelihood of unemployment. Given that the majority of the affordable housing units are located in urban areas where public transportation is highly accessible, the findings show that a decrease in log distance to the city center is associated with a 0.3653 ($p < 0.01$) increase in yearly real labor income, meaning that that living closer to the city center significantly boosts earnings. Additionally, their findings suggest that living in affordable housing increases individuals' probability of starting vocational training by about 2.15 percentage points.

Additionally, research done by Acolin and Wachter (2017) emphasizes the role of housing access in shaping economic opportunity. Their work highlights that proximity to employment centers, access to public transit, and the affordability of housing plays a significant role in labor force participation. Using decennial census data from 2000 and the American Community Survey data for 2006 and 2014, Acolin and Wachter examine the relationship between changes in employment, education, and housing costs. The results indicate that metropolitan areas that experienced above-median employment growth also experienced faster

nominal rent and house price growth. Between 2000 and 2006, house values increased at an annual rate of 11.1% in metropolitan areas with above-median employment growth, compared to 7.3% in lower-growth areas. Similarly, rent increased by 4.5 percent in high-growth areas compared with 3.9 percent in areas that are not high growth. Furthermore, their analysis reveals that areas experiencing above-median employment growth disproportionately attracted higher-skilled workers. Between 2000 and 2014, the annual population growth rate for individuals with bachelor's degrees in these high growth areas was 2.2%, while the growth rate for those without bachelor's degrees was only 0.9%. This dynamic illustrates regional income disparities, as lower-skilled workers experience greater barriers to living in high-growth areas due to the increase in housing costs. Acolin and Wachter suggests that policies promoting affordable housing in high-growth urban areas can mitigate economic disparities by facilitating access to better job opportunities and social services. They also highlight the potential spillover effects of housing stability on skill development and workforce participation, as individuals with affordable housing are better positioned to invest in education and vocational training, thus reducing unemployment rates.

3. Data

In this empirical research project I employed data from the ACS 2023 (5-Year Estimates), reflecting data collected from 2018 to 2022. The data are aggregated at the county level and covers a broad scope of the U.S. population, including individuals aged 16 and over in the labor force and those with reported educational attainment by gender. Specifically I used tables A00002: Population Density (Per Sq. Mile), A17002: Labor Force for Population 16 Years and Over, A10036: Median House Value for All Owner-Occupied Housing Units, A14007: Median Household Income by Race, A12001A: Educational Attainment for Male Population 25 Years and Over and A12001B: Educational Attainment For Female Population 25 Years and Over. The data are aggregated at the [insert correct geographic unit, e.g., census tract or county level]. The sample size of this data is 1,007 observations, originally 3,222 observations. The reduction in sample size is primarily due to the presence of missing values in key variables required for analysis. For instance, observations were dropped if data was missing for labor force participation (A17001_003), median home value (A10036_001), or median household income

(A14007_001), which are all essential for constructing the main dependent and independent variables.

The complete list of variables used, along with their definitions and any transformations applied, is provided in Table 1: Variable Definitions. Most variables were originally recorded per 1,000 population and were rescaled by dividing by 10 for scalability. Key variables include the participation rate, affordability, which is the ratio of median house value to median household income, and population density measured in persons per square miles. Additionally, income ratios by race and educational attainment levels by gender are included to capture socioeconomic and demographic variation across counties. Descriptive statistics for these variables are presented in Table 2: Summary Statistics. The mean labor force participation rate is approximately 60.854% with a standard deviation of 6.77 percentage points. The participation rate ranges from 25.13% to 84.31%, with most counties clustered between 56.79% and 65.62%. The distribution is moderately left-skewed (-0.55), with some outliers at both extremes. Housing affordability has a mean value of 1.188 and standard deviation of 1.980, but the distribution is highly right-skewed (skewness = 9.25) with extreme outliers reaching as high as 31.49 indicating large differences in housing cost burdens across counties. The average population density is about 11.26 people per square mile, but the standard deviation of 44.47 indicates a wide range across urban and rural areas. The table also includes variables related to educational attainment and racial income ratios that displays notable variation, reflecting diverse economic and demographic landscapes across the dataset.

Figure 1 illustrates a scatter plot, plotting labor force participation rate against housing affordability. The downward slope suggests a negative correlation between the two variables, indicating that as housing becomes less affordable, labor force participation decreases. The clustering of points on the left side of the graph shows that most counties have relatively affordable housing, but even within this range, variation in LFP is visible. Overall, Figure 1 is a visual representation of the diminishing relationship between affordability and labor market engagement.

4. Empirical Model

To examine the relationship between affordable housing and workforce participation, I estimated the following regression model:

$WorkforceParticipationRate_i = \beta_0 + \beta_1(MedianHouseValue_i/MedianIncome_i) + \beta_2PopulationDensity_i + \beta_3EducationLevel_i + \beta_4Gender_i + \beta_5Race_i + \beta_6Age + \gamma_s\mathbf{X} + \delta_s + \epsilon_i$,
 where i indexes each county in the United States, $\gamma_s\mathbf{X}$ is a vector of control variables for education, gender composition, racial composition, and age distribution at the county level, δ_s represents state fixed effects to account for unobserved heterogeneity across states, and ϵ_i is the error term.

One possible mechanism in which affordable housing could influence workforce participation is that high housing costs relative to income can reduce geographic mobility, limiting individuals' ability to move closer to job opportunities. However, access to affordable housing can lower the financial burden on individuals, making it easier for them to enter and remain in the labor market. When individuals secure affordable housing, they are more likely to invest in job searches, which is particularly important in metropolitan areas where both housing costs and employment opportunities are high.

To evaluate the relationship between affordable housing and workforce participation, I estimated two regression models. The first model includes affordability, a measure of the ratio of median house value to median household income, population density, and various socioeconomic controls such as educational attainment by gender and income ratios by race. This baseline model tests whether housing affordability alone is associated with labor force participation rates on the county level.

In the model the interaction term is affordability ($MedianHouseValue/MedianIncome$) x population density, exploring how the effect of housing affordability on workforce participation varies across areas with different population densities. It is a given that affordable housing may not have the same effect on workforce participation everywhere. By multiplying affordability ($MedianHouseValue/MedianIncome$) with population density, you can see how the relationship between affordability and workforce participation varies depending on how densely populated an area is. In high-density areas, housing affordability may have a more significant impact on workforce participation because of factors like limited space, higher demand for housing, and greater job competition. The expected sign of the parameter corresponding to the interaction term is negative because in high-density areas, less affordable housing may more strongly discourage workforce participation, because people can't afford to live near jobs.

By including two models, one with and another without an interaction term, I am not only assessing the main effect affordable housing has on workforce participation but also whether that effect is heterogeneous across various different geographic regions and contexts. A statistically significant and negative interaction term would suggest that the negative impact unaffordable housing has on workforce participation is more apparent in densely populated counties.

It is important to note that this analysis does not estimate a causal relationship between housing affordability and workforce participation. Endogeneity may arise due to omitted variable bias due to unobserved factors like local economic development and public transportation access that may influence both housing affordability and labor force participation but are not included in the model.

5. Empirical Analysis

To examine the relationship between housing affordability and workforce participation, two regression models were estimated: one without interaction terms and one with interaction terms. Both models include various control variables such as population density, education levels and income ratios by race. The models also include state fixed effects accounting for unobserved heterogeneity.

In the model without the interaction term, the coefficient for affordability is -0.242 with a p value of 0.247. In the model with the interaction term the coefficient for affordability is -0.231 with a p value of 0.275. In both models, the p value for affordability is greater than 0.05 meaning that affordability is not statistically significant at the 5% level. This suggests that, contrary to the hypothesis, housing affordability does not have a statistically significant impact on workforce participation. The estimated elasticity of labor force participation with respect to affordability, without the interaction term is 0.0047 meaning, a 1% increase in affordability is associated with a 0.0047% decrease in labor force participation. This effect is not economically significant, suggesting that changes in affordability have a minimal impact on labor force participation. Despite the economic insignificance, I calculated the differential impact and its economic significance. Holding other variables constant, moving from the 25th to the 75th percentile of affordability is associated with a 13.27 percentage point decrease in labor force participation. Although this change appears to be large, the lack of statistical significance indicates that the relationship may be driven by noise rather than a true effect.

For Model 2, the main coefficient of interest is the interaction term between affordability and population density. The coefficient of the interaction term is $-.0089085$, which suggests that for each unit increase in population density, the effect of affordability on labor force participation decreases by $-.0089085$, holding other factors constant. The p value is 0.624 , suggesting that the interaction term is not statistically significant at the 5% level. The estimated elasticity of this interaction term is -0.00646 , showing that a 1% increase in affordability leads to only about a 0.0065% decrease in labor force participation which is an extremely small and economically insignificant effect. Once again, I calculated the differential impact and its economic significance. At the 25th percentile the marginal effect is -0.2329 ; at the 75th percentile, it is -0.2769 . These correspond to elasticities of approximately -0.0045 and -0.0054 , respectively, indicating that even in high-density areas, the impact of affordability on labor force participation remains economically small. Therefore, these results do not support the hypothesis that housing affordability has a stronger negative effect on labor force participation in more densely populated areas. The coefficient on the interaction term is negative as expected, but it is not statistically significant, and the effect size is economically small. We then fail to reject the null hypothesis that the interaction effect is zero. The lack of statistical significance can be attributed to the presence of multicollinearity between affordability and population density.

In addition to the main variable of interest, affordability, several covariates were statistically significant and of expected sign. For instance, the share of high school educated women was positively and significantly associated with labor force participation, suggesting that being a woman with this education level plays an important role in workforce engagement. Despite what I initially thought, having an advanced degree has a large and statistically significant negative coefficient, which is seemingly counterintuitive and may warrant further investigation into how this variable is constructed or interacts with other factors. Finally, many state fixed effects were large and significant, such as Iowa, Nebraska and South Dakota, indicating substantial geographic variation in labor force participation across the U.S.

6. Conclusion

The purpose of this paper is to explore the relationship between housing affordability and workforce participation in the United States, using county level data from the 2023 American

Community Survey. Despite the widespread policy interest and the original theoretical link between affordable housing and the labor market, the results do not provide strong statistically significant evidence to support this justification. The affordability covariate and its interaction with population density were both not statistically significant predictors of labor force participation. Although the signs of these coefficients were as expected, which suggest that unaffordable housing may deter workforce participation, particularly in highly densely populated areas, the estimated effect sizes were economically small and not robust.

However, there were several covariates that produced significant and policy-relevant findings. The share of high school educated women was positively and significantly associated with labor force participation, reinforcing the importance of targeted educational investments. Conversely, the large and highly significant negative coefficient on advanced education levels was not as expected and suggests the need for deeper investigation into potential data or model specification issues. We also found large and significant state fixed effects, specifically in states with lower populated dense counties. This suggests the influence of localized economic, policy, or labor market conditions.

When looking at this from a policy perspective, these findings suggest that although affordable housing remains a critical issue for economic stability, its direct relationship to labor participation is more complex and less intuitive than initially hypothesized. It is likely that factors such as access to public transportation, job quality or the availability of childcare can influence workforce participation. Therefore, policies aimed at boosting labor force engagement should take a more holistic approach, combining affordable housing initiatives with investments in public transit, job training programs, and family support services. By employing more holistic policies, this could remove barriers to employment where affordability alone may not be sufficient to enable full workforce participation.

7. References

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Table 1: Variable Definitions

Variable Name	Definition
lfp	Share of the working-age population participating in the labor force.
affordability	Ratio of median house value to median income
population_density	Number of people per square mile,
white_income_ratio	Ratio of white median household income to the overall median income
black_income_ratio	Ratio of Black median household income to the overall median income
hispanic_income_ratio	Ratio of Hispanic median household income to the overall median income
asian_income_ratio	Ratio of Asian median household income to the overall median income
americanindian_income_ratio	Ratio of American Indian median household income to the overall median income
nativehawaiian_income_ratio	Ratio of Native Hawaiian median household income to the overall median income
somerace_income_ratio	Ratio of Some Other Race median household income to the overall median income
tworace_income_ratio	Ratio of Two or More Races median household income to the overall median income

male_less_hs	Share of male population with less than a high school education
male_hs_only	Share of male population with exactly a high school diploma
male_some_college	Share of male population with some college education, no degree
male_bachelors	Share of male population with a bachelor's degree
female_less_hs	Share of female population with less than a high school education
female_hs_only	Share of female population with exactly a high school diploma
female_some_college	Share of female population with some college education, no degree
female_bachelors	Share of female population with a bachelor's degree
male_advanced	Share of male population with a graduate degree
female_advanced	Share of female population with a graduate degree

Table 2: Summary Statistics

Variable	min	max	mean	sd
lfp	25.133	84.35	60.854	6.774
affordability	0.0203	31.49	1.185	1.974
population_density	0	880.4	11.26	44.47
adv_education	0.0755	0.459	0.193	0.0432
white_income_ratio	0.0230	63.80	1.588	2.802
black_income_ratio	0.0246	5.090	1.091	0.414
male_bachelors	0	0.0295	0.00248	0.00200
male_hs_only	0.0134	0.299	0.114	0.0431
female_hs_only	0.0290	0.331	0.142	0.0457
male_some_college	0	0.319	0.0570	0.0315
female_some_college	0.00318	0.175	0.0391	0.0220
female_bachelors	0	0.0109	0.00168	0.00118
hispanic_income_ratio	0.000762	8.226	0.169	0.410
asian_income_ratio	0.199	37.71	1.357	2.111
americanindian_income_ratio	0.0281	41.57	1.227	1.942
nativehawaiian_income_ratio	0.114	41.17	1.326	2.253
somerace_income_ratio	0.228	36.17	1.632	2.509
tworace_income_ratio	0.0188	42.11	1.476	2.793
white_alone_income_ratio	0.0143	33.89	1.307	2.414
<i>N</i>	1007			

Table 3: Regression Results, Workforce Participation Model

VARIABLES	(1) Workforce Participation Model Without Interaction	(2) With Interaction
affordability	-0.242 (0.209)	-0.231 (0.211)
population_density	0.00867* (0.00501)	0.0170 (0.0195)
c.affordability#c.population_density		-0.00891 (0.0182)
adv_education	-59.23*** (7.172)	-59.21*** (7.180)
white_income_ratio	0.0412 (0.0760)	0.0451 (0.0767)
black_income_ratio	0.0256 (0.347)	0.0282 (0.347)
female_bachelors	-75.99 (446.7)	-77.37 (447.1)
male_bachelors	-226.8 (277.5)	-227.5 (277.8)
male_hs_only	6.226 (9.123)	6.158 (9.138)
female_hs_only	32.28*** (10.85)	32.51*** (10.88)
male_some_college	-27.19 (17.36)	-27.26 (17.38)
female_some_college	37.10 (27.47)	37.03 (27.47)
hispanic_income_ratio	-1.410 (1.268)	-1.445 (1.273)
asian_income_ratio	-0.0362 (0.172)	-0.0280 (0.174)
americanindian_income_ratio	-0.159 (0.199)	-0.157 (0.198)
nativehawaiian_income_ratio	0.272 (0.265)	0.269 (0.264)
somerace_income_ratio	-0.166 (0.205)	-0.175 (0.208)

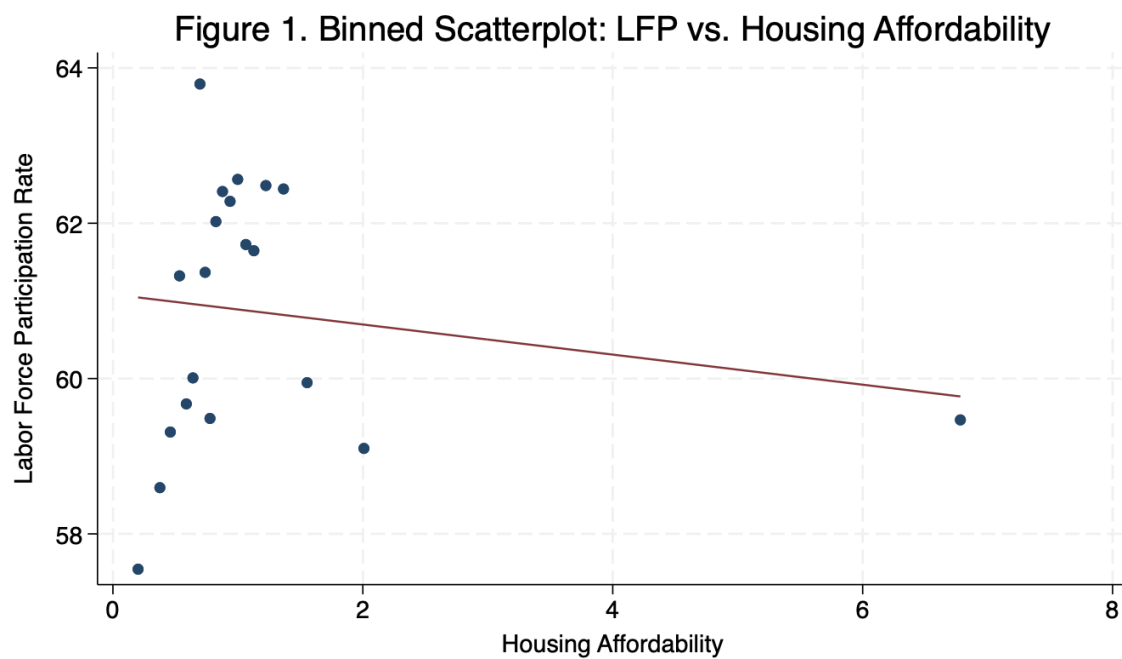
tworace_income_ratio	0.567*** (0.185)	0.571*** (0.186)
2.state	7.334*** (2.457)	7.382*** (2.467)
4.state	-7.953*** (1.475)	-7.910*** (1.467)
5.state	2.520*** (0.964)	2.522*** (0.964)
6.state	-0.136 (1.026)	-0.134 (1.027)
8.state	3.605** (1.647)	3.637** (1.652)
9.state	2.809*** (0.823)	2.809*** (0.822)
10.state	1.168 (2.768)	1.246 (2.811)
11.state	3.196* (1.743)	3.205* (1.742)
12.state	-3.697** (1.472)	-3.709** (1.474)
13.state	4.393*** (0.783)	4.407*** (0.784)
15.state	2.127 (3.115)	2.460 (2.924)
16.state	5.615*** (1.252)	5.659*** (1.250)
17.state	3.698*** (0.930)	3.686*** (0.932)
18.state	5.151*** (0.789)	5.157*** (0.789)
19.state	8.096*** (0.903)	8.103*** (0.904)
20.state	5.770*** (1.076)	5.764*** (1.078)
21.state	3.118*** (0.987)	3.135*** (0.989)
22.state	2.884** (1.137)	2.876** (1.138)
23.state	1.691 (1.243)	1.681 (1.245)

24.state	4.545*** (1.341)	4.615*** (1.357)
25.state	3.147*** (1.116)	3.158*** (1.117)
26.state	-0.135 (0.936)	-0.129 (0.936)
27.state	6.859*** (1.150)	6.864*** (1.151)
28.state	0.664 (1.219)	0.670 (1.219)
29.state	4.094*** (0.777)	4.095*** (0.777)
30.state	5.233*** (1.474)	5.298*** (1.454)
31.state	10.00*** (1.008)	10.01*** (1.008)
32.state	-0.798 (3.507)	-0.790 (3.522)
33.state	3.436** (1.378)	3.435** (1.376)
34.state	3.621*** (1.024)	3.622*** (1.026)
35.state	-1.399 (1.362)	-1.370 (1.363)
36.state	-0.783 (0.810)	-0.794 (0.810)
37.state	1.780** (0.812)	1.811** (0.816)
38.state	7.885*** (1.856)	7.919*** (1.863)
39.state	2.624*** (0.826)	2.618*** (0.826)
40.state	1.014 (0.893)	1.018 (0.894)
41.state	-1.102 (1.457)	-1.090 (1.458)
42.state	2.622*** (0.747)	2.621*** (0.748)
44.state	4.041*** (1.537)	4.101*** (1.496)

45.state	1.952** (0.907)	1.964** (0.911)
46.state	11.08*** (1.591)	11.11*** (1.583)
47.state	3.765*** (0.830)	3.761*** (0.831)
48.state	2.896*** (0.808)	2.905*** (0.809)
49.state	9.284*** (2.101)	9.301*** (2.104)
50.state	3.925*** (1.195)	3.911*** (1.198)
51.state	4.554*** (0.969)	4.542*** (0.970)
53.state	-0.250 (1.493)	-0.209 (1.498)
54.state	2.389* (1.326)	2.388* (1.329)
55.state	4.238*** (1.119)	4.243*** (1.120)
56.state	3.342* (1.735)	3.396* (1.750)
Constant	65.07*** (2.340)	65.03*** (2.345)
Observations	1,007	1,007
R-squared	0.569	0.569

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1



8. Appendix

Formal Hypothesis Test:

Null Hypothesis: $H_0 : \beta_0 \neq 0$

Alternative Hypothesis: $H_1 : \beta_1 < 0$

Results: Coefficient of affordability in Model 1 is -0.242 with a p value of 0.247 and coefficient of affordability in Model 2 is -0.231 with a p value of 0.275. In both models $p > 0.05$ so this is not statistically significant at the 5% level.

Results: Coefficient of interaction term (affordability x population density) in Model 2 is -0.0089085 with a p value of 0.624. $p > 0.05$ so this is not statistically significant at the 5% level.

Conclusion: Fail to reject H_0 affordability is not statistically significant at the 5% level.

Calculations of elasticities:

Model 1(without interaction term):

$$\text{Elasticity} = -0.24177 \cdot (60.952661 \cdot 1.187511) = -0.24177 \cdot 0.01948 \approx -0.00471$$

Differential Impact (Model 1):

Using the 25th and 75th percentiles of affordability

$$\Delta \text{LFP} = -0.242 \times (1.1668 - 0.6186) = -0.1326644$$

With Interaction (Model 2)

Marginal effect of affordability+population density on lfp =

$$-0.23072 + (-0.00891 \cdot 11.32367) = -0.23072 - 0.10093 = -0.33165$$

$$\text{Elasticity} = (-0.33165) \cdot 1.187511 / 60.95266 = -0.00646$$

centile population_density, centile(25 75)

$$\text{At 25th percentile marginal effect is } -0.23072 + (-0.00891 \cdot 0.24) = -0.23072 - 0.00214 = -0.23286$$

$$\text{At 75th percentile marginal effect is } -0.23072 + (-0.00891 \cdot 5.18) = -0.23072 - 0.04617 = -0.27689$$

$$\text{Calculating elasticity for 25th: } -0.23286 \cdot 1.187511 / 60.95266 \approx -0.23286 \cdot 0.01948 = -0.00454$$

$$\text{Calculating elasticity for 75th: } -0.27689 \cdot 1.187511 / 60.95266 \approx -0.27689 \cdot 0.01948 = -0.00539$$