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The dynamics of house price responsiveness and locational sorting: Evidence from air quality changes☆

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ABSTRACT

Despite extensive use of housing data to reveal valuation of non-market goods, the process of house price adjustment remains vague. Using the restricted access American Housing Survey, a high-frequency panel of prices, turnover, and occupant characteristics, this paper examines the time path of prices and preference-based sorting in response to air quality changes caused by differential regulatory pressure from the 1990 Clean Air Act Amendments. The results suggest that owner-occupied units capitalize changes quickly, whereas rent prices lag behind amenity levels. The delayed but sharp rent response temporally coincides with evidence of sorting, indicating a strong link between location choices and price dynamics.

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1. Introduction

Charles Tiebout (1956) argued that households should "vote with their feet" and choose residential locations with the optimal bundle of amenities and price. Since that time, and especially after Rosen's (1974) formal development of hedonic theory, hedonic valuation has become a workhorse model among economists – Google Scholar reports over 30,000 articles using or discussing the method.[1] This impressive level of application is justifiable given that housing market data can be used to uncover people's preferences and values for a wide range of spatially delineated non-market goods including school quality, crime, open space, and air pollution.

Despite the extensive use of housing data to reveal valuation of non-market goods, the process of house price adjustment remains vague. Hedonic theory is based on equilibrium; the compensating differential in housing prices across locations reflects the value of amenity differences, such that the marginal mover is indifferent between locations. Rosen's model assumes costless relocation, which most empirical applications extend to indicate immediate price responses reflecting the changed amenity. Of course this assumption does not reflect reality, and our understanding of how prices and households dynamically respond to a change in amenity levels is limited. Further, the extent to which housing market dynamics impact the resulting valuation estimates is unknown. A study with a short time span could produce biased estimates of the amenity value due to insufficient time for price adjustment. A study with a long time span may also produce biased estimates if important determinants of house prices, which change on the time span of a decade but not one or two years, are unobserved and correlated with amenity changes.

This paper addresses these dynamic extensions of Tiebout's ideas in the context of large improvements in air quality that occurred in the United States during the 1990s. Specifically, I examine the path of prices for both owners and renters in response to a change in air

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[1] The search term was "hedonic valuation" excluding "wage" and "labor", and the counts were as of August 21, 2014.

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quality – going beyond *if prices change* to *how prices change* – and assess how these price response patterns may bias valuation estimates. Further, I analyze preference-based sorting and seek to understand the links between sorting behavior and price dynamics.

The keystone of addressing these questions is the American Housing Survey (AHS), which collects information from a nationally representative panel of housing units and their occupants every two years, including self-reported home value or rent. The high frequency and regularity of observations is essential for examination of price dynamics and sorting, and no other non-proprietary data offers this.[2] I match housing units from the AHS to particulate matter (PM_{10}) concentrations measured from nearby air quality monitors, and I exploit the structure of the 1990 Clean Air Act Amendments (CAAA) to identify quasi-exogenous variation in PM_{10}. Similar to the seminal work of Chay and Greenstone (2005), I employ an Instrumental Variables (IV) strategy that relies on non-attainment designations of the air quality standards to address the endogenous relationship between air quality and housing prices.

Importantly, I gained access to the confidential version of the AHS through a Census Restricted Data Center. Unlike the public use AHS, which only identifies the geographic location of a housing unit at the MSA level, the confidential version identifies the census tract where each unit is located. This fine scale enables two critical aspects of the present research. First, the air quality that a given household faces can be measured with far greater precision. Second, the IV identification strategy can exploit localized air quality regulation intensity stemming from within-MSA differential regulatory pressure, which Auffhammer et al. (2009) show is the principal factor determining reductions in PM_{10}.

The results suggest that while both owner and renter prices are responsive to air quality changes, the path of prices markedly differs. Owner-occupied housing units capitalize changes in air quality immediately, and capitalization rates and elasticities stay fairly constant across time. On the other hand, renter-occupied housing units show statistically insignificant and economically small price responses shortly after air quality changes, but the estimated valuation sharply increases at a lag of six years and continues to increase after that. Ten years after air quality began to change, estimated price elasticities are comparable to the owner-occupied units. Tests of statistical differences support the ideas that rental price responses increase over time and that short-term price responses are different for owners and renters, though with the later point, the evidence is mixed. This suite of results is robust to controlling for sample selection and controlling for pre-treatment price trends.

Several hypotheses are examined that could explain why rental prices lag behind amenity changes, including rental market rigidities, like rent control, and disparities in the characteristics of people and units that rent versus own. However, in each case the results maintain their pattern. Speculatively, the disparities in price response patterns could be due to owners being more attentive of amenity levels given their anticipated tenure and financial stake in the property. Interestingly, adjustment costs of moving, which are substantially larger for owners, appear not to be a factor affecting price dynamics.

The results support the idea that the owner and renter market are fairly distinct. Disparities between the two markets have already been documented in terms of the occupants and housing stock by Glaeser and Gyourko (2007), but demonstrating disparities in price dynamics is new. The different patterns of price responses lead to arbitrage opportunities between the owner and renter market purely based on air quality. However, at a maximum the disparity in annual housing costs is about $600, which is unlikely to be enough for households to delay home purchase and certainly not enough to cover the financial costs of selling a home in order to be a renter. In sum, the price response results lend credence to the hedonic method for owner data, but suggest caution with renter data. For renters, the immediate price response is about one tenth of the eventual price response, suggesting substantial bias with the hedonic method if too short of a time interval is chosen.

The striking price dynamics observed in the rental market offer an excellent opportunity to examine the interplay between valuation and preference-based sorting. I analyze changes in turnover and demographic variables related to age, race, education, and income in response to changes in air quality. The results suggest that neighborhoods that experience improvements in air quality see an increase in the turnover frequency and the likelihood of families with children moving in relative to other neighborhoods, but only at a lag of six or more years. Thus, the results indicate a temporal correspondence between price dynamics and preference-based sorting and offer a strong empirical confirmation of Tiebout's ideas.

There are three main contributions of this paper. The first is to shed new light on how housing prices respond to a change in amenities. Despite extensive use of hedonic valuation, very few papers have addressed the dynamic details of price responses.[3] Blanchard and Katz (1992) find that house prices decline after a negative shock to employment, but rebound faster than employment levels. Cellini et al. (2010) examine the effect of school spending from bond passage on house price sales. Their results suggest that capitalization rates tend to increase for two to three years following a bond and then stabilize, likely reflecting the trend that spending ramps up for three to four years following the referendum and then declines. Together, my results and others' agree that owner-occupied capitalization is quick, even for different amenities for which residents may have different preferences for and information about.

Second, I go beyond looking at the owner market, as Cellini et al. have done, and examine the dynamics of rental price responses as well. This aspect complements several recent papers that examine price responses for owner and renter units separately: Grainger (2012) and Bento et al. (forthcoming) assess the distributional impacts of the 1990 CAAA and Davis (2011) examines the housing market impacts of new power plants. Each paper finds that rental prices are responsive to amenity changes, but less so than their owner-occupied counterparts. However, each of these papers use decennial census data, and thus only address differences in levels of price responses, whereas I employ the high frequency AHS to investigate differences in patterns of price adjustments. Interestingly, in a cross sectional setting, Banzhaf and Farooque (2013) and Winters (2012) both find that rental prices are more correlated with public goods and quality of life than owner values, which raises the possibility that rents better reflect amenity preferences in equilibrium. In contrast, my results suggest that when amenities are changing rapidly owner values better capture preferences.

Third, this paper complements prior work on the links between price response and preference-based sorting.[4] Sieg et al. (2004) and Bayer et al. (2007) examine how general equilibrium effects can be substantially larger than direct effects of an amenity differential alone

[2] Additionally, the structure of the AHS obviates standard concerns when estimating a hedonic model. First, the omission of unobserved unit or location characteristics commonly biases hedonic estimates. The AHS offers multiple observations for each housing unit and thus time-invariant omitted variables do not pose a problem. When using sales data, researchers often rely on repeat sales to purge these time-invariant confounders. However, a repeat sales model can exclude as much as 97% of observations (Case and Quigley, 1991). Further, transacting properties are not random; Case et al. (1997) show that properties that transact more tend to appreciate more, as well as have different structural characteristics. Appreciation estimates from the AHS will not have this same bias since all units report price changes, not just those that sell, and the units are randomly sampled.

[3] Figlio and Lucas (2004) and Pope (2008) are additional papers that examine the responsiveness of house prices. Both papers examine changing information, not changing amenities, and find that prices are quick to respond to new information.

[4] Other prominent papers that examine preference-based sorting include: Cameron and McConnaha (2006) and Greenstone and Gallagher (2008) in response to Superfund cleanups; Cellini et al. (2010) for school quality; Card et al. (2008) for racial preferences; and Banzhaf and Walsh (2008, 2013) for toxic emissions.

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