

Housing Vouchers and the Price of Rental Housing

Michael D. Eriksen^{*}
Department of Real Estate
University of Georgia
Athens, GA

Amanda Ross
Department of Economics
West Virginia University
Morgantown, WV

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Abstract

We estimate the effect of increasing the supply of housing vouchers on rents using a panel of units in the American Housing Survey. We do not find that an increase in vouchers affected the overall price of rental housing, but do estimate differences in effects based on an individual unit's rent before the voucher expansion. Our results are consistent with voucher recipients renting more expensive units after receiving the subsidy. We also find the largest positive price increases for units in relatively supply inelastic cities, suggesting policy makers should take local attributes into account with targeting future housing subsidies.

Keywords: Housing Policy; In-Kind Transfers; Housing Supply; Vouchers

^{*} Corresponding Author: 206 Brooks Hall Athens, GA 30602; eriksen@uga.edu; 706-542-9774

I. Introduction

The U.S. federal government provided over \$50.2 billion in housing assistance to low-income families in 2010 (U.S. OMB, 2012). Prior to 1974, the federal government relied almost exclusively on supply-side housing policies that constructed and operated housing units at below market rents. Since then, there has been a shift towards demand-side programs, known as housing vouchers, that subsidize recipients to reside in privately-supplied rental units. Figure 1 illustrates that low-income housing subsidies have more than quadrupled since 1980, while outlays for cash assistance programs have remained relatively constant.¹ This increase roughly coincides with a change in low-income housing policy from supply- to demand-side housing subsidies.

Although there are many advantages of demand-side voucher programs over public housing [see Olsen (2003) for a review], one potential consequence of housing vouchers is that demand-side programs may increase the price of rental housing. This price increase would occur due to the subsidy increasing recipients' demand for eligible units without a sufficient supply response. In this paper, we draw upon a plausibly exogenous increase in the supply of housing vouchers to analyze how an increase in the number of vouchers affected the price of rental housing units.

While a large social experiment in the 1970's found that vouchers had no statistically or economically significant impact on market rents, a more recent study by Susin (2002) reached a different conclusion. He estimates that the increased demand by voucher recipients increased the price of rental housing for unsubsidized households by 16% in the lowest average income

¹ U.S. Office of Management and Budget (2011a) estimates of federal outlays for low-income cash and housing assistance between 1960 and 2010 are presented in Figure 1. Cash assistance programs represented in the figure includes outlays associated with Temporary Assistance to Needy Families (TANF) and its predecessor Assistance to Families with Dependent Children (AFDC).

neighborhoods. The results from that study suggest that the increase in rental prices caused a large net wealth transfer from unsubsidized, low-income households to private market landlords as a result of the voucher program.

One concern with Susin's results is that his estimates may be biased due to unobserved determinants of rent that are correlated with the existing supply of vouchers (Olsen, 2003). To address concerns about potential omitted variables, we construct a panel data series of rental units from the American Housing Survey (AHS) and estimate the effect of a relatively large increase in the supply of vouchers on rents of individual units. This increase in vouchers represented one of the largest increases since vouchers were first allocated (U.S. GAO, 2006) and created significant variation between cities in the supply of vouchers.² We draw upon this variation and individual unit fixed effects to identify the change in rents associated with the voucher expansion based on voucher eligibility requirements.

The maximum rent for a housing unit that is occupied by a voucher recipient is determined annually by the U.S. Department of Housing and Urban Development (HUD) and is approximately equal to the median rent in the metropolitan area during the previous year (Susin, 2002). We do not find a statistically or economically meaningful impact of the increase in the supply of housing vouchers on rents for either all rental units or the units with a previous rent below this maximum rent limit within a city. We do estimate significant differences in the effect of the additional vouchers based on an individual unit's rent before the voucher expansion. These estimated differences are consistent with voucher recipients increasing their demand for

² Vouchers were allocated through these programs based on the quality of the application submitted by Public Housing Authorities (PHA) who administer the vouchers within their jurisdiction. We provide evidence that voucher allocations were not made in a systematic way related to the past changes in rent and did not have a discernible effect on rent on ineligible units after the expansion.

higher-quality units after receiving the subsidy, but decreasing their demand for lower-quality units they would have occupied without the subsidy.

We also find evidence that the increase in the supply of vouchers had a different effect on the rents of individual units based on MSA-wide characteristics. Using MSA supply elasticity estimates provided in Saiz (2011), we estimate the greatest positive price effect of the voucher expansion on medium-quality units in MSAs estimated to be supply inelastic (i.e., with an MSA supply elasticity estimated to be less than 1). In contrast, we estimate the greatest negative price effect on lower-quality units in MSAs with a relatively elastic housing supply. This price decrease is consistent with a kinked-housing supply curve originally suggested by Glaeser and Gyourko (2005), which argues there is an inelastic portion of the housing supply curve due to the durable nature of housing. Our results suggest that policymakers should consider the distributional consequences when targeting housing subsidies in the future.

The rest of the paper proceeds as follows. We first describe the programmatic features of the housing voucher program, as well as provide a discussion of the underlying theoretical predictions and prior research. We then describe our empirical strategy, along with descriptions of our AHS sample and voucher expansions. We next present results of the effect of vouchers on rents in Section V and in Section VI consider how these effects vary based on the housing supply elasticity. The final section concludes with policy implications of the research.

II. Background Information

Overview of the Housing Voucher Program

Housing vouchers were first allocated nationwide through Section 8 of the U.S. Housing and Community Development Act of 1974. Prior to the use of vouchers, the federal government had

relied on place-based subsidized housing programs that located, constructed, and operated housing units with below-market rents for low-income families. Housing vouchers were viewed as an attractive policy alternative to public housing since they gave recipients the freedom to choose where to live, given that the unit met minimum quality requirements. In addition, vouchers were considered to be more cost-effective, as they subsidized households to live in existing housing rather than constructing new housing units for that purpose (see Olsen (2003) for a review). The descendent of the original Section 8 voucher program was renamed Housing Choice Vouchers (HCV) in 1998 and is currently the largest rental housing assistance program in the U.S. The HCV program provided a subsidy to 2.2 million families in 2010 at an estimated cost of \$18 billion (OMB, 2011b).

A household is eligible to receive a housing voucher if its current income is less than 50% of the household-size-adjusted median income in its metropolitan area.³ Unlike other social welfare programs, the supply of housing vouchers in a local area is fixed and in most cities there is usually excess demand by eligible households. In order to receive a housing voucher, an individual must apply through his or her local Public Housing Authority (PHA), which uses a waiting list to allocate the subsidy to eligible families.⁴ In most large cities, the waiting list to receive a voucher is so long that the applicants cannot be accommodated in a reasonable amount of time, so the local PHA may choose to not accept new applications at that time (Olsen, 2003).

Once an individual is allocated a voucher, he or she has between 60 and 90 days to find an apartment appropriate for his or her household's size that meets the minimum quality

³ In addition, 75% of all housing vouchers must go to households with income less than or equal to 30% of the area size-adjusted median income. More information on voucher eligibility requirements is available at: http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing.

⁴ See Olsen (2003) for a discussion of when certain populations may be moved to the top of the waiting list. Typical exceptions include the elderly, disabled, or homeless. Recipients who first received a voucher in 1998 waited on average 28 months to receive the subsidy after first applying (HUD, 1998).

guidelines as determined by HUD. The generosity of the subsidy is determined by the area's Fair Market Rent (FMR) for a unit with a similar number of bedrooms as determined annually by HUD, as well as the household's current adjusted income. The FMR does not vary within an MSA and is approximately equal to the 40th percentile of estimated local housing rents during the prior year.⁵

Figure 2 represents the budget set for voucher recipients where consumption of housing services (Q_H) is measured on the horizontal axis and consumption of a composite good (Q_X) is on the vertical axis. Assuming that income (Y) and the market prices of housing (P_H) and the composite good (P_X) are fixed, unsubsidized households will consume some combination of Q_H and Q_X given the budget constraint

$$Y = P_H Q_H + P_X Q_X . \quad (1)$$

In order to receive a subsidy, voucher recipients must consume a minimum quantity of housing services (Q^{MIN}). So long as the household consumes that minimum of housing services, the federal government provides a payment to the landlord equal to the gap between the recipient's contribution of 30% of their household income and the market rent for that unit, up to the FMR.

Voucher recipients, therefore, make the same contribution towards rent for housing services Q^{MIN} through Q^{FMR} . However, the generosity of the subsidy is the greatest if they consume housing services equal to the FMR.⁶ If the household consumed housing services at the FMR, the subsidy would equal

$$Subsidy = P_H Q^{FMR} - 0.3Y . \quad (2)$$

⁵ Individual PHAs may define their own voucher payment standard to be within 10% of the FMR threshold (McClure, 2005)

⁶ Previous research has shown housing voucher recipients significantly increase their total housing expenditures, own contribution plus government subsidy, after receiving the subsidy (Gubits et al, 2006).

Since 1998, voucher recipients may rent a unit exceeding the FMR limit, but the subsidy's generosity remains fixed at the amount set by Q^{FMR} . Any amount beyond the FMR is paid entirely by the household, but the recipient's total contribution towards rent cannot exceed 40% of their household income.

Theoretical Impact of a Voucher Increase on Rent

While the additional housing vouchers will increase the demand for housing near the FMR threshold, the impact of the demand shift on the price of rental housing is likely to depend on the price elasticity of supply. For example, if the supply of rental housing is perfectly elastic, then any changes in demand induced by additional housing vouchers would result in an adjustment in the quantity supplied of rental housing with minimal impacts on rents. However, if the price elasticity of supply is perfectly inelastic, then there will not be a quantity response when demand increases and the shift in the demand curve will create a sizable increase in price.

The existing research on the supply of rental housing suggests that there is an important temporal component in the supply response and that a great deal of heterogeneity exists between cities for when that eventual response occurs (see DiPasquale (1999) or Gyourko (2009) for reviews). Past research has found that the supply of housing is almost perfectly inelastic in the immediate term since it takes time to produce new or modify existing units (Rosenthal, 1999). Over time, however, the response is more elastic depending on the supply of developable land and the presence of land-use regulations (Glaeser, Gyourko, & Saks, 2008). Saiz (2011) developed a theoretical model and showed empirically that land-constrained cities are not only more expensive, but are also relatively more supply inelastic with respect to demand shocks. Depending on the supply of developable land and prices, he estimated the short- to intermediate-

term supply elasticity for the average, population-weighted metropolitan area to be 1.75, but range from a low of 0.60 in Miami, FL (inelastic) to a high of 5.45 in Wichita, KS (elastic). Based on these range in estimates, we anticipate significant heterogeneity between MSAs in the estimated effect on rental prices based on the increased demand by voucher recipients.

Previous research has also suggested that the supply response to a demand shock may vary significantly for housing units within a city due to the durable nature of housing. According to filtering models of housing supply first discussed by Sweeney (1974), the supply of lower-quality housing may only be provided as a result of “optimally” deteriorated medium- and higher-quality housing resulting in separate housing markets for each type. If separate markets exist for each quality type, we anticipate differences in the price effects within cities due to the kinked-supply curve suggested by Glaeser and Gyourko (2005). They argued the kink occurs because housing supply is more elastic in response to increases rather than decreases in demand due to the durable nature of the housing stock.

Previous Research

The Housing Allowance and Supply Experiment (HASE) from the 1970s provided the first analysis of whether the predicted increase in rents after the allocation of additional housing vouchers actually occurs. HASE offered housing vouchers to *all* income-eligible applicants in Green Bay, Wisconsin and South Bend, Indiana and compared these markets to similar cities without vouchers. Results from this field experiment did not find any significant differences in

overall market rents between the two cities that received vouchers as compared to those that did not (Barnett, 1979; Struyk & Bendick, 1981).⁷

Despite the strength of using data collected from a field experiment, there are concerns about the external validity of HASE, especially compared to the modern voucher program. First, modern housing vouchers are not an entitlement program, so not all eligible recipients receive the subsidy as they did in HASE. In addition, the structure of the modern subsidy differs from that offered through HASE. For example, the subsidy associated with HASE was independent of actual housing expenditures of recipients, while recipients today receive a more generous subsidy for renting units closer to the FMR.⁸ Furthermore, it is difficult to draw generalizations about today's national housing market from two moderately sized mid-western cities in the 1970's.

Susin (2002) revisited this question using national data from the AHS and found dramatically different results. To obtain his results, he first split the rental housing stock into terciles based on the neighborhood's average income in 1993. He then regressed the number of vouchers per poor household on the estimated change in average rent for each tercile between 1974, when vouchers were first allocated nationwide, and 1993. His results suggested that low-quality rental markets are quite supply inelastic and that the housing voucher program resulted in a 16% increase in rental prices for unsubsidized households in the lowest income neighborhoods.

While Susin's results are more externally valid and have greater power than HASE, there is concern that omitted determinants of rent which are correlated with the past supply of voucher allocations may have biased his estimates (Khadduri & Wilson, 2006; Olsen, 2003; Schill &

⁷ Researchers did, however, find that landlords in the two cities with vouchers were more likely to make repairs to existing units to meet the minimum quality standards of the program. See Struyk & Bendick (1981) for a review of the HASE research.

⁸ See Olsen (2003) for more information on the differences between HASE and the modern voucher program.

Wachter, 2001). Olsen (2003) was particularly concerned with the comparison of the average rents in 1974 with those in 1993 in the lowest third of neighborhoods ranked by income, as the average quality of units changed significantly over that period.

III. Empirical Strategy

To address the concerns discussed in the previous section, we create a panel data series of individual rental units from the American Housing Survey (AHS) from 1997 to 2003. To control for unobserved determinants of rental prices, we include a separate intercept, or fixed effect, for each individual housing unit in the panel. In regression form, we estimate

$$R_{it} = \alpha_i + \beta V_{tm} + \theta X_{tm} + \delta_t + \varepsilon_{itm} , \quad (3)$$

where i indexes individual units and t indexes survey year, R is the log of reported rent plus utilities, V is the log of the supply of housing vouchers in the MSA where the unit is located, and ε_{it} is an idiosyncratic, unit-specific error term. X is a vector of observed time-varying determinants of rent at the individual unit and MSA-level and δ_t are year fixed effects to control for common unobserved determinants of rent.⁹ Given the presence of the individual unit fixed effects, α_i , the coefficient β represents the price elasticity of rental housing with respect to vouchers and will be identified using variation in the supply of vouchers across MSAs over time.

According to the U.S. Government Accountability Office (2006), the supply of housing vouchers dramatically increased between 1997 and 2003. That increase represented one of the largest increases in the supply of vouchers since the program's inception and is primarily explained by two separate allocation programs initiated by Congress. The first program was the Welfare-to-Work Housing Voucher Demonstration (WtWV) that allocated an additional 50,000

⁹ The time-variant MSA-level determinants of rent are the log of population, per capita income, and rental vacancy rates. The unit-specific determinants of rent that vary over time are reported evidence of rodents, presence of a washer or dryer, cracks in the walls larger than a dime, and if the sewer has backed up in the previous 2 years.

vouchers in 2000. The second was the Fair Share Voucher Allocation program that allocated an additional 154,605 vouchers between 2000 and 2002. Together, the two programs increased the supply of vouchers by 18.2% between 2000 and 2002.

While nationwide there was a large increase in the supply of vouchers, there is variation across MSAs in how much of an increase in the voucher stock each locality experienced. Table 1 presents information on the increase in housing vouchers per 1,000 units of existing rental stock. As evident in Table 1, there is a large degree of variation between MSAs in the number of vouchers that were awarded. Fresno, CA received the largest increase with an additional 170.83 vouchers per 1,000 rental units between 2000 and 2002, while 18 MSAs received no vouchers through either program. Of the 135 MSAs identified in the AHS, the median increase was 15.69% in both the Gary-Hammond-East Chicago, IN MSA and the Rockford, IL MSA with inter-quartile ranges of 32.46 in the Oklahoma City, OK MSA and 6.89 in the Greenville-Spartanburg, SC MSA, respectively. This variation across MSAs and over time is what will allow us to obtain our estimates.

It is important to recognize that we assume the voucher allocation process is exogenous to the anticipated two-year change in the rent of individual units within an MSA. This assumption is likely to be valid because the vouchers were awarded to cities primarily based on the strength of the application by the individual PHAs and state-level attributes based on the previous Census, which would be absorbed by the individual unit fixed effects.¹⁰

¹⁰ The Fair Share Vouchers were allocated as part of a two-step process where individual PHAs applied to HUD for vouchers set aside for each State based on 1990 Census attributes. PHAs received favorable consideration if they were considered to be well-run, based on criteria such as how many previous recipients had signed up for a federal savings program (U.S. Federal Register, 2002). The vouchers allocated under the WtWV were similarly competitive with individual PHAs receiving more vouchers based upon the strength of their application and the integration of the allocated vouchers with the other stated aims of the demonstration (Mills et. al., 2006).

Given the importance of this underlying assumption, we estimate in Table 2 which MSA attributes explain prior and future allocations of housing vouchers to the 135 MSAs identified in the public-use AHS. The coefficients in the first column of Table 2 report the determinants of prior allocations as of 1999, while the coefficients in the second column report the determinants of the change in vouchers between 2000 and 2002. While we find that larger, more impoverished cities in the Northeastern U.S. were significantly more likely to have received housing vouchers prior to 1999, we do not find any statistically significant differences between MSAs that explain the change in vouchers between 2000 and 2002. This result supports our argument that the allocation of housing vouchers was exogenous to anticipated changes in rents. We discuss this issue further when describing the caveats of the research in the conclusion.

IV. Data and Sample Characteristics

The main dataset we draw upon is the national sample of the AHS. This survey is conducted every two years by the U.S. Census Bureau and is intended to be nationally representative of all housing units in the U.S. We restrict our sample to the 8,388 rental housing units located in the 135 identified MSAs in the public-use version of the AHS with a reported rent in 1997 and at least one other year between 1999 and 2003.¹¹ We also exclude from our sample rental units indicated to be either publicly-owned (i.e., public housing) or to have rents controls in place. The remaining sample includes 24,721 unique unit-by-survey year observations. The first two columns of Table 3 show the mean and standard deviation of the unit-specific characteristics of

¹¹ Our MSAs are defined by 1980 Decennial Census since this is what available in the publically available national sample of the AHS. We aggregate all reported MSA data series to this consistent level of geography throughout the analysis.

our sample. The average housing unit in our sample had a reported rent and utility costs of \$1,013 per month.¹²

We supplemented this core data series with several other publicly available data sources. Annual population, per capita income and rental vacancy rates were obtained from the U.S. Census Bureau. The number of housing vouchers available in 1997 and the FMR were obtained from HUD.¹³ The average unit in our sample was located in an MSA that had a rental vacancy rate of 8% and a population of 3.53 million.¹⁴ In addition, the average unit in our sample was located in an MSA that had 20,499 previously allocated housing vouchers and an average FMR for a two bedroom unit of \$912.45.

Unfortunately, HUD does not maintain a consistent time-series of voucher availability at the MSA-level on an annual basis prior to 2002. We determined the stock of existing housing vouchers in each metro area prior to the voucher expansion using the 1997 Picture of Subsidized Households (HUD, 1998). The number of additional housing vouchers allocated between 2000 and 2002 to each MSA was determined by geocoding the ZIP code of the public housing authorities that were awarded vouchers through each program in the Federal Register.¹⁵ Table 1 summarizes the number of vouchers awarded through each program at the MSA-level. The Fair Share program resulted in 106,957 additional vouchers allocated in 116 of the 135 MSAs identified by the AHS. The WtWV program allocated an additional 29,603 vouchers to the 54

¹² All dollar values reported in the paper are in 2010 current dollars adjusted by the Consumer Price Index.

¹³ Fair Market Rents determined by HUD for each MSA are available to download at <http://www.huduser.org>.

¹⁴ Note that our summary statistics are calculated at the unit level, not the MSA level.

¹⁵ While HUD does not create an annual list of vouchers by MSA, the agency is required to publish a notice of award in the Federal Register for new voucher allocations to public housing authorities. We do not include vouchers allocated to State Housing Authorities in our sample as these agencies primarily serve non-metro areas in most states and the MSA where the vouchers were offered to recipients may be different than the agency itself (Olsen, 2003).

MSAs identified in the AHS. The combined programs represented an average increase of 18.2% in the supply of housing vouchers for the 135 MSAs identified in the public-use AHS data.

V. Impact of Vouchers on the Price of Rental Units

The first column of Table 4 reports the elasticity of rents with respect to vouchers for all rental housing units in our sample. In addition to the listed MSA control variables in the table, the estimates also include unit-specific and year fixed effects and time-varying unit-specific attributes.¹⁶ Standard errors are clustered at the MSA level to allow for non-independence of idiosyncratic errors within MSAs and are reported in parentheses below each coefficient estimate.

As reported in Table 4, we do not find that units located in MSAs with larger increases in housing vouchers between 2000 and 2002 experienced statistically significant or economically meaningful differences in rents. Our point estimate of the elasticity is 0.007 for all rental units with a standard error of 0.015. We estimate the elasticity of an individual unit's rent with respect to MSA per capita income to be 0.792, population to be 0.360, and rental vacancy rates to be -0.019. Each of these estimated elasticities, with the exception of rental vacancy rates, is statistically significant at the 5% level with standard errors clustered at the MSA level.

The second column of Table 4 restricts our sample to the 4,337 units (51.7% of the total sample) with a rent less than 120% of the FMR in 1997. As discussed earlier in the paper, the generosity of the voucher subsidy is capped at approximately the FMR of the MSA and voucher recipients cannot contribute more than 40% of their gross income towards rent. These restrictions make units with rents beyond 120% of the FMR ineligible to be occupied by voucher

¹⁶ The inclusion of the unit-specific and year fixed effects were supported through conducting a joint test of their significance.

recipients.¹⁷ We therefore anticipate the effect of vouchers on rents to be greatest for this subset of units below the limit.

Although we estimate a marginally higher elasticity of 0.011 with respect to vouchers for these eligible units, our estimate is still not statistically different from 0 and economically is quite small. Given the average monthly rent for all units with a 1997 rent below 120% of the FMR was \$770.11, our estimate implies a 1% increase in the local supply of vouchers would coincide with a \$0.08 increase in monthly rent. Given the precision of the estimates, the 95% confidence interval of that estimate is also quite small and ranges from -\$0.11 to \$0.28 per month. The third and final column of Table 4 reports the estimated elasticity when the sample is restricted to the 4,051 units (48.3% of the sample) with a 1997 rent exceeding 120% of the FMR limit. Voucher recipients would be unable to occupy these higher-priced units, so we would not anticipate that additional vouchers would have any significant effect on this segment of the market if the allocations were exogenous to anticipated changes in rent. We do not find a discernible effect of additional vouchers on rent for these units, further supporting the validity of the empirical model.

In addition to the elasticity estimates reported in Table 4, we used a variety of alternative specifications to test the sensitivity of our results. First, we used 200%, instead of 120%, as the FMR limit used to restrict our sample in the middle column of Table 4. We also omitted housing units where a respondent reported that a housing voucher was used, as Susin (2002) argued these units should be omitted because their rents may be insulated against market forces. In both instances, we continued to estimate an economically small and statistically insignificant effect of increasing the supply of housing vouchers on the overall price of rental housing.

¹⁷ We relax this assumption later in the paper by instead estimating a polynomial gradient of effects with respect to the FMR limit relative to prior rent.

Unit Quality

While we do not estimate an economically or statistically meaningful difference in rents for units in MSAs with larger increases in the supply of vouchers, we expect heterogeneity in the effects depending on the quality of the individual unit prior to the voucher expansion. We anticipate these differences will exist due to the subsidy structure encouraging recipients to vacate lower quality, and thus lower priced, rental housing and occupy units at or near the local FMR limit in their respective MSA. If cross-price elasticities between the sub-markets are sufficiently low, we anticipate a price increase in units with rents near the FMR limit prior to the expansion, but a price decrease in units with a prior rent significantly below that amount, as new voucher recipients would vacate those units.

We provide evidence of the heterogeneity in effects based on unit quality using graphical and statistical techniques. We begin by modifying our previous estimation equation (3) to allow for heterogeneous effects based on how close the unit is to the FMR. We adjust the equation to include an interaction of the log of vouchers (V) with a flexible k^{th} order polynomial of the log of the ratio of the individual unit's rent in 1997 divided by the 1997 FMR, adjusted for bedroom size, in the MSA where that unit was located. This model is specified as

$$R_{it} = \alpha_i + \sum_{j=0}^k BV_{tm} [R_{i,1997} / FMR_{m,1997}]^j + \theta X_{tm} + \delta_t + \varepsilon_{itm}, \quad (4)$$

where j denotes the order of the exponent of the interaction terms and B is a vector of coefficients to be estimated using OLS. $R_{i,1997}$ is the unit's rent in 1997 and $FMR_{m,1997}$ is the size-adjusted FMR in the MSA where the unit is located. By interacting this ratio with the number of vouchers, we allow the voucher expansion to have a heterogeneous effect based on the proximity

of that unit's rent relative to the FMR before the voucher expansion.¹⁸ The order of the polynomial was selected using Information Criterion suggested by Akaike (1997) based on the entropy maximization principle, which maximizes the fit on the model while penalizing the introduction of additional parameters.

Using these coefficients, we illustrate the marginal effect of the voucher expansion based on the proximity of an individual unit's prior rent relative to the FMR limit in their local MSA in Figure 3. The fit of the model was maximized using a 5th order interacted polynomial with the supply of housing vouchers, although the general shape of the estimated effects remained similar with even order polynomials. The solid line in Figure 3 represents the rental price elasticity from plotting the estimated B 's, where the x-axis is defined as the FMR ratio and the y-axis is the estimated rental price elasticity. The dashed lines represent the 90% confidence intervals of the interacted polynomial obtained using the delta-method. As anticipated, we estimate significant differences in effects based on an individual unit's prior rent in 1997 before the voucher expansion. We find the greatest increase in rents for units within approximately 20% of the FMR threshold and a statistically significant decrease in price for units with a prior rent less than 80% of that limit.

Next, we estimate if the heterogeneous effects that appear in the figure are statistically different using stratified regressions. These results are presented in Table 5. The first two columns of Table 5 stratify the sample based on whether a unit's rent was either below 80% or within 20% of the FMR limit in 1997. For units with a prior rent below 80% of the FMR, we estimate a negative elasticity of 0.095, implying that a 1% increase in the supply of vouchers resulted in a 0.095% decrease in rents. When we alternatively restrict the sample to medium-

¹⁸ To reduce the influence of outliers on the shape of the polynomial, we restrict the sample to units with a 1997 rent within 20 and 170% of the FMR, which includes approximately 90% of our sample.

quality units with a 1997 within 20% of the FMR ratio, we estimate a positive elasticity of 0.038. Since the average rent for units with a rent below 120% of the FMR was \$770.11, these estimates imply a 1% increase in the local supply of vouchers resulted in an average decrease of \$0.74 for lower-priced units, and \$0.29 increase in monthly rent for units within 20% of the FMR limit.¹⁹ Using standard errors clustered at the MSA-level, we find both of these effects are statistically distinct from 0 at the 5% level of significance. The third column of Table 5 pools the sample and uses an interaction term to test whether the coefficients are different from each other. The difference between the coefficients is statistically distinct from 0 at the 1% level of significance and is consistent with recipients occupying higher-quality rental housing after receiving a subsidy.

Falsification Test to Check for Pre-Existing Trends

An alternative explanation for the above patterns is that HUD may have differentially targeted vouchers to MSAs based on anticipated changes in rent. For example, HUD may have purposely allocated additional housing vouchers to MSAs where the rents of lower quality units were already decreasing. While we have already shown that there were no observable differences in allocation patterns between MSAs and that additional vouchers had no impact on higher quality units, we test whether pre-existing trends are present in Table 6. To do this, we conduct a falsification test (similar to those used by Rothstein (2010), Figlio (2006), and Finkelstein (2002)) and specify an alternative model where we assume that the vouchers allocated between 2000 and 2002 were instead allocated between 1997 and 1999. In other words, we re-estimate

¹⁹ The average increase in the supply of vouchers as a result of the voucher expansion that occurred between 2000 and 2002 was 18.2%, resulting in an average decrease from the expansion of \$13.47 for units with a previous rent less than 80% of the FMR before the voucher expansion and an average increase of \$5.28 for units with a previous rent within 20% of the FMR threshold.

equation (3) using two survey years of data and define 1997 as the pre-voucher expansion period and assign 1999 to the post-voucher expansion period. If pre-existing trends in rents are present and factor into future vouchers allocations, we would find a significant coefficient of the voucher variable, even though the increase in the voucher supply did not actually occur in 1999.

In the first column of Table 6, we show that future changes in housing vouchers had no explanatory effect on prior rents for all units less than 120% of the local FMR threshold. For these units, we estimate an economically small and statistically insignificant coefficient of -0.009. In the second and third columns of Table 6, we stratify our sample based on whether units were within or below 20% of the FMR threshold in 1997. Whereas previously we estimated a significant difference in rents based on these cutoffs, we do not estimate a significant difference in rents from each other or 0 before voucher expansion occurred. Overall, the results in Table 6 provide evidence that the voucher allocation process was not correlated with prior trends in rent.

VI. Elasticity of Supply Results

In addition to the differences in the effect of the program across the price distribution within an MSA, we also anticipate heterogeneity in effects based on the supply elasticity of the MSA where the additional vouchers were allocated. Economic theory suggests that the effect of vouchers on the price of rental housing should be the greatest in areas with a relatively less elastic housing supply. In areas where supply is more elastic, we anticipate changes in demand from allocating additional vouchers would induce a larger supply response, thus mitigating the positive effects on rents.

We again use a series of variables interacted with the local voucher supply to test if a heterogeneous effect on rents exists between MSAs based on supply elasticity. Our MSA supply

elasticity estimates originate from Saiz (2011), who used Geographic Information Systems data to derive elasticity estimates for cities with a year 2000 population exceeding 500,000.²⁰ Based on estimates reported in that paper, we were able to assign supply elasticities for 94 of the 135 MSAs geographically identified in the AHS.

Similar to the heterogeneous price effects based on prior rents presented in Figure 3, we interact the log of voucher supply at the local level with a 5th order polynomial of the log of the MSA supply elasticity.²¹ The solid line in Figure 4 plots the estimated B 's of the polynomial where x-axis is defined as the MSA supply elasticity and the dashed lines represent 90% confidence intervals of those estimates. Based on visually inspecting Figure 4, there was a positive price effects for individual units located in an MSA with an estimated supply elasticity less than 0.83. We also estimate a negative and statistically significant price effect for units located in MSAs with an estimated supply elasticity greater than 1 indicative of a supply response in those areas.

The first column of Table 7 reports the elasticity of rent with respect to vouchers for the subset of units located in an MSA with a supply elasticity reported by Saiz (2011) and a 1997 rent less than 120% of the FMR limit. As before, we do not find an economic or statistically significant effect of additional vouchers on these units. In the second column of Table 7, we introduce an interaction term of the supply of vouchers in the MSA with an indicator that equals one if Saiz estimated the supply elasticity in that MSA to be greater than or equal to 1 (i.e., supply elastic). The coefficient on the interaction term can be interpreted as the difference in estimated elasticities, with the coefficient on log of vouchers now interpreted as the elasticity of rent with respect to vouchers in supply inelastic areas (i.e., an estimated supply elasticity less

²⁰ See Saiz (2011) for more details on how he created his MSA supply elasticity estimates.

²¹ Similar to our unit-quality estimates, we also restrict the sample to rental units with a 1997 rent between 20 and 170% of the FMR to reduce the influence of outliers on the polynomial shape.

than 1). Based on the coefficients with the interaction term, we estimate the average marginal effect to be 0.113 for units in cities with a previously estimated supply elasticity less than 1, and -0.077 for units in more elastic areas.

In the final column of Table 7, we include interactions of the supply of housing vouchers with both the indicator that the estimated elasticity of supply of the MSA is greater than one and the indicator that a unit's rent divided by the FMR before the voucher expansion is less than 80% to test if one effect dominates.²² We find the coefficient on both interaction terms to be negative and significantly different from 0 at the 5% level of significance. In Table 8 we calculate the estimated linear combination of coefficients on the interaction terms reported in the last column of Table 7. Based on those coefficient estimates, we find that the positive effect of vouchers is the greatest in relatively supply inelastic cities (i.e., with a supply elasticity less than 1) and the negative effect is the greatest in relatively supply elastic areas. Both estimated elasticities are sizeable in economic terms (0.232 and -0.297, respectively) and statically different from 0 at the 5% level of significance. In dollar terms, they suggest a 1% increase in vouchers resulted in a \$1.79 increase and a \$2.29 decrease in monthly rent for each category of unit.²³

As explained earlier, the negative effect in the supply elastic cities for the lowest quality units could be due to the ability of suppliers to produce new medium-quality units in response to the increase demand by recent voucher recipients in those areas. This supply-response would result in large decreases in rents for durable lower-quality units that would have been rented in

²² We also include an interaction of each interaction, although do not find a significant difference in rents for these subset of units.

²³ We also considered the effect of the regulatory environment by interacting the supply of vouchers with the Wharton Residential Land-Use Regulatory Index developed by Gyourko, Saiz, and Summers (2008). We estimate a positive and statistically significant price elasticity for medium-quality units near the FMR limit with respect to vouchers for units in cities with regulatory index value greater than 0. We prefer the MSA supply elasticity estimates of Saiz (2011) due to the possible endogenous reasons such regulations could originate, but the results are available from the authors upon request.

the absence of the subsidy, a finding consistent with the kinked-supply curve originally suggested by Glaeser and Gyourko (2005)

VII. Summary and Policy Implications

In this study, we do not find that additional housing vouchers increased the overall price of rental housing. This finding is in contrast to earlier research that found housing vouchers significantly increased the price of low-quality rental housing to the detriment of unsubsidized renters, but these earlier findings may have been biased due to unobserved determinants of rent. We addressed concerns about omitted variable bias confounding previous research by constructing a panel of individual rental housing units observed in multiple waves of the AHS before and after a relatively large expansion in the supply of housing vouchers.

While we do not detect a discernible overall effect of housing vouchers on the change in rents, we do find important differences in estimated effects based on the individual unit's rent in 1997 before the voucher expansion. Based on a unit's 1997 rent relative to the maximum allowable rent under the program in their local area prior to the voucher expansion, we estimate a 1% increase in vouchers resulted in a 0.039% increase in the price of rental housing for units with a rent within 20% of the local Fair Market Rent in 1997. We also estimate a 1% increase in vouchers resulted in a 0.095% decrease in rent for lower-quality units with a 1997 rent less than 80% FMR. Considering average rents, the 18.2% increase in the supply of vouchers nationwide between 2000 and 2002 resulted in an average increase in monthly rents \$5.28 for medium-quality units and an \$13.47 decrease for lower-quality units.

Our results are consistent with the subsidy structure encouraging recipients to vacate lower quality units to occupy higher quality units after receiving the subsidy. We also find that

rent increases were the highest for units in an MSA with a previously estimated supply elasticity less than 1. It is important to recognize that since the housing voucher program is continuously evolving, it is unclear if our results are externally valid beyond the time period of our study and different voucher allocation programs. In addition, our identification strategy is based on the assumption that the voucher allocation process was exogenous to future changes in rental prices given the controls in our model. While we provide evidence that there is no statistical difference between MSAs in predicting future voucher allocations and include unit and time fixed effects to control for remaining unobserved determinants of rent correlated the voucher expansion, we hope future research will address both of these points given the importance of the topic.

Our results suggest that future housing policy should take into account unique city attributes when targeting different subsidies. Currently, the majority of federal housing subsidies are allocated to cities based on per capita measures to ensure an equal distribution across the country, with little regard to which policies may work best based upon the characteristics of the local housing market. More specifically, we have shown cities with a relatively elastic housing supply are perhaps best suited for housing vouchers, since increased demand by recipients would lead to expansions in supply, whereas supply-based rental subsidies may be better suited to areas with a relatively less elastic housing supply. Future research should attempt to further identify these specific local factors policy makers should take into account when attempting to maximize the effectiveness of housing subsidies.

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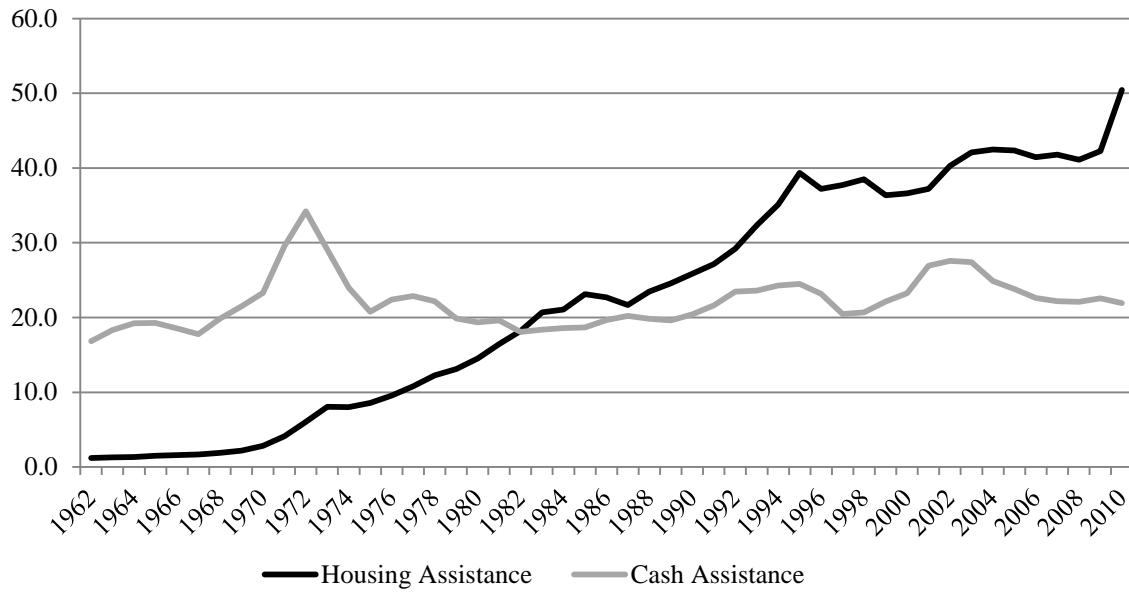
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Figure 1. Federal Outlays for Low-Income Housing and Cash Assistance Programs



Source: U.S. Office of Management & Budget (2011); Constant 2010 \$'s deflated using Consumer Price Index

Figure 2. Budget Set of Housing Voucher Recipients

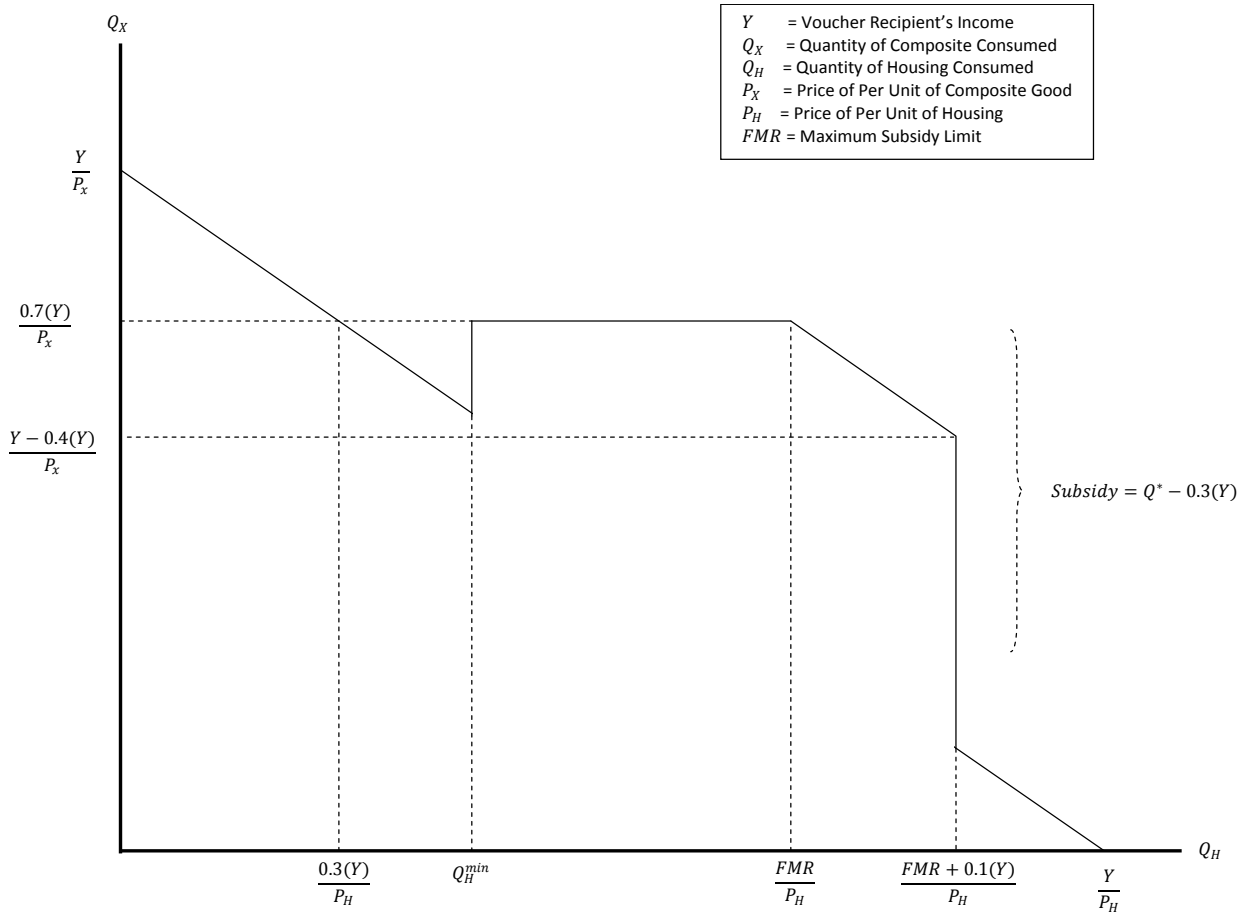
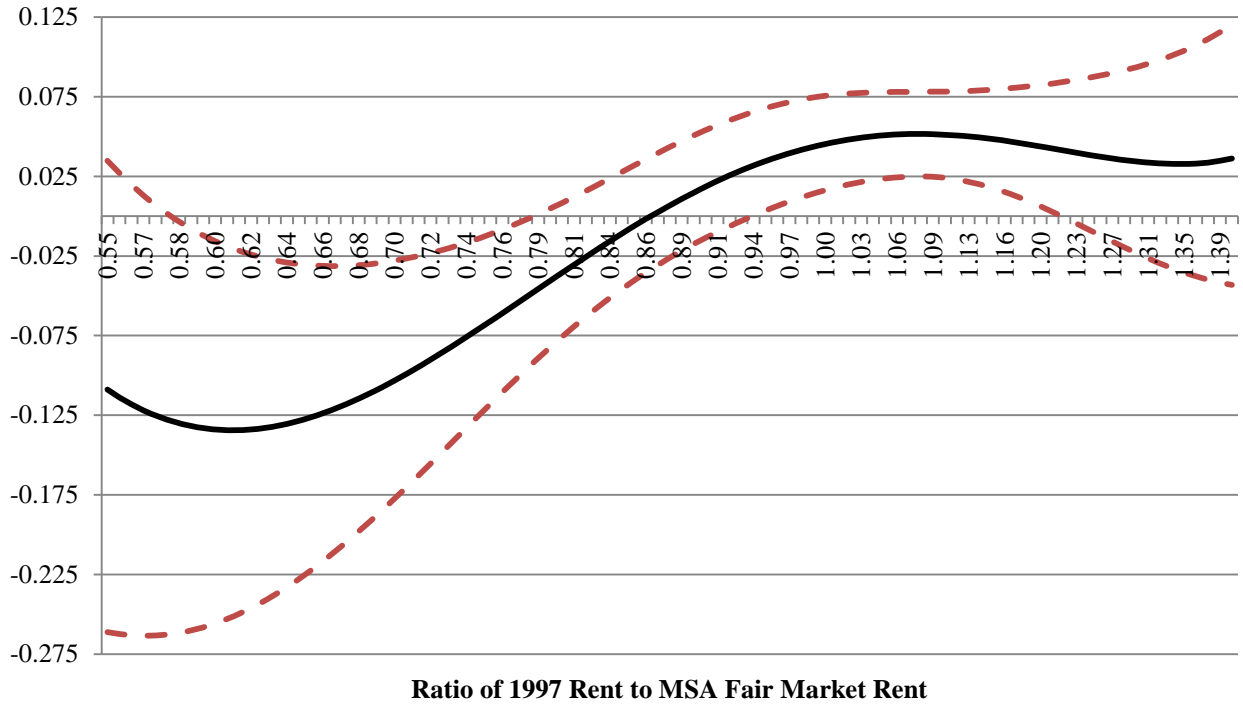
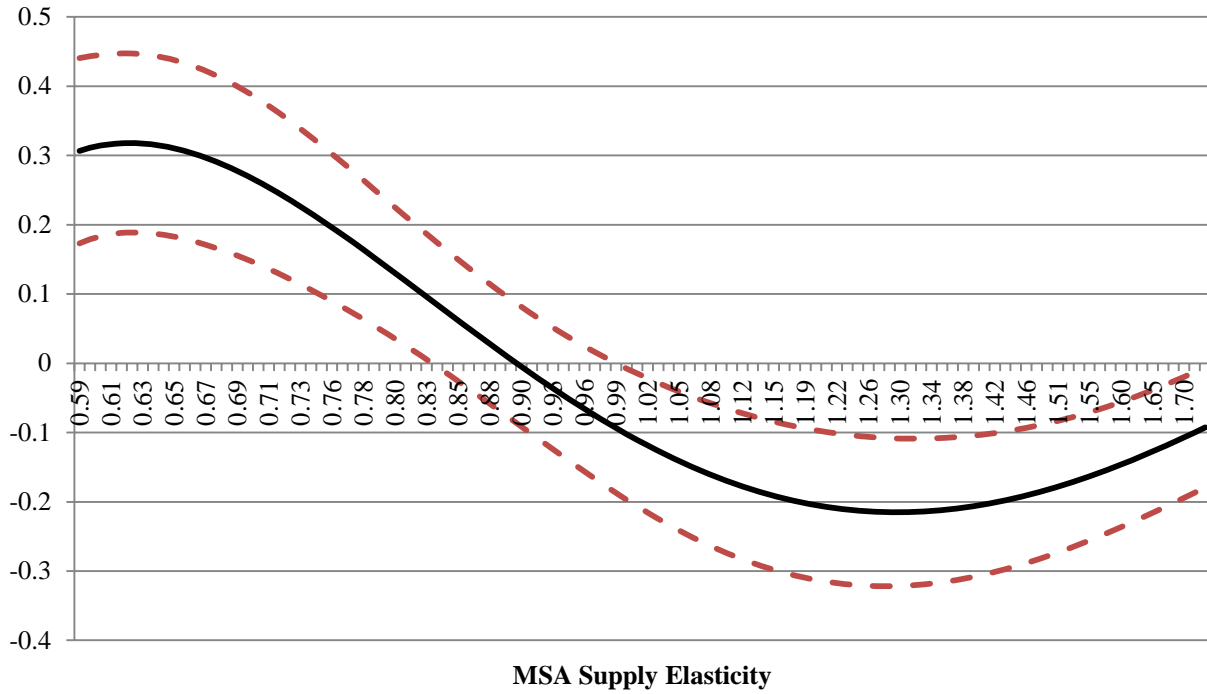


Figure 3. Elasticity of Rental Price with Respect to Vouchers by Ratio of 1997 Rent Divided by MSA Fair Market Rent



Note: Authors' calculations from interacting the supply of vouchers with 5th order polynomial of an individual unit's rent before the voucher expansion in 1997 to the Fair Market Rent for a unit of similar size in its MSA according to HUD. Dashed lines represent 90% confidence intervals.

Figure 4. Elasticity of Rental Price with Respect to Vouchers by MSA Supply Elasticity



Note: Authors' calculations from interacting vouchers with a 5th order polynomial MSA supply elasticity estimates created by Saiz (2011). Dashed lines represent 90% confidence intervals.

Table 1. Increase in Housing Vouchers by Rank, 2000-2002

Rank	Metropolitan Area	# of Vouchers in 1997	Additional Vouchers ('00-'02)		
			Fair Share Allocation	Welfare-to- Work	Per 1,000 Rental Units
1	Fresno, CA	4,792	3,069	1,400	170.83
2	Santa Barbara, CA	3,737	1,385	0	110.18
3	Augusta, GA	2,172	699	865	94.79
4	Stockton, CA	2,733	929	700	91.54
5	San Jose, CA	8,352	2,704	1,066	87.48
32	Los Angeles, CA	66,132	6,392	1,575	32.85
33	Oklahoma City, OK	6,109	1,010	100	32.46
34	San Antonio, TX	10,161	1,668	0	31.74
65	Lakeland, FL	954	0	373	16.24
66	Gary, IN	1,751	419	0	15.69
67	Rockford, IL	1,496	200	0	15.69
68	Charleston, SC	3,202	393	0	15.60
98	Indianapolis, IN	1,699	360	0	7.34
99	Greenville, SC	2,460	189	0	6.89
100	Appleton, WI	738	74	0	6.82
111	Pensacola, FL	1,637	50	0	3.03
112	Nassau, NY	7,448	384	0	2.97
113	Orlando, FL	2,956	161	0	2.83
114	Kansas City, MO	6,933	131	0	2.42
115	Utica, NY	1,829	26	0	2.11
<i>Total in AHS Sample</i>		751,765	106,957	29,603	22.85

Notes: The Table indicates the number of existing and additional housing vouchers allocated through the Fair Share Allocation program from 2000 and 2002. The table is sorted by rank of additional vouchers allocated as a share of existing rental housing prior to the expansion. The public-use version of the American Housing Survey (AHS) identifies 135 unique metropolitan statistical areas, of which 20 received no additional allocations through either program.

Table 2. MSA Determinants of Past and Future Housing Voucher Allocations

	Previously Allocated Vouchers as of 1999	% Change in Vouchers Between 2000 and 2002
Log of MSA Population (1999)	1.040* (0.536)	-4.948 (5.506)
Log of MSA Per Capita Income (1999)	0.559 (0.623)	-6.776 (7.401)
Log Fair Market Rent (1999)	-0.039 (0.201)	2.777 (3.049)
Log of Vacancy Rate (1999)	0.008 (0.232)	-4.145 (4.241)
Log of MSA Poverty Rate (1999)	0.580* (0.331)	4.429 (4.799)
Log of Voucher Eligible Individuals (1999)	-0.607** (0.251)	-0.648 (1.519)
MSA Located in Northeastern Census Region	0.397** (0.169)	-1.705 (1.735)
MSA Located in Western Census Region	0.047 (0.197)	3.179 (3.253)
MSA Located in Southern Census Region	0.017 (0.173)	-0.920 (1.140)
R^2	0.596	0.055
Observations (MSAs)	135	135

Notes: The table shows the coefficient of MSA-level regressions where the dependent variable is defined as the percentage increase in housing vouchers between 2000 and 2002. The first column estimates were obtained from regressing observed MSA attributes in 1999 on the future change in voucher. The second column included the change in MSA attributes between 1997 and 1999. Robust standard errors are in parentheses and asterisks indicate statistical significance at the following levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3. Descriptive Statistics for American Housing Survey (AHS) Sample

	Mean	Standard Deviation	Standard Deviation Net of Unit and Year Fixed Effects
Unit Attributes			
Monthly Rent plus Utilities	1,013.43	558.69	271.24
Monthly Rent as % of FMR	1.13	0.52	0.29
Evidence of Rodents	0.14	0.34	0.24
Presence of Washer or Dryer	0.39	0.49	0.20
Large Cracks in Wall	0.08	0.27	0.20
Recent Sewage Problems	0.02	0.14	0.11
MSA Attributes			
Housing Vouchers	20,498.82	24,935.43	1,185.31
Rental Vacancy Rate	0.08	0.03	0.01
Population (1,000's)	3,653.26	3,125.65	79.98
Per Capita Income (1,000's)	39.41	6.49	0.77
Monthly Fair Market Rent	912.45	288.62	79.56
Census Regions			
Northeast	0.20	0.40	.
South	0.28	0.45	.
Midwest	0.22	0.41	.
West	0.30	0.46	.
# of Units	8,388	.	.
MSAs	135	.	.

Notes: Sample restricted to rental units in the American Housing Survey (AHS) between 1997, 1999, 2001, and 2003. FMR indicates the Fair Market Rent as determined by the Department of Housing and Urban Development. See text for additional sample restrictions and descriptions of variables. All summary measures are based on the average of all rental units in the sample.

Table 4. Elasticity of Housing Rents with Respect to Housing Vouchers

	Full Sample	Ratio of 1997 Rent Divided by HUD Fair Market Rent	
		Ratio < 120%	Ratio ≥ 120%
Log of Vouchers	0.007 (0.015)	0.011 (0.013)	-0.002 (0.025)
Log of MSA Per Capita Income	0.808*** (0.209)	0.872*** (0.209)	0.874*** (0.278)
Log of MSA Population	0.359** (0.175)	0.343* (0.194)	0.458** (0.202)
Log of Vacancy Rate	-0.019 (0.020)	-0.010 (0.019)	0.019 (0.030)
Unit Fixed Effects	8,388	4,337	4,051
Year Fixed Effects	4	4	4
Within R^2	0.094	0.172	0.044
<i>Observations</i>	24,721	14,029	10,692

Notes: The table indicates the coefficients of panel regressions where the dependent variable is defined as the log of monthly housing rent plus utilities between 1997 and 2003. The first column reports results for the unrestricted AHS sample. The second and third column report estimates where the AHS sample is stratified based on the individual unit's rent in 1997 divided by the US Department of Housing and Urban Development (HUD) Fair Market Rent (FMR) adjusted for bedroom size in the MSA where the unit is located. Each set of regressions includes individual unit and year fixed effects and unit-specific controls for: evidence of rodents, presence of washer or dryer, large cracks in the wall, and if sewage system broke down in last two years. Robust standard errors clustered at the MSA level are in parentheses and asterisks indicate statistical significance at the following levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 5. Heterogeneous Effects of Vouchers on Housing Rents by Ratio of 1997 Rent Divided by HUD Fair Market Rent Before the Voucher Expansion

	Stratified by Ratio of 1997 Rent Divided by HUD Fair Market Rent		w/ Interaction if Prior Rent < 80% of FMR
	Rent < 80%	80% ≤ Rent < 120%	
Log of Vouchers	-0.095*** (0.036)	0.039** (0.016)	0.040** (0.017)
Interaction of Vouchers w/ Indicator Variable if Rent < 80% of FMR			-0.140*** (0.044)
Log of MSA Per Capita Income	1.220*** (0.405)	0.944*** (0.176)	0.976*** (0.215)
Log of MSA Population	0.344 (0.359)	0.621*** (0.149)	0.545*** (0.206)
Log of Vacancy Rate	0.053 (0.057)	-0.012 (0.019)	0.004 (0.025)
Unit Fixed Effects	1,398	2,939	4,337
Year Fixed Effects	4	4	4
Within R^2	0.340	0.159	0.195
Observations	4,467	9,562	14,029

Notes: The table indicates coefficients from panel regressions where the dependent variable is defined a log housing rent plus utilities between 1997 and 2003. The first and second column report estimates where the AHS sample is stratified based on the individual unit's rent in 1997 divided by the US Department of Housing and Urban Development (HUD) Fair Market Rent (FMR) adjusted for bedroom size in the MSA where the unit is located. The third column includes an interaction variable where log of vouchers is interacted with an indicator variable which equals one if the individual unit's prior rent was less than 80% of the FMR in 1997. Each set of regressions includes individual unit and year fixed effects and unit-specific controls for: evidence of rodents, presence of washer or dryer, large cracks in the wall, and if sewage system broke down in last two years. Robust standard errors clustered at the MSA level are in parentheses and asterisks indicate statistical significance at the following levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6. Falsification Test to Check for Pre-Existing Trends in Rent by Specifying Change in Housing Vouchers Instead Occurred between 1997 and 1999.

	Ratio of 1997 Rent Divided by HUD Fair Market Rent		
	Rent < 120%	Rent < 80%	80% ≤ Rent < 120%
% Change in Future Vouchers	0.009 (0.019)	-0.022 (0.110)	0.004 (0.014)
Unit Fixed Effects	2,362	712	1,650
Observations	4,724	1,424	3,300

Notes. The first column reports results for the unrestricted AHS sample. The second and third columns report estimates where the AHS sample is stratified based on the individual unit's rent in 1997 divided by the US Department of Housing and Urban Development (HUD) Fair Market Rent (FMR) adjusted for bedroom size in the MSA where the unit is located. Standard errors are clustered at the MSA level and are reported in parentheses and indicate significance at the following levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7. Heterogeneous Effects of Vouchers on Rents by MSA Supply Elasticity

	No Interaction	w/ MSA Supply Interaction	w/ MSA Supply & Ratio of Prior Rent Interaction
Log of Vouchers	0.023 (0.057)	0.113* (0.064)	0.232*** (0.056)
Interaction of Vouchers w/ Indicator Variable if Supply Elasticity ≥ 1		-0.190** (0.091)	-0.254*** (0.086)
Interaction of Vouchers w/ Indicator Variable if Rent < 80% of FMR			-0.279** (0.126)
Interaction of Vouchers w/ Indicator Variable if Supply Elasticity ≥ 1 & Indicator Variable if Rent < 80% of FMR			0.004 (0.007)
Unit Fixed Effects	3,973	3,973	3,973
Year Fixed Effects	4	4	4
Within R^2	0.177	0.177	0.204
Observations	12,861	12,861	12,861

Notes: The table indicates coefficients from panel regressions where the dependent variable is defined a log housing rent plus utilities between 1997 and 2003. The sample is restricted to 3,974 housing units with a 1997 housing rent less than 120% of the FMR limit and with an estimated housing supply elasticity reported by Saiz (2011). Estimates reported in the first column include no interaction term. Estimates in the second column include an interaction of the log of housing vouchers with an indicator variable that equals one if the estimated supply elasticity in the MSA where the unit is located is greater than or equal to 1. Estimates in the third column interact of the supply elasticity indicator and the ratio of the unit's 1997 rent divided by the FMR is less than 80% of the FMR indicator. Each set of regressions includes individual unit and year fixed effects, MSA specific controls (log of population, income, and rental vacancy) and unit-specific controls (evidence of rodents, presence of washer or dryer, large cracks in the wall, and if sewage system broke down in last two years). Robust standard errors clustered at the MSA level are in parentheses and asterisks indicate statistical significance at the following levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 8. Summary of Heterogeneous Effects of Vouchers on Housing Rent Based from Interactions of Supply Elasticity and Prior Rent Before the Voucher Expansion

		Stratified by Ratio of Prior Rent in 1997 Divided by HUD Fair Market Rent	
		Rent < 80%	80% ≤ Rent < 120%
MSA Supply Elasticity	< 1	-0.046 (0.143)	0.232*** (0.056)
	≥ 1	-0.297** (0.132)	-0.022 (0.074)

Notes: The table indicates the linear combination of the interacted coefficients reported in Table 7. Robust standard errors clustered at the MSA level of those combined estimates are in parentheses and asterisks indicate statistical significance at the following levels: * p < 0.1, ** p < 0.05, *** p < 0.01.