Minnesota's Housing Stability in Single-Parent Households

Introduction

The objective of this study is to develop predictive models to identify key factors influencing housing cost burdens among single-parent households in Minnesota. This analysis aims to support Minnesota's Housing Stabilization Services by highlighting the most significant predictors of housing stability and quantifying their impact to help develop targeted policy interventions.

Variable of Interest

The variable of interest in this study is housing cost-burdened status, defined as the percentage of household income spent on housing costs. It is calculated where:

- **OCPIP** represents housing costs as a percentage of income.

- **GRPIP** represents gross rent as a percentage of household income.

Households are categorized as:

- **Cost-Burdened**: Spending more than 30% of income on housing

- **Severely Cost-Burdened**: Spending more than 50% of income on housing

By differentiating between households that spend more than 30% and those that spend more than 50% of their income on housing, this analysis acknowledges that cost-burdened status exists on a spectrum. A household spending 31% of its income on housing faces a different level of hardship than one spending 60%, and this distinction is critical when visualizing cost burdens and recognizing policy intervention needs.

Summary Statistics of Variable of Interest:

There are 43,436 cost-burdened households and 56,114 non cost-burdened households in the dataset. 56.4% of the households are cost-burdened, while 43.6% are not. The majority of these households are clustered near or surrounding the state capitol in our most urbanized counties.

Total Cost-Burdened Households by County in Minnesota
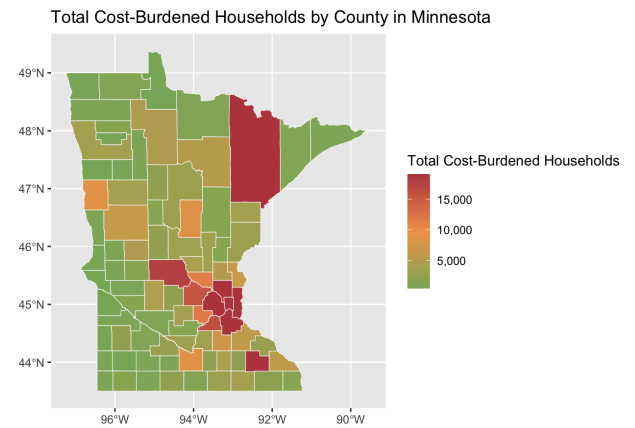
Data Source

The data for this study comes from the 2023 ACS PUMS dataset for Minnesota, focusing on single-parent households, identified as those where the head of household is a female or male with children under 18 and no spouse or partner present.

However, we cannot confirm that all single-parent households were accurately captured in this analysis due to data limitations. The dataset does not verify that all resident children are biologically related to the household head, which may lead to misclassification of some households. Additionally, undercounting of young children is a known issue, with Census Bureau estimating that approximately 13% of children under age 5 may be missing from the ACS. Lastly, complex household structures, such as children splitting time between multiple households, introduces further measurement errors in accuracy of identifying single-parent households.

Single Variables and Models
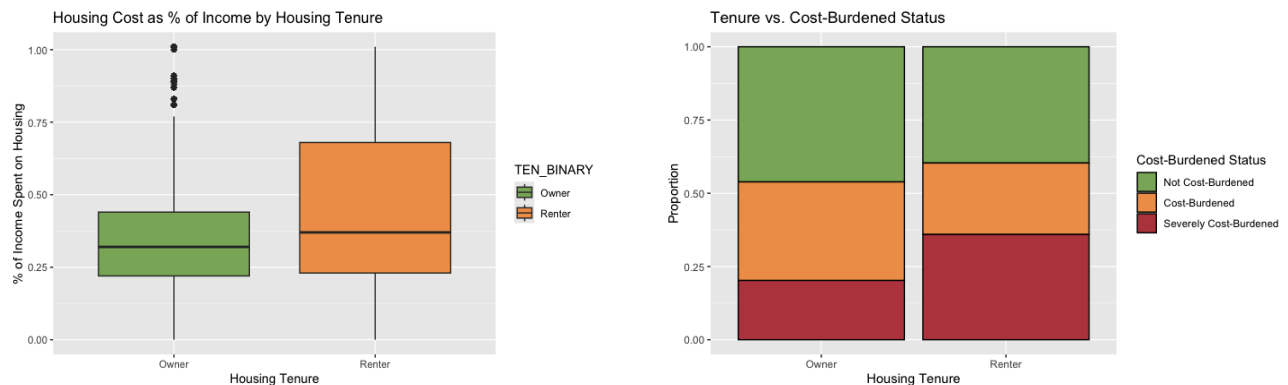
Household Income and Cost-Burdened Status

Household income was chosen as a factor in understanding housing affordability because it can represent the financial resources available to a household. Given that housing costs are often a fixed or semi-fixed expense, households with lower incomes are more vulnerable to experiencing cost burden. The histogram of household income reveals a strong right skew, with most cost-burdened households concentrated on the lower end of the income scale. This suggests that lower-income households are more likely to struggle with housing costs. A general linear model also shows a strong negative relationship between income and cost-burden status. There is a clear downward trend in cost burden as income increases.
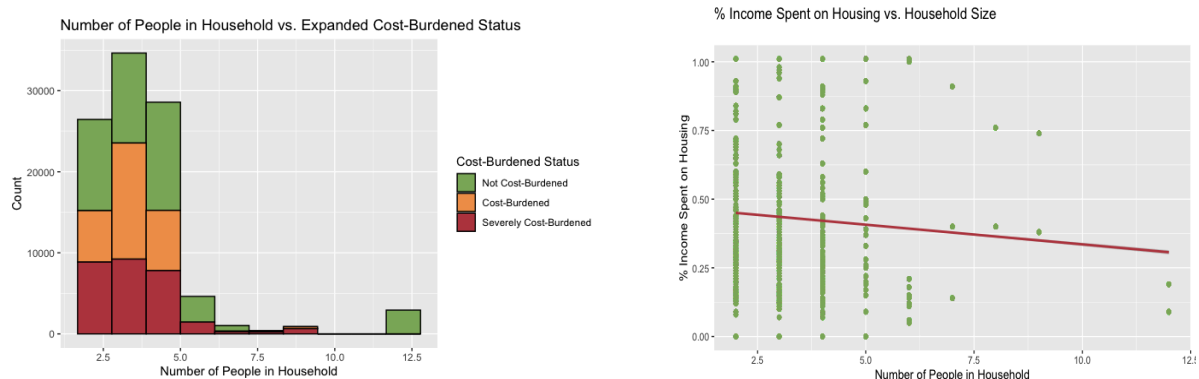

Tenure and Cost Burdened Status

Housing tenure was selected as a factor in understanding cost burden because it could reflect the differences in financial obligations between homeowners and renters. Renters typically face more variable and often rising housing costs, while homeowners may have more stable payments, especially if they have fixed-rate mortgages. A box plot of tenure shows that the renters typically spend a slightly higher percentage of their income on housing. A bar plot shows

that there are nearly even proportions of cost-burdened households in both populations, however renters have a higher proportion of severely cost-burdened households. A logistic regression model confirms this, indicating that renters are 31.5% more likely to be cost-burdened relative to homeowners.


Number of People in Household and Cost Burdened Status

Household size was selected as a factor to influence cost burden because the number of people in a household affects both income sources and living expenses. Larger households may have multiple earners contributing to income, but they also have higher overall living costs. The histogram of household size indicates that cost burden is more common among smaller households, particularly single-person and two-person households. A linear model shows a very small negative trend between household size and housing cost, with each additional household member being associated with a 1.5% decrease in housing cost.

Birth of a Child and Cost Burdened Status

The birth of a child in the past 12 months was analyzed as a potential factor influencing cost burden, as new parents may have new childcare costs and medical expenses. The bar plot reveals that there is a higher proportion of cost-burdened households among those who had a child in the past 12 months compared to those that did not. A logistic regression model confirms this trend, revealing that households with a recent birth are 16.6% more likely to be cost-burdened compared to those without a recent birth.
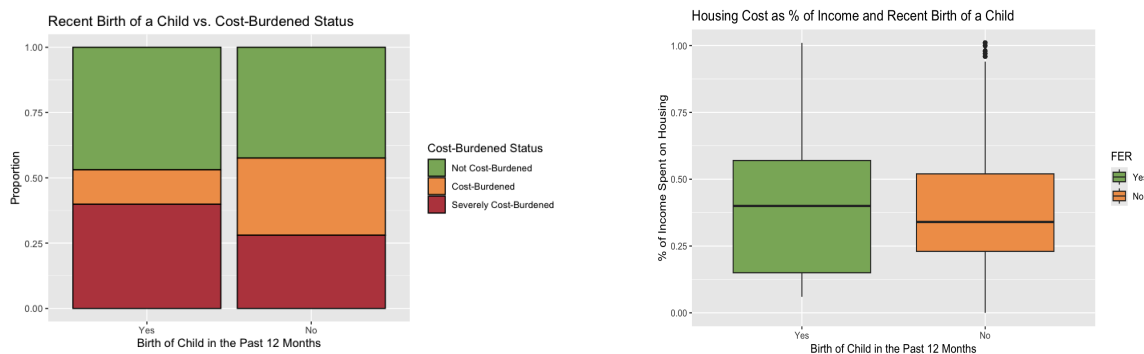
Citizenship Status and Cost Burdened Status

Citizenship status was analyzed as a potential factor in housing affordability, as non-citizen households may face additional economic challenges such as employment restrictions or limited access to financial assistance. However, a bar plot and box plot comparing the two groups reveals that a larger proportion of citizens fall into the cost-burdened or severely cost-burdened categories. A logistic regression model reveals that citizen households are about 141.5%. more likely to be cost-burdened than non-citizens.
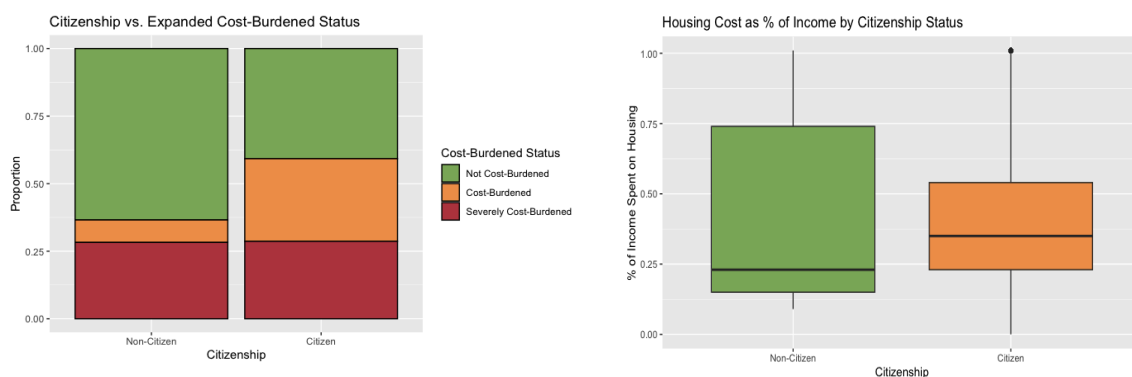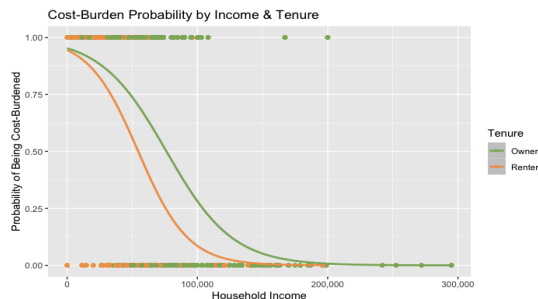
Multivariate Models

Income & Tenure

Cost Burdened ~ Household Income + Tenure

This model examines how household income and housing tenure (owner vs. renter) impact the likelihood of being cost burdened. Since we established earlier that renters typically face higher housing cost burdens than homeowners, we expect tenure to play a key role. However, the visualization shows that in this model owners have a significantly higher probability of being cost burdened across all income levels. The model reveals that renters are only 57% *less likely* to be cost-burdened as homeowners, after controlling for income. Among both tenure groups, higher-income households are significantly less likely to be cost-burdened, with a household earning $10,000 more being 36% *less likely* to be cost-burdened.


Initially, the single-variable model suggested renters are 31.5% *more likely* to be cost-burdened, but the multivariate model revealed renters are only 51.7% *less likely* to be cost-burdened at the same income level. This can be known as Simpson's Paradox. This shift happened because renters, on average, have lower incomes than homeowners. Lower-income households are generally more likely to be cost-burdened. However, within the same income level, homeowners may face higher cost burdens due to mortgages, property taxes, and maintenance costs. The single-variable model failed to account for income differences, which made it look like renters

were more cost-burdened. Once income was controlled for, the model revealed that homeowners actually had higher cost burdens at the same income level.

Income, Tenure & Citizenship

Cost Burdened ~ Household Income + Tenure + Citizenship Status + Household Income:Tenure

This model expands the previous one by introducing citizenship status. Non-citizens may face additional barriers in housing affordability due to employment limitations and lack of financial assistance. A box plot of predicted probability of cost-burden status across citizenship and tenure shows that citizens have a higher probability of being cost-burdened. Renters who are non-citizens are the most vulnerable group. Non-citizens are 4.15% less likely to be cost-burdened compared to citizens, holding all tenure and income constant. Additionally, a $10,000 increase in income *reduces* cost burden odds by 32.6% for homeowners and 40.7% for renters. In contrast to the graph below, citizenship status does not significantly impact cost burden when controlling for income and tenure. Non-citizens appeared less cost-burdened, but the differences in housing tenure and income fully explain that effect.
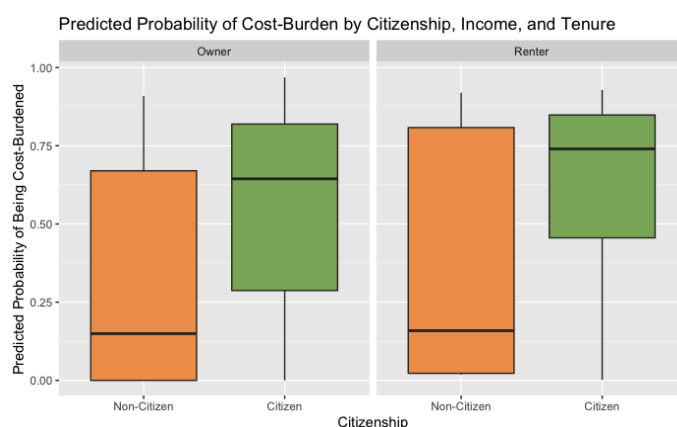
Tenure, and Birth of a Child

Cost Burdened ~ Birth of a Child + Tenure + Birth of a Child:Tenure

Households with a new child face increased expenses, potentially leading to greater financial strain. An added interaction term is added to account for the potential differing effect of birth on renters and homeowners. A logistic model with an interaction term shows that among homeowners, those with a recent birth are 35% *less likely* to be cost-burdened compared to homeowners without a recent birth. In contrast, renters with a recent birth are 56% *more likely* to be cost-burdened compared to renters without a recent birth.

Number of People, Income, and Tenure

Cost Burdened ~ Household Size + Household Income + Tenure + Household Size:Tenure

Larger households may experience higher financial strain despite potentially pooling incomes. This model helps determine whether household size independently contributes to cost burden. An interaction term was added to account for potential differing effects of household size in different tenure groups. A logistic model shows that in this model, for homeowners, each additional person in the household *increases* the odds of being cost-burden by 7.8%. For renters, each additional person *increases* those odds to 14.1%. A scatterplot of household size vs. predicted cost burden probability shows that as the number of people in the household *increases*, the predicted cost-burdened probability tends to *decrease* relative to household income.
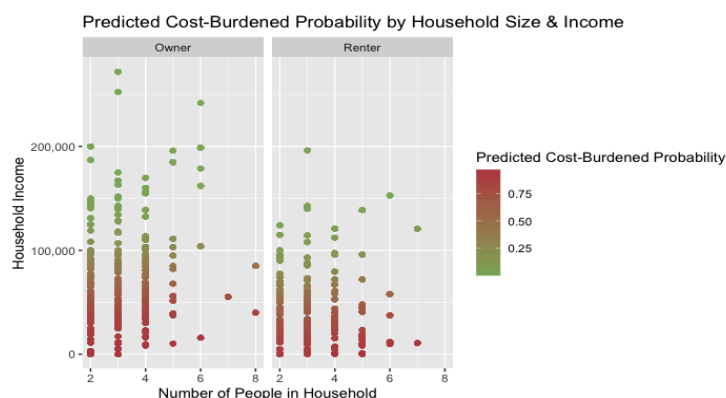
Income, Number of People, Citizenship, Birth of a Child

Cost Burdened ~ Income + Household Size + Citizenship Status + Birth of a Child + Birth of a Child:Household Size + Income:Birth of a Child

Larger households may experience different financial pressures depending on housing tenure, so an interaction term was included to examine whether the effect of household size varies between renters and homeowners. Households in this model that had a child in the past 12 months are 290% more likely to be cost-burdened, reinforcing the financial strain of a new child, however as household size increases, the impact of having a child on cost burden decreases by 81%. Also, for households with a recent birth, a higher income slightly increases cost burden, with each $1,000 increase in income increasing the odds of being cost-burdened by approximately 10.5%.

Selection of Best Multivariate Models

I chose three models to elaborate on based on their AIC values and strong predictive power. The Income & Tenure Model (AIC: 91992) is simple and clear, showing that tenure effects cost-burdened probability and that higher income reduces this burden. The Household Size, Income, & Tenure Model (AIC: 91682) improves upon this slightly by incorporating household size. Lastly, the Income, Household Size, Citizenship, Tenure, & Birth Model (AIC: 90730) had the best overall fit, showing that having a child increases financial strain, although the impact is affected significantly by household size.

Income and Tenure Model

Cost Burdened ~ log(Household Income) + Tenure

The Income & Tenure Model captures the relationship between income, housing tenure, and cost burden. The R-squared value suggests that income and tenure explain about 32.5% of the

variation in cost-burdened status. To improve model fit, I tested a log transformation of income log(HINCP+1) to account for its skewed distribution. However, this resulted in a ~37,000 increase in AIC (from 91,992 to 129,490), indicating a worse model fit. Additionally the updated model can only explain about 5% of the variation in cost-burdened status, decreasing by almost 30%. Using this model to predict cost burden probabilities, a renter earning $40,000 has a 57% probability of being cost-burdened, whereas a homeowner with the same income has a 59% probability.

Number of People, Income, Tenure

Cost Burdened ~ sqrt(Household Size) + Household Income + Tenure + sqrt(Household Size):Tenure

This model initially had the lower AIC (91703), indicating a strong fit. It suggests that income, tenure, and household explain about 32.8% of the variation in cost-burdened status. I introduced interaction terms between household size and tenure to consider that the effect of household size may differ for renters and owners. While the interaction was not statistically significant, applying a square root transformation to household size (sqrt(NP)) slightly reduced the AIC, suggesting that the relationship is nonlinear. However the R-squared value remains almost identical. Predictions from this model indicate that a renting household with 3 people and a household income of 50,000 has a 56.9% probability of being cost-burdened.

Income, Number of People, Tenure, Citizenship Birth of a Child

Cost Burdened ~ Income + Household Size + Housing Tenure + Citizenship + Birth of a Child + Birth of a Child:Household Size + Income:Birth of a Child

This model provided important demographic insights and also had the lowest AIC out of the models. I tested removing the citizenship status variable since it had the highest p-value in the

original model. Dropping the citizen variable led to a small reduction in AIC, confirming that it did not meaningfully contribute to the model. Additionally, the R-squared value remains the same at 33.4%.When using this model to run predictions on a household with four people, a child born in the past 12 months, and a household income $60,000, it predicts that if that household rents there is a 15% probability of it being cost-burdened, alternatively if the household owns a home, that probability increases to 29%.

Final Model and Implications:

Cost Burdened ~ Income + Household Size + Housing Tenure + Birth of a Child + Birth of a Child:Household Size + Income:Birth of a Child

The above model is the most effective for understanding cost burden dynamics in single-parent households. It shows that larger households tend to moderate the financial impact of a recent birth, but renters with new children remain at high risk. Additionally, tenure plays a role, with homeowners facing a greater likelihood of being cost-burdened at similar income levels.

For practical application, policymakers and housing assistance programs can use this model to identify high-risk households and target support efforts. By inputting household size, income, tenure status, and recent child status, the model can predict the probability of cost burden. For example, if a single-parent homeowner with a household size of three, recent birth of a child, and a $80,000 income is predicted to have a 22.4% chance of being cost-burdened.

However, these predictions should not be interpreted as definitive outcomes for any individual household as they reflect general trends based on population data. External factors outside the model predictors such as job loss or other fluctuations may significantly impact individual circumstances in ways that the model cannot fully capture. Additionally, while the model helps explain who is most at risk, it does not determine the root causes of cost burden.

References

Jacobsen, L., Mather, M., & Reamer, A. (n.d.). *The Census Project*. "America's Essential Data at Risk".https://thecensusproject.org/wp-content/uploads/2022/03/census_white-paper_final _march_2022.pdf