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The trade-offs between population density and households' transportation-housing costs

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ABSTRACT

As metropolitan area governments and others promote density-promoting "smart growth" policies, finer analysis is needed to quantify the impact of such policies on households transportation and housing costs. Existing research suggests that households in urban areas trade-off between housing costs and transportation costs, but does not explore how policies to increase urban densities might explicitly impact this balance. Furthermore, the research does not adequately distinguish between the effect of urban area density and the effects of other factors associated with urban area density (e.g metropolitan area size and household incomes) on housing costs. This paper uses the 2000 Census Public Use Micro Sample (PUMS) person and household data from 23 of the nation's most densely populated states to identify the impact of increased population density on three housing cost measures: household rents, housing unit values, and monthly mortgage payments. Log linear models were estimated for each housing cost measure using least-squares regression. Dependent variables included household, housing unit, and geographic area characteristics, including population density. The models were found to be very similar to one another in terms of the statistical significance and values of estimated model parameters. Population density (measured at the PUMS area level) was found to be statistically significant at the 0.01 level for all housing cost measures. Although significant, the parameter estimates show that the elasticity of housing cost with respect to population density is low, ranging from 0.041 to 0.05. This research also explores the relationship between housing costs and accessibility. Results show that households living in areas closer to jobs (as indicated by shorter average commute times) and households utilizing fixed route transit systems have marginally higher housing costs.

1. Introduction

1.1. Background

Several large metropolitan areas are currently debating or implementing regional plans that will dramatically increase their communities' population densities and the number of residents living in multi-family units near transit stations. Most recently, the Association of Bay Area Governments (ABAG) in Northern California adopted a plan for transforming many existing communities into transit-oriented neighborhoods with densities as high as Manhattan in New York City (Association of Bay Area Governments, 2013). The rationale for this is to reduce vehicle miles traveled (VMT) and greenhouse gas emissions by increasing population densities and transit oriented development (TOD).

Although urban area VMT can be reduced by increasing urban population density, doing so may also increase the cost of housing as a consequence of limiting the supply of developable land. This could impede efforts to increase urban population density. It could also result in the unintended consequence of stimulating exurban and bedroom community development, and undermine the objective of reducing VMT and greenhouse gas emissions. Therefore, in order to fully understand the potential consequences of increasing urban area population density, it is important to understand the relationship between population density and housing cost. This paper quantifies that relationship by examining three housing cost measures: household gross rents, household monthly mortgage costs, and housing unit values.

Unlike prior research, models are constructed using a very large sample of household-level data collected from 23 states using the Census Public Use Microdata Sample (PUMS). The highly disaggregate

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nature of the PUMS data enabled the models to control for a number of urban area, household and housing unit factors that confound the relationship between density and housing cost. Multiple density-promoting policies are available for city and regional governments, including building height restrictions (Brueckner and Sridhar, 2012), land use and planning regulations (Geshkov and DeSalvo, 2012), and property taxes (Song and Zenou, 2006). Quantifying the effects of these specific policies is not the aim of this paper, however, our models provide a tool to see how density changes from such policies increases would impact rents, mortgage costs and housing unit values. Our paper raises the possibility that PUMS data could be used to model specific impacts from these policies in the future.

The models developed produce elasticities of the relationship between densities on these dependent variables for specific market segments: single-family units and multi-family units for renters and home buyers. One set of models is put forward explicitly as a tool for urban and state governments to model impacts of density on rents and mortgage payments in their communities.

1.2. Paper organization

The paper is organized as follows. Section 2 reviews prior work that quantifies the impacts of population density either explicitly or in the form of pedestrian accessibility on higher housing prices. Section 3 provides an overview of the data source, cleaning and preparation. Models and specifications are presented and discussed in Section 4, followed by the results in Section 5 which includes alternative specifications. Section 6 presents the validation and explores the results of testing the models developed on half of the data in predicting depending variables on the other half of the data. The model diagnostics and discussion section is provided in Section 7 and Section 8 concludes this research with future remarks.

2. Literature review

A key objective of increasing urban population density is to reduce VMT and associated adverse consequences such as greenhouse gas emissions. The literature supporting the correlation of increased density with reduced VMT at the household level is extensive and detailed (Hotzclaw et al., 2002; Handy, 2005). Although some research has raised issues regarding the confounding effect of residential self-selection, more recent research has confirmed the effect of population density on travel behavior by attempting to control for self-selection effects (Handy and Mokhtarian, 2005; Brownstone and Golob, 2009; Valle, 2011). In one study, Qing (2011) controlled for supply conditions and selection effects and still found a significant and negative impact of density on fuel usage. The literature on how this affects housing in terms of prices, rents and mortgage payments, however, is less conclusive.

Several studies have identified how the transportation related benefits of density are associated with increasing housing costs. Studies looking at the impact of walkability indexes on housing unit values and sales prices have found that housing units located in areas which enable residents to walk to meet most or all daily needs see increased prices and rents (Leingberger and Alfonzo, n.d.; Cortright, 2013). Because walkability is a measure of the number of amenities and employment within walking distance of a unit, it can be interpreted in this context as a proxy for immediate neighborhood densities. Research by the Center for Neighborhood Technology (CNT) found that while average residential unit sales values declined from 2006 to 2011, they rose for units with proximity to transit during that same period in Phoenix, Chicago, Boston, Minneapolis and St. Paul, and San Francisco (Becker et al., 2013). A recent overview of the literature supports the idea that households taking fixed route transit, especially those in transit oriented developments, pay a premium for that greater accessibility (Wardrip, 2012).

Other studies suggest that prices should rise with density because density reflects the demand to live near employment centers. This is based on the 'monocentric' model of a city, which posits a concentric city with a central business district (CBD) at its core and assumes that households prefer to live near the CBD to minimize their travel costs. Household demand for proximity to the CBD causes land and housing prices and rents to be higher there than in more distant locations. Developers respond by increasing the density of their development projects in order to capitalize on household unit demand and to reduce the cost of land per developed unit (Alonso, 1964; Muth, 1969; Mills, 1967). Recent applications of the model have confirmed the hypothesis that population density and housing costs decline as distance from the CBD increases. Kulish et al. (2011) tested the model's assumptions on postal code level median housing prices in major cities in Australia and found distance to CBD a significant and negative predictor of housing prices.

Research using hedonic price and rent models has produced mixed findings regarding the impact of density on housing prices and rents. Several researchers found positive relationships between population density and housing prices. Ottensmanna et al. (2008) found a significant positive correlation between the distance to multiple employment centers and housing prices using a series of hedonic housing price models in a study of Marion County, Indiana. Fisher et al. (2009) found a highly significant log–log density coefficient for rents in the greater Boston area of 0.03 for single family units and 0.024 for condominiums.

The opposite relationship was found by one study of owner-occupied housing values in Portland, Oregon. Using housing data at the census block level from 1990 and 2000, Jun (2006) estimated hedonic housing price models for housing units in the Portland metropolitan area's three counties. A dummy variable was included which identified whether the census block-group was contained within the urban growth boundary (UGB). The dummy variable was found to be insignificant, but a block group population density variable was found to be significant and have a negative coefficient. Although this finding suggests that housing prices decline with increasing population density, caution is advised for several reasons. First the study's use of block groups as the unit of analysis means that the model relates block-group averages of household and housing unit attributes. The resulting ecological correlations may not reflect actual relationships between housing costs and household and housing unit characteristics. In addition, the analysis does not appear to differentiate between owner-occupied housing for single-family detached units, attached units and units in a multi-unit structure so observed price differences between census block groups could be reflecting unit composition differences.

Density itself may contribute to the growth of certain amenities in an area that in turn further population growth in that area, including specialized employment opportunities and consumptive amenities like restaurants, museums and other cultural amenities. Schiff (2012) finds population density, along with demographic variables, positively correlates with the diversity of unique cuisines available at the MSA level, noting that overall population of MSAs and their densities jointly predict restaurant diversity. This suggests that a combination of a large population with large concentrations of people together yield the positive returns to density for households that may be associated with gentrification and rising housing costs–restaurants, "hip" social establishments, etc. Rappaport (2008) finds a powerful correlation between MSA density and a broad range of consumer amenities including–outdoor recreational opportunities,