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The impact of employment changes on house prices: An examination of county-level data between 2012 and 2021 in the United States

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Abstract
Extensive research has been undertaken on the housing market since the global financial crisis of 2008-2009, with a particular focus on the United States. Various economic factors influence the movement in housing prices and this paper explores the impact of employment changes on house prices value at the county level in the US. The Zillow Home Value Index is the dependent variable of interest while the main independent variable is the percentage change in employment. Other independent variables include the 30- year US mortgage rates, as well as the percentage change in annual payroll and population at the county level. The research uses data spanning from 2012 to 2021.

Keywords: Employment, house prices, population

1. Introduction

The 2008/2009 housing market collapse significantly contributed to the events leading to the global recession. The popularity of subprime mortgages and unethical practices of credit rating agencies played a big role in the collapse. This paper seeks to identify the impact of employment changes on house prices value at the county level in the US. The null hypothesis for this research states that changes in employment affect the movement in housing prices. The intuition behind this is that a positive change in employment will increase the number of individuals who can secure mortgages. This increased demand for houses subsequently drives up house prices. The alternative hypothesis states otherwise that changes in employment do not impact house prices. Kerri Agnew (2018) [1] explores the influence of employment on housing prices in Ireland. His findings reveal that following the creation of an additional 1000 jobs, monthly rents on nearby properties exhibited an increase ranging from approximately 0.5% to 1%. However, it is worth noting that this impact was not consistent across sectors and varied based on specific factors. Using the Ordinary Least Square regression analysis, the results revealed that our main predictor variable, employment was statistically significant at the 5% level and has an impact on house prices at the county level albeit a moderate one. The results showed a positive relationship between employment change and house prices which is in line with economic expectations.

The Zillow Home Value Index, which serves as an indicator for housing prices, is the dependent variable. Percentage change in employment is the main independent variable, while control variables are the percentage change in annual payroll at the county level, the 30-year US mortgage rates, and the percentage change in population at the county level.

The rest of the paper is organized as follows. Section 2 examines the data sources and analysis, Section 3 presents the motivating summary statistics, section 4 outlines the research methodology, Section 5 presents the empirical results and research findings, and Section 6 presents the Data Appendix.

2. Data Section

We acquired data on the housing index from Zillow's housing dataset. Our focus was on the Zillow Home Value Index, which was collected at the county level and serves as our dependent variable.

Unlike other indexes it is measured using the value of housing units in current dollars. ZHVI tracks monthly changes in Zestimates at the property level, covering both the valuation and appreciation of home values across diverse geographic areas and housing types. It concentrates on real market price adjustments rather than changes in market categories or property types. Zestimate is an algorithm that leverages neural networks and machine learning approaches, to incorporate the history of property data such as tax assessments, sales transactions, and public records, as well as home details such as square footage and location. This way, it accurately serves as an indicator for the average property worth and changes in the real estate market within a particular area and housing category. The ZHVI data used in this research represents the typical value for residences falling within the 35th to 65th percentile range.

For data pertaining to employment and annual payroll at the county level, we sourced it from the County Business Pattern dataset. Employment data was extracted as raw employment count for both public and private sector at the county level in the US and later converted into percentage change for the analysis. The payroll data calculates the annual overall compensation for employees in both the public and private sectors at the county level, measured in current US dollars. The employment and payroll data obtained from the County Business Pattern come from the Business Register (BR), a database covering both single and multi-establishment companies. The Business register offers the most recent data for business establishments. For multi-establishment companies, the annual Company Organization Survey provides specific establishment details, while data for single-establishment companies is gathered from various Census Bureau programs, like the Economic Census (conducted every five years), the Annual Survey of Manufactures, and Current Business Surveys. Administrative records from the Internal Revenue Service (IRS), the Social Security Administration (SSA), and the Bureau of Labor Statistics (BLS) also contribute to the information.

County-level population data was obtained from the United States Census Bureau dataset. Data was gotten using the Census Bureau's Population Estimates Program (PEP), which produces estimates of the population for various regions in the United States.

Furthermore, data regarding mortgage rates was extracted from the Federal Reserve Economic Data portal using data from the Federal Home Loan Mortgage Corporation Database also called Freddie Mac. Mortgage rates were obtained by analyzing applications submitted to corporations from lenders nationwide. Specifically, we utilized the 30-year mortgage rates for this analysis due to its stability and consistency, making it a reliable control variable for changes in house prices. The 30-year mortgage rates represent the annual cost borne by homeowners in servicing loans spanning a 30-year period. We made use of the 30- year mortgage rates at the national level.

Consumer Price Index (CPI) data, used to adjust the housing index and annual payroll variables for inflation, was obtained from the Bureau of Labor Statistics. CPI measures the average change over time in the prices paid by consumers for a market basket of goods and services.

The study will utilize data spanning from 2012 to 2021. To enhance the accuracy of the estimation model, both the dependent and independent variables were transformed into percentage changes. Consequently, the primary analysis will encompass the period from 2013 to 2021, with the 2012 data exclusively used for the calculation of percentage change values for the year 2013. The research will employ percentages as the standard unit of measurement.

We used the gen function to compute the annual average of the 30-year mortgage rate, spanning 2012 to 2021. This adjustment was necessary to align the data with the scope of our research, which centers on annual data, in contrast to the original 30-year rates downloaded from the FRED database in daily form.

Summary Statistics

Table 1: Show of the Variable, Mean (Standard deviation)

Variable	Mean (Standard deviation)	90th percentile	50th percentile	10th percentile
Zillow housing value index ($)	161,524.9 (109,694.6)	277,536	141,109.6	71,253.6
Employment count	38,735.7 (141,210.61)	74,617	6,520.5	886
Annual Payroll (in $1,000)	1,900,466.1 (8,911,504)	2,991,975.4	222,662.7	26,783.3
Population count	106,727.6 (326,600.8)	230,298	25,932	5,507.5
Payroll to Population ratio	138.72 (5,814.4)	33.6	8.7	1.7

Zillow housing value index vs. Employment Count: Scatterplot visualization

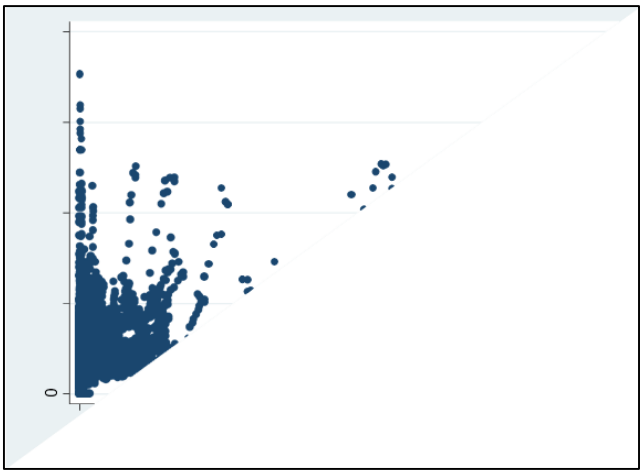

Fig 1: Scatterplot visualization

In our descriptive analysis, we made a deliberate choice to examine the actual values of the variables used in the research. The choice was driven by the belief that it would yield more valuable insights on the nature of the data used for the analysis.

A close examination of Table 1 yields several key observations relevant to our research question. Notably, there is a substantial disparity in employment numbers between the 90th and 10th percentiles. This discrepancy is mirrored in the average housing prices for these regions, with a considerable difference of about $200,000. While this observation lends some form of support to our primary hypothesis, it is important to bear in mind that our central research question revolves around understanding how changes in employment affect house prices. Additionally, the payroll-to-population ratio reveals a significant contrast among U.S. counties, with the 90th percentile registering a ratio of 33.6 compared to just 1.7 in the 10th percentile.

Examining Table 2, we note a contrast in percentage change in employment counts between the 90th and 10th percentiles. The data highlights a 23% growth in the 90th percentile, while the 10th percentile exhibits a -1% change approximately, underscoring the prevalence of employment growth in the 90th percentile regions. Additionally, it is noteworthy that the percentage change in the housing index follows a discernible pattern. In the 90th percentile, this change is positive, signifying an increase in house values. This trend aligns with the robust employment growth in the region. Conversely, the 10th percentile registers a negative percentage change in employment and a corresponding decline in housing index values, indicating a less favorable scenario for the housing market in this region.

3. Research Methodology

$$ZHVICct = \beta0 + \beta1EMPCct + \beta2PAY\_POPCct + \beta3POPCct + \beta4RATEt + FE + \mu ct \quad i$$

ZHVIC- Representing the percentage change in the Zillow Value Housing Index, this serves as the dependent variable of interest for this study. Data was obtained from Zillow housing Database. The Zillow Home Value Index is an indicator of the average property worth and shifts in the real estate market within a specific area and housing category, with the original data measured using the value of housing units in current dollars. It represents the typical value for residences falling within the 35th to 65th percentile range. The data was adjusted for seasonal variations and inflation. As mentioned earlier the ZHVI is not a typical index and is measured using the value of housing units in current dollars.

EMPC - The primary independent variable of interest in this study, this variable is measured by the yearly percentage change in the number of employees at the county level. Employment data was initially obtained in the form of raw counts from the County Business Pattern database and was later transformed into percentages during the analysis. This variable serves as the key to addressing the central research question, which explores how changes in employment impact house prices. All things being equal, a positive change in employment numbers should correspond with a positive change in house prices. The intuition is that a positive change in employment figures within a specific region enhances the ability of residents to secure mortgages and purchase homes. Consequently, this increased demand for housing is expected to drive up house prices.

Control Variables

PAYANNC – This variable represents the percentage change in the total annual payroll at the county level. The data was sourced from the County Business Pattern datasets and originally presented in current US dollars (in thousands). The payroll data calculates total income for employees in both the public and private sectors at the county level. During the analysis, the payroll data was converted into percentage, following an initial adjustment for inflation. All things being equal it is expected that a positive change in population will correspond with a positive change in house prices. This expectation is rooted in the belief that an increase in total wages within a region should drive greater demand for houses, subsequently influencing house prices in that area. Notably, during the analysis, we observed a robust correlation between this variable and the primary independent variable, employment change. The issue with this is that it makes it challenging to isolate the individual effect of these variables on the dependent variable and can compromise the reliability and accuracy of the analysis. In response, we introduced a new variable that calculates the payroll-to-population ratio for each county, to replace the payroll variable.

PAY_POPC – This variable represents the percentage of the payroll-to-population ratio in each county. It was introduced

as a replacement for the annual payroll change variable, primarily due to its significant correlation with the primary independent variable. The payroll-to-population variable is an appropriate control variable to add to the model as it serves as an indicator of income per person and economic well-being of the county. All things being equal, a positive change in the payroll-to-population variable will correspond with a positive change in house prices. The introduction of this new variable successfully mitigated the correlation issues initially encountered. The expectation is grounded in the belief that an increase in the payroll-to-population ratio signifies a positive economic trend, potentially leading to increased demand for houses and, in turn, influencing house prices.

POPC – This variable signifies the percentage change in the annual population count, measured using the population data for each county. The population data was initially collected as raw counts from the County Business Pattern database and later transformed into percentages during the analysis. Ceteris paribus, it is expected that a positive change in population will correspond with a positive change in house prices. The intuition behind this is that an influx of individuals into a specific county will increase the demand for houses in that area, subsequently increasing house prices in the region. To accurately assess the influence of employment changes on house prices, it is important to isolate the effect of this variable in the analysis.

RATES – This variable is represented by the 30-year mortgage rates applied to home loans. It represents the annual cost borne by homeowners in servicing loans spanning a 30-year period. The selection of the 30- year mortgage rates for this analysis was deliberate, as it serves as a stable benchmark for studying fluctuations in house prices. Data on mortgage rates was sourced from the Federal Reserve Economic Data portal using data from the Federal Home Loan Mortgage Corporation Database also called Freddie Mac. Mortgage rates have a significant impact on house prices changes, and their inclusion as a control variable is crucial for this analysis. All other factors held constant, it is expected that an increase in mortgage rates will increase the cost of home purchases, owing to the inverse relationship between mortgage rates and house prices, leading to a consequent reduction in house prices.

FE – The fixed effect in the model controls for the specific characteristics in the counties that might introduce bias to the estimation result. This allows us to truly assess the effect of the predictor variables on the dependent variable.

4. Empirical Results and Findings

In this section we present the results of the OLS regression analysis used to estimate the relationship between employment change and house prices in counties. The OLS regression estimation was the go-to-choice for this analysis as the research makes use of panel data and other estimation techniques such as VAR (Vector Autoregression) and VECM (Vector Error Correction Mechanism) are more suitable for time series analysis.

For the regression analysis we made use of the fixed effect model to control for the specific characteristics in the counties that might introduce bias to the estimation result. The fixed effect model allows us to truly assess the effect of the predictor variables on the dependent variable. In our analysis, we employed geo_id as a distinctive identifier for each county. This unique identifier served as the basis for applying fixed effects in our study.

From the regression estimation result, we notice immediately that the employment change variable (empc) is significant at all levels, supporting the hypothesis that employment changes in counties affect house prices. The coefficient estimate is 0.0011 indicating that a 1 percent increase in employment is correlated with a 0.11% rise in house prices in that county, which is in line with conventional expectation that increase in total employment should drive up the value of houses in that region. Observing the F-stat, we note a p-value of 0 indicating that the model is a good fit for the data and is statistically significant in explaining the dependent variable.

Examining other independent variables, we see that the rate variable is significant in explaining percentage changes in house prices at the 5% level with a coefficient of -0.15, indicating that a 1 percent increase in the 30-yr mortgage rate is correlated with a 1.5% decline in house prices in that region. This aligns with conventional wisdom on the inverse relationship between interest rates and house prices, as a higher cost of borrowing to finance mortgages will lead to a drop in demand for houses and a subsequent drop in house prices due to the fall in demand.

The payroll to population change variable was significant only at the 10% level although the associated coefficient makes us understand that the variable has no significant impact on changes in house prices. Finally, the population change variable was statistically insignificant in explaining changes in house prices.

We ran a VIF code which helped us measure multicollinearity within the dataset We discovered that the removal of the annual payroll change variable earlier in the research was effective as the VIF for all the independent variables were less than 2 with a mean VIF of 1.1, as opposed to a mean VIF of 12.6 for the model with the payroll variable included. Please see table 2 in the data appendix section for the regression results.

5. Conclusion

From the OLS regression analysis, we were able to answer the main research question of the impact of employment changes on house prices across regions. We discovered that employment changes have a statistically significant impact on house prices albeit a moderate one due to the coefficient of 0.11 indicating that a positive employment change in a county will lead to a rise in house prices in that region.

We also discovered that the 30-yr mortgage rate was significant in explaining changes in house prices, while payroll to population and population change variables were not significant in explaining changes in house prices, with the latter being statistically insignificant. Also of note is the creation of the payroll to population ratio variable, which replaced the annual payroll change variable effectively mitigating the multicollinearity issue with the model, evidenced by the low mean Variance Inflation factor present in the model.

6. References

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Appendix

Fixed-effects (within) regression — Number of obs = 28,455
Group variable: geo_id1 — Number of groups = 2,989

R-sq:
within = 0.0021
between = 0.0272
overall = 0.0239

Obs per group:
min = 1
avg = 9.5
max = 10

F(4,25462) = 13.70
corr(u_i, Xb) = 0.0667 — Prob > F = 0.0000

zhvic	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
empc	.0010988	.0001967	5.59	0.000	.0007132	.0014844
pay_popc	2.05e-06	1.22e-06	1.68	0.093	-3.41e-07	4.45e-06
popc	.0013216	.0010312	1.28	0.200	-.0006997	.0033429
rate	-.0152185	.0046895	-3.25	0.001	-.0244103	-.0060267
_cons	.2063931	.0187224	11.02	0.000	.1696961	.2430901
sigma_u	.93543048					
sigma_e	.35806221					
rho	.87220534	(fraction of variance due to u_i)				

F test that all u_i=0: F(2988, 25462) = 61.75 — Prob > F = 0.0000

VIF with total payroll in the model

Variable	VIF	1/VIF
empc	24.57	0.040704
payannc	23.91	0.041822
popc	1.20	0.831009
rate	1.00	0.999972
Mean VIF	12.67	

VIF with payroll to population variable

Variable	VIF	1/VIF
empc	1.19	0.838851
popc	1.19	0.841485
pay_popc	1.00	0.996055
rate	1.00	0.999972
Mean VIF	1.10	