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**Do Low-Income Rental Housing  
Programs Complement Each Other?  
Evidence from Ohio**

Brett Barkley, Amy Higgins, and  
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We characterize rental subsidy use in units developed with construction subsidies and explore whether the subsidy overlap responds to needs unmet by a tenant-based program alone. We present a subsidy allocation model allowing for program complementarity to guide our analysis of multiple subsidy use in Low Income Housing Tax Credit (LIHTC) units. Findings for Ohio in 2011 suggest that rental assistance in LIHTC exhibits some degree of subsidy complementarity, particularly, when serving very poor households with special housing needs. We also find that very low income voucher holders who face a less affordable market or a potential gain in neighborhood quality are attracted to use their voucher in a LIHTC unit. However, our analysis finds a significant portion of households in LIHTC units that could seemingly be housed in the private rental market, signaling some degree of inefficient allocation of subsidies.

Keywords: Affordable Housing, Housing Choice Vouchers, Low-Income Housing Tax Credit, Housing Policy, Neighborhood Quality.

JEL Codes: R38, H71, R23.

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# 1 Introduction

The longstanding debate over cost-effectiveness in the provision of rental housing subsidies is influenced by whether the housing goods offered by different programs are considered substitute or complement products. Assuming that programs provide equal access to housing units and environments of similar quality, researchers show that tenant-based programs are less costly than their project-based counterparts (Olsen, 2009; GAO, 2002). More specifically, Olsen and Zabel (2015) argue that the most cost-effective way to provide affordable housing is from existing housing stock. Thus, under the substitutability assumption, it is possible to house a larger number of eligible households when allocating funds away from project-based and into tenant-based programs. Alternatively, when project-based programs support neighborhood revitalization efforts or increase access for low-income households to areas of opportunity, they may complement tenant-based programs by reaching subpopulations whose needs would be unmet under a tenant-based program alone. Programs can also exhibit complementarity at the individual level. For instance, an elderly, extremely low income individual may need the human services provided through a project-based program, and the deep rental subsidy provided by a housing voucher. Thus, some argue that programs should be best seen as complementary in the provision of housing for low-income households. Under the complementarity assumption, the goal from a social planner's perspective would be to optimally allocate resources across both programs in order to cover the heterogeneous needs of eligible families.

The Low-Income Housing Tax Credit (LIHTC or Tax Credit) is a suitable case study to examine the question of complementarity in affordable housing policy as it is often used in concert with multiple programs. O'Regan and Horn (2013) reported that between 33.7% and 49.6% of low-income qualifying LIHTC tenants received additional rental assistance (based on a sample of ten states) and older studies by GAO (1997) and Buron et al. (2000) reported that by 1994 37%-39% of LIHTC tenants received additional project-based or tenant-based rental assistance. This paper considers the potential complementarity of tenant and project-based programs within LIHTC units. We analyze combined subsidy use in LIHTC to assess whether or not it is consistent with some general form of complemen-

tarity. Specifically, we see if the incidence of dual subsidy use is associated with tenant, rental market, or neighborhood characteristics that reduce access to housing via a tenant subsidy alone.

Previous research has documented the incidence of tenant-based rental assistance in LIHTC units, but has not looked into whether this combined subsidy provides housing services that would be difficult to obtain absent the project-based subsidies (Galvez, 2002). This analysis would require a counterfactual comparison of housing outcomes for households with tenant-based rental assistance in and out of LIHTC units, accounting for selection. Lacking the data needed to implement such an approach, we take an alternative path: We lay out a simple allocation model that allows for complementarity of a project-based subsidy such as LIHTC with a tenant-based subsidy like the HCV, and we consider potential solutions under alternative optimization criteria. The model guides our subsequent analysis characterizing the subset of users who use vouchers in LIHTC and the market and neighborhood conditions in which they use them. Comparing this set with the overall population of HCV users allows us to gauge whether the dual subsidy use serves a distinct population, offers improved neighborhood conditions, or provides wider access to affordable housing relative to using a tenant-based subsidy alone. We find, in less affordable markets, that voucher users are more likely to use their rental subsidies in a LIHTC unit. However, it is not clear that voucher households in LIHTC see improvements in neighborhood quality compared to the overall HCV population. The time period analyzed spans 2011 and 2012. We use subsidized household level data in Ohio for 2011, provided by the Ohio Housing Finance Agency (OHFA) and HUD’s Public Use Microdata Sample (PUMS) for the year 2012. Tract level data for HCV users is from HUD’s Picture of Subsidized Households, 2011, and neighborhood quality variables are from the Census Bureau<sup>1</sup>, 2010.

In Section 2 we provide an overview of the affordable rental housing programs included in the analysis. Section 3 discusses relevant literature. Section 4 develops a simple

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<sup>1</sup>2010 data in 2000 tract boundaries by Geolytics, Inc.

housing subsidy allocation model with program complementarity, and Section 5 presents the empirical analysis. The last section discusses policy implications and provides some concluding thoughts.

## **2 Overview of Affordable Rental Housing Programs**

The Low Income Housing Tax Credit program is the second largest and the primary source of subsidies for the construction or rehabilitation of rent restricted housing units (Table 1). LIHTC is designed so one of the following conditions apply: at least 40% of its units are affordable to households with incomes at 60% of area median income (AMI), or at least 20% of units are affordable to households with incomes at 50% of AMI, with some states implementing competitive selection preferences for units that have income restrictions as low as 30% of AMI (NCSHA, 2014)<sup>2</sup>. The amount of tax credits awarded to a project in part depends on the number of units that meet the affordability guidelines so in practice it is not uncommon for a project to have very few or zero market-rate units. Still, given program design, most LIHTC units will not be affordable to the neediest households, who would need additional rental assistance in order to comfortably afford a LIHTC unit. In Ohio, approximately 50% of LIHTC households receive additional rental assistance, either tenant-based assistance (TBA or vouchers) or project-based assistance (PBA) (Table 1).

The Housing Choice Voucher program is the main source of tenant-based subsidies. There are approximately 13,524 households in Ohio who redeem their voucher in a LIHTC unit.<sup>3</sup> As conceived, the HCV program relies on the market supply of rental units at the Fair Market Rent (FMR), set at the 40th percentile of gross rent for typical, non-

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<sup>2</sup>In this context, a rental is affordable if it amounts to no more than 30% of household income. In the US, 10% of all LIHTC units placed in service during 2012 were allocated at the 30% AMI level. Louisiana allocated the largest portion (48%) of LIHTC units at this threshold.

<sup>3</sup>Some households receive tenant-based assistance through programs other than HCV, for example, through the federally-funded HOME program or state-funded programs, which typically have similar eligibility rules as HCV. In Ohio, a small number of jurisdictions have received HOME funds to provide tenant-based rental assistance but there is not a state-funded voucher program. For simplicity, in this paper we generally refer to the TBA population in Table 1 as HCV users redeeming their vouchers in a LIHTC unit.

Table 1: Units in Subsidized Housing Programs Providing Additional Rental Assistance Subsidies in LIHTC, 2011

	Ohio	United States
<b>Total units by program</b>		
Housing Choice Voucher	94,674	2,107,949
Low-Income Housing Tax Credit	87,933	1,943,359
Public Housing	46,065	1,069,681
Section 8 New Construction/Substantial Rehabilitation	41,789	791,258
Rural Housing Services 515	24,943	658,307
Section 8 Loan Management Set-Aside	24,255	310,914
Section 8 Property Disposition	6,478	50,363
Project Rental Assistance Contract/202	5,850	108,416
Project Rental Assistance Contract/811	1,477	29,124
Other HUD project-based assistance	479	41,713
Rental Assistance Payments	0	11,047
Rent Supplement Program	0	2,948
<b>Distribution of additional rental subsidies in LIHTC</b>		
Tenant-based assistance (TBA or vouchers) (%)	15.38*	NA
Project-based assistance (PBA) (%)	36.85*	16.05*
Section 8 Loan Management Set-Aside (%)	35.24	19.42
Rural Housing Services 515 (%)	30.43	54.74
Section 8 New Construction/Substantial Rehabilitation (%)	26.23	30.74
Section 8 Property Disposition (%)	7.62	3.41
Public Housing (%)	2.12	5.48
Other HUD project-based assistance (%)	1.59	2.45
Project Rental Assistance Contract/202 (%)	0.84	0.65
Project Rental Assistance Contract/811 (%)	0	0.06
Rent Supplement Program (%)	0	0.24
Rental Assistance Payments (%)	0	0.68
Project-based vouchers (%)	NA	NA

Source: Data is from HUD's Picture of Subsidized Households, National LIHTC Database, National Housing Preservation Database, and the Ohio Housing Finance Agency (OHFA). NA stands for not available. \*Note: Overall Ohio TBA and PBA estimates are based on data from OHFA representing about 71% of the total LIHTC households in Ohio in 2011. US PBA estimate, as well as distribution within PBA for both Ohio and the US, are based on data from the National Housing Preservation Database. For Ohio, the National Housing Preservation Database estimates that approximately only 28% of LIHTC households in Ohio receive additional project-based assistance, but it does not include project-based vouchers which partially explains the relatively large difference with the 36.85% PBA estimate in the OHFA data. Though data from OHFA doesn't identify project-based vouchers specifically, it would be reported by property managers as project-based assistance.

substandard units in a given local housing market, and the willingness of landlords to certify their units under HUD rules. It requires the voucher holder to pay 30% of their income on housing. The remaining portion of the rent is covered by the voucher. By design, housing should be affordable and accessible to all HCV users, provided the market supplies enough units satisfying HUD requirements to meet demand. Local public housing authorities (PHAs) must allocate at least 75% of their vouchers to extremely low-income tenants (households at or below 30% of AMI) with the remainder of vouchers eligible for very low-income tenants (households at or below 50% AMI). It is also important to note that PHAs can alter basic targeting requirements under special circumstances (e.g., based on family size, age, disability status) to reduce wait times for such applicants and place them in suitable housing. PHAs can also "project-base" up to 20% of their allotted Housing Choice vouchers, in which case the vouchers are assigned to a specific unit rather than a tenant. All other Housing Choice vouchers are unrestricted, and when tenants choose to redeem their voucher in a LIHTC unit, they are recorded as TBA vouchers. We are unable to identify what percent of all PBAs in LIHTC are project-based vouchers tied to a LIHTC unit. However, the number is likely quite small given that, of the 94,674 HCVs in Ohio, only about 3.5% are project-based (HUD, 2016).

The largest portion of the PBA population in LIHTC lives in projects that were originally constructed or rehabilitated under various HUD programs from the 1960s to the 1980s and have since been preserved with LIHTC investment. These include Section 8 Loan Management Set-Aside (LMSA), Rural Housing Services Section 515 (RHS 515), Section 8 New Construction/Substantial Rehabilitation (NC/SR), Section 8 Property Disposition (PD), and Public Housing. RHS 515 also uses LIHTC investment to produce new subsidized housing. Two additional programs, Project Rental Assistance Contract/202 and 811, also actively produce housing along with rental assistance, respectively, to very low-income elderly and persons-with-disabilities households—but these comprise less than 1% of PBA households in Ohio's LIHTC units.

Section 8 NC/SR consist of privately owned and operated units under housing assistance payment (HAP) contracts with HUD. Tenants can have incomes up to 80% AMI but



at least 40% must have incomes below 30%. The vast majority of tenants—over 75%—tend to be extremely low-income and nearly 60% are elderly or disabled (Schwartz, 2010). RHS Section 515 is a program managed by the U.S. Department of Agriculture to provide affordable multifamily rental housing in rural areas. It extends 1% interest mortgages to private developers so that rents will be generally affordable to low-income households. Additional rent subsidies are available to households at 50% AMI or below to ensure they pay no more than 30% of their adjusted income in rent; 75% of Section 515 projects receive these additional subsidies (Schwartz, 2010). Eligible tenants can have up to 80% AMI though nearly 95% are in fact very low-income with with annual income of tenants averaging \$11,000 (Rapoza, 2012). For existing projects originally placed in service during the early 1980s or before, both Section 8 NC/SR and RHS 515 property owners can seek LIHTC investment to fund needed renovations. A small number of Public Housing developments, usually in combination with the HOPE VI program, have received LIHTC funds for similar purposes. In addition to preserving existing RHS 515 units, developers producing new RHS 515 units often use LIHTC in order to provide much of the equity financing for the project.

Section 8 LMSA and Section 8 PD were originally created in the 1970s to shore up financially struggling or foreclosed projects originally placed in service under the mortgage subsidy programs of the 1960s, Section 221(d)3 and Section 236. Both Section 8 programs in addition to providing needed capital also provided additional project-based rental assistance, which the mortgage subsidy programs did not provide, to relieve rent-burdened households paying more than 30% of their income in rent. These projects have since received additional LIHTC investment in the 1990s and 2000s. Though it varies by case, most units from these legacy programs are still targeted according to the original eligibility rules and continue receiving the corresponding project-based assistance, requiring tenants to pay only 30% of their income in rent.

In summary, a distinguishing feature of tenant- versus project-based rental subsidies used in LIHTC is that TBAs offer rental assistance to the tenant, while PBAs tie rental assistance to a specific unit. So TBA incidence reflects the choice of HCV holders to use

their voucher in a LIHTC unit whereas tenants with a PBA lose their subsidy if they move out of the unit. Most HCVs used in LIHTC are TBAs, but a small portion of HCVs in LIHTC join the various programs described in this section to provide rental assistance attached to the LIHTC unit. Our data allows us to see both types of rental assistance used in LIHTC. The core of our analysis focuses on identifying the household-level, neighborhood, and market characteristics under which rental subsidy use in LIHTC is more likely. Comparing TBA users with the general HCV population and with the aid of a basic subsidy allocation model, we assess the extent to which the simultaneous use of rental and construction subsidies can be considered complementary.

### **3 Literature Review**

As described above, most LIHTC units will not be affordable to the neediest households. O'Regan and Horn (2013) argue that the HCV program has a significant role in allowing households with extremely low income to access LIHTC developments. The analysis finds that states with higher rates of HCV use in LIHTC also have higher rates of extremely low-income households served by LIHTC and LIHTC households without additional rental assistance experience higher levels of instability (i.e. occupancy turnover) than LIHTC households using a HCV. Williamson et al. (2009) analyze 2004 household level data from Florida to determine the extent of the HCV-LIHTC overlap in general. The study finds that a significant portion of HCV-LIHTC users (30%) are housed in LIHTC units located in Qualified Census Tracts (QCTs), usually low-income neighborhoods where developers receive 1.3 times the tax credit that would be allocated outside of QCTs. In a subsequent study, Williamson (2011) finds that LIHTC households also receiving HCV assistance are much less likely to be cost burdened than other LIHTC households.

The aforementioned studies characterize the HCV population in LIHTC relative to other LIHTC tenants. However, such analyses are unable to inform on whether the subsidy overlap responds to needs unmet by a tenant-based rental subsidy alone. The relevant counterfactual analysis for such test would imply comparing the housing conditions

of tenant-based HCV households within a locality, with and without the availability of project-based subsidized rental units. As Williamson et al. (2009) suggest, it is possible that the use of HCV holders in LIHTC units is a response to the scarcity of minimum standard quality rental units in the private rental market. It may also signal household preferences for newer, higher quality units than what are typically available to HCV users—all LIHTC units have been built or renovated since 1987 (Galvez, 2002). HCV users may also choose LIHTC units in search for better neighborhoods or the provision of special services within the living environment.

Two strands of literature in housing policy research thus inform the core of our study. The first relates to the private market supply of affordable housing units and its interaction with construction and rent subsidy programs given the potential issue that HCV use in LIHTC may respond to the under-supply of quality FMR units in the local market. The second body of literature pertains to work around the neighborhood quality accessible to subsidized housing tenants.

Sinai and Waldfoegel (2005) estimated a crowd-out effect such that adding an additional unit to the subsidized housing stock raises the total occupied housing stock in a Census place or Metropolitan Statistical Area (MSA) by between 0.35 and 0.52 units, or in other words that three additional subsidized units may only add as much one unit to the overall stock. The crowd-out effect is smaller in areas with a larger number of eligible subsidy recipients relative to the general population and also varies across HUD's tenant-based (smaller) and project-based (larger) programs. Eriksen and Rosenthal (2010) and Baum-Snow and Marion (2009) extend analysis to the LIHTC program—measuring the crowd-out effect in terms of new construction—with the former finding evidence for a crowd-out effect at small geographies (10-mile radius) of nearly 100% although with large standard errors. Baum-Snow and Marion (2009) differentiate between declining, stable, and gentrifying areas at the tract level, showing that the effect is smaller in declining and stable areas. One of the largest experiments conducted by HUD in 1973 provides additional valuable insight on private rental market responses to an expansion of tenant-based housing subsidies (Frieden, 1980). The Experimental Housing Allowance Program

(EHAP) consisted of three components: a demand-side experiment (how families would make use of their allowances), a supply-side experiment (local housing market responses to increased demand), and an administrative experiment (to test effectiveness of different administrative arrangements). Despite the fear that discriminatory practices would affect take-up rates, the experiment showed that minority and “hard to house” families were able to find housing of acceptable quality. Female-headed households and families on welfare assistance were the main participants, but participation by the elderly was low. Still, only about half of families eligible for allowances participated and the program had small effects on mobility and quality of housing. Importantly, there was virtually no increase in rents of nearby market-rate units following the open enrollment policy but this was partly due to the low take-up rate and also thanks to program incentives for landlords to repair substandard rentals.

While the use of HCV in LIHTC units might be a response to a shortage of minimum standard quality rental units in less affordable markets, desirability of better quality/newer units, or need for special services, it could also represent an opportunity for HCV households to access better neighborhoods in close proximity to their workplace or social networks. Neighborhood environment influences can have a profound impact on the lives of individuals. The program design of both TBV and LIHTC consider the importance of neighborhood quality. TBVs were originally designed to allow for movement out of public housing units by providing neighborhood choice to poor households. As for LIHTC, many states preference their credits to projects that are part of a broader community revitalization plan in an effort to improve neighborhoods or, conversely, award points to LIHTC projects proposing to locate in a low-poverty area.

Unfortunately, most studies of neighborhood quality access by housing subsidy users consistently reach disappointing conclusions. Deng (2007) studies HCV and LIHTC programs in six Metropolitan Statistical Areas (MSAs), San Jose, New York, Boston, Cleveland, Atlanta, and Miami. She finds that both HCV and LIHTC units were predominantly located in areas with low school quality. On the other hand, Newman and Schnare (1997) find slightly better prospects for HCV than LIHTC households. Compared to public hous-

ing, LIHTC units provide poor households access to better quality neighborhoods; but when compared to HCVs, LIHTC unit dwellers experience lower neighborhood quality.

Lens et al. (2011) investigate whether HCVs assist tenants in moving to neighborhoods with less crime. Their analysis makes use of two datasets, 2000 census tract level crime data for 91 cities and census tract data from 1998-2008 for Austin, Chicago, Cleveland, Denver, Indianapolis, Philadelphia, and Seattle. The authors find that voucher households occupied lower crime neighborhoods compared to tenants occupying LIHTC and public housing units. Residents living in LIHTC and public housing units experienced crime rates comparable to poor renters in general. Richter et al. (2013) consider neighborhood quality of HCV and LIHTC households in 2000 and the 2006-2009 period for Cuyahoga, Franklin, and Hamilton counties in Ohio, as well as Allegheny County in Pennsylvania (quality is a function of poverty, education, and employment indicators). They find that Allegheny County neighborhoods with LIHTC projects placed in service by 2000 improved in quality relative to other poor neighborhoods without LIHTC projects. And the level of quality experienced by LIHTC users in 2006-2009 was comparable to that of HCV users. However, these results did not hold for any of the Ohio counties studied.

## **4 An Allocation Model of Housing Subsidies**

We present a simple model of housing subsidy allocation that comports to the complementarity assumption of housing programs. Assume there is a fixed population of low-income households  $H$  and that subsidies to rent and construction are available. The rent-subsidy program subsidizes the rent of units with a subsidy inversely related to the income of the renter. The construction program subsidizes the construction or rehabilitation of planned units designed under specific guidelines with the condition that rent be restricted to a certain level in order to be affordable to a targeted low-income population. The housing subsidy cost is denoted by  $C_r$  for rent subsidy and  $C_p$  for a planned subsidized unit, and we assume that  $C_r < C_p$ .

Let households in  $H$  be characterized by two binary variables. Variable  $y$  classifies the population into poor ( $y = 0$ ) and very poor ( $y = 1$ ) such that poor—yet not very poor—households can marginally afford to rent in the open market and planned subsidized units with around 30% of their income<sup>4</sup>. Variable  $z$  captures non-income factors that classify them as “hard to house,”<sup>5</sup>, considerably reducing the value of a market unit relative to a planned subsidized unit. These factors may include the household’s own characteristics but also those of the housing market she faces. In this stylized model, the threshold that defines  $z$  is such that it takes the value of 1 if the household requires a planned unit to be housed, either because it provides an additional unit to a tight market or because of the additional housing services or increased neighborhood quality it offers.

Thus, households are classified into four types  $T(y,z)$  as follows:  $T_1 = T(0,0)$ ,  $T_2 = T(1,0)$ ,  $T_3 = T(0,1)$ ,  $T_4 = T(1,1)$ , with the last category encompassing the hard to house, very poor households. Given this classification and denoting the number of households in each type by  $n_j$ , we can specify  $H = \{(i,j) \mid i = 1, \dots, n_j, \text{ and } j = 1, \dots, 4\}$ , where  $(i,j)$  represents the  $i^{\text{th}}$  household of the  $j^{\text{th}}$  type. We define subsidy binary variables as

$$r = \mathbb{1}\{\text{rent subsidy assigned}\},$$

$$p = \mathbb{1}\{\text{planned subsidized unit assigned}\},$$

so  $(r(i,j), p(i,j))$  denotes a subsidy assignment to household  $(i,j)$  by the social planner, according to some optimization criteria. Subsidy assignments take values  $(1,1)$ ,  $(1,0)$ ,  $(0,1)$ , or  $(0,0)$  if both subsidies, rent only, planned unit only, or no subsidies are accessible to  $(i,j)$ , respectively.

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<sup>4</sup>Say a poor household has income at 60% AMI and a very poor household has income at 50% AMI. For a family of four, respectively, this would equate to approximately \$991 and \$782 per month in the Cleveland MSA. The 40th percentile or fair market rent for a 2 bedroom unit in the Cleveland MSA is \$727 per month.

<sup>5</sup>Cunningham et al. (2005) refer to the “hard to house” as high-need households, such as grandparents caring for grandchildren, persons with disabilities, very large households, and families coping with an array of difficult problems and barriers to housing access. Here, we extend this concept to include market characteristics that, interacted with household conditions, narrow choices in the low-income rental market.

The housing outcome function  $h(r(i, j), p(i, j))$  defined in Table 2 takes the value of 1 if household  $(i, j)$  can be housed given the subsidy allocation  $(r(i, j), p(i, j))$  and 0 otherwise.

Table 2: Tabulation of the housing outcome function  $h(r(i, j), p(i, j))$

Type ( $j$ )	$y$	$z$	$r$	$p$	$h(r(\cdot, j), p(\cdot, j))$
1	0	0	1	1	1
			1	0	1
			0	1	1
			0	0	1
2	1	0	1	1	1
			1	0	1
			0	1	0
			0	0	0
3	0	1	1	1	1
			1	0	0
			0	1	1
			0	0	0
4	1	1	1	1	1
			1	0	0
			0	1	0
			0	0	0

Given Table 2, we can express the housing outcome function for household  $(i, j)$  with the help of the logical *and* operator,  $\wedge$ , as:

$$h(r(i, j), p(i, j)) = \begin{cases} 1, & \text{if } j = 1 \\ r(i, j), & \text{if } j = 2 \\ p(i, j), & \text{if } j = 3 \\ r(i, j) \wedge p(i, j), & \text{if } j = 4 \end{cases} \quad (1)$$

So type  $T_1$  households can be housed without a subsidy and type  $T_2$  households can be housed if assigned a rent subsidy but not a planned unit since they could not afford it. Type  $T_3$  households are hard to house in the local rental market but can afford and be housed with a planned unit. Finally, type  $T_4$  households are hard to house and very poor so they can only be housed in a planned unit and with an added rental subsidy. We

assign weights  $w_j$  reflecting the social planner's value of housing type  $T_j$  relative to other household types.

The total budget allocation to housing programs is  $B$  and we assume that  $B$  is not large enough to entirely house any of the three types in need of a subsidy.

$$B \leq \min\{n_2 C_r, n_3 C_p, n_4 (C_r + C_p)\} \quad (2)$$

We now proceed to consider alternative optimization goals. Suppose the objective is to allocate subsidies  $(r(i, j), p(i, j))$  among households in  $H - T_1$  in order to house the largest number of households with no particular preference among household types. Then,  $w_j = 1/3$  for all  $j = 2, 3, 4$ , and we have:

$$\begin{aligned} & \underset{q_r, q_p}{\text{maximize}} && \sum_{j=2}^4 \sum_{i=1}^{n_j} w_j h(r(i, j), p(i, j)) \\ & \text{subject to} && q_r C_r + q_p C_p \leq B \\ & && q_r = \sum_{j=2}^4 \sum_{i=1}^{n_j} r(i, j) \\ & && q_p = \sum_{j=2}^4 \sum_{i=1}^{n_j} p(i, j) \end{aligned} \quad (3)$$

Given that  $C_r < C_p$  and the restriction imposed in 2, the problem stated in 3 is solved when all resources are devoted to house  $\lfloor B/C_v \rfloor$  households of type  $T_2$  with rent subsidies, the least costly alternative, as illustrated in Figure 1, point A<sup>6</sup>. With this setup, it is best to invest all resources in the type for which the lower cost subsidy delivers the needed housing. This implies taking all resources away from the hard to house groups, which is clearly an undesirable outcome.

If on the other hand, the goal is to house the most disadvantaged (those with both, economic and non-economic barriers to housing), then  $w_4 = 1$  and  $w_j = 0$  for all  $j \neq 4$ .

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<sup>6</sup>The floor function  $\lfloor x \rfloor$  gives the largest integer that is smaller than  $x$ .



In this case,  $\lfloor B/(C_r + C_p) \rfloor$  households in  $T_4$  will be housed (see point D in Figure 1). Alternatively, the objective could require benefiting households from all types. In the figure,  $F$  is just one solution satisfying this condition. Under  $F$ , subsidies are provided for  $q_2$  households of type  $T_2$ ,  $q_3$  households of type  $T_3$ , and  $q_4$  households of type  $T_4$ .

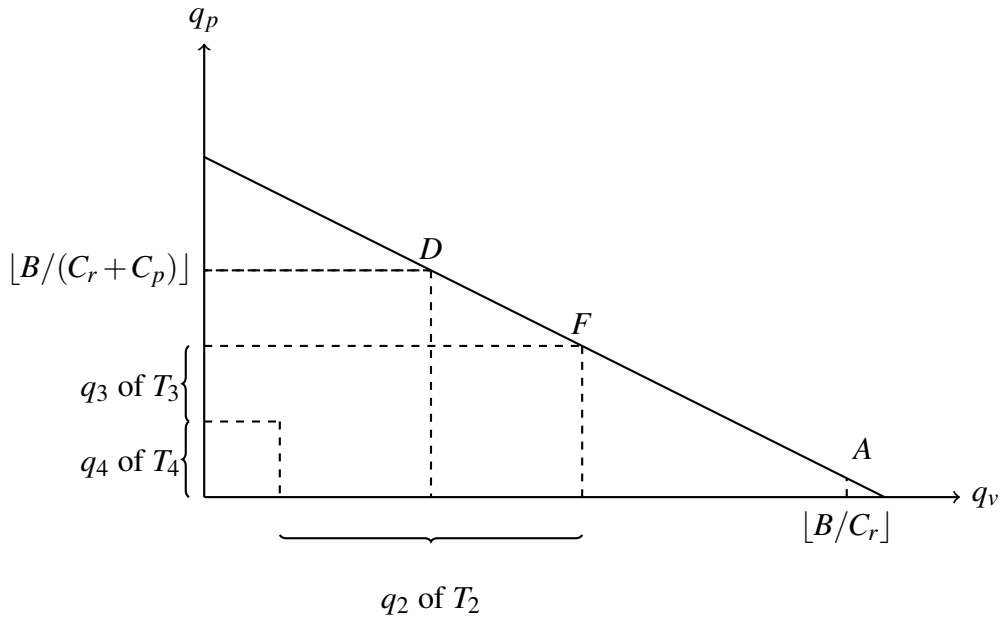


Figure 1: Housing subsidy allocations resulting from various optimization setups

Now, let's step away from the idealized scenario in which the social planner can identify types and assign subsidies accordingly. Much like in actuality, both subsidies are available, with income restrictions applying for rent subsidy qualification and rent restrictions for construction of planned subsidized units. Thus, type  $T_2$  households may be allowed to use their rent subsidies in a planned subsidized unit and likewise, type  $T_1$  households may choose to rent in a planned subsidized unit. According to the above objective, both these scenarios would constitute an inefficient allocation of resources. In reality, however, it is difficult to devise a strict classification of households into types. What we consider type  $T_1$  households may be on the margin of becoming type  $T_2$  households if their income fluctuates and barely surpasses the affordability threshold.  $T_1$  and  $T_2$  households may also

be close to falling into the  $T_3$  and  $T_4$  groups, respectively, if the supply of affordable market units decreases in quantity or quality. While idealized, the model provides a general framework to analyze the data in section 5 with respect to tenant characteristics and rental subsidy use in LIHTC units.

## 5 Empirical Analysis

We proceed to describe the data used to compare PBA, TBA, LIHTC-only, and all HCV users by the characteristics of individuals they house. HCV data is from PUMS, for the year 2012, while PBA and TBA data is from OHFA for the year 2011.<sup>7</sup> Household-level LIHTC data is available to us from OHFA. However, due to non-reporting issues, of the 87,933 LIHTC units in service in Ohio as of 2011 according to HUD's National LIHTC Database, 62,292 LIHTC units (71%) placed in service between 1990 and 2011 are available to us. We believe this 71% sample is well suited to characterize the HCV population in LIHTC, analyze program complementarity, and neighborhood location.

We then characterize tenants of construction subsidized LIHTC units by type of rental subsidy: tenants receiving project-based rental assistance (PBA), those with tenant-based assistance (TBA), or no additional assistance (LIHTC-only). Insofar as housing administrators allocate the larger subsidies to the hardest to house, poorer households, we would expect to see a concentration of type  $T_4$  households in PBA units and type  $T_3$  households in LIHTC-only units. On the other hand, the extent to which type  $T_2$  households use PBA or TBA units, and type  $T_1$  households are found in LIHTC-only units may suggest an inefficient allocation of resources. In less affordable housing markets, assuming that landlords in the open market have less incentives to rent to HCV holders, we would expect to see larger shares of households choosing to redeem their vouchers in LIHTC units. Some of these households may classify as  $T_4$ 's even when in weaker markets they could fall into the  $T_2$  group.

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<sup>7</sup>The PUMS for subsidized households is not available in 2011

Table 3: Characteristics of LIHTC and HCV households in Ohio, 2011-2012.

	Household Head/Unit Characteristics				Neighborhood/Market Characteristics		
	Elderly (%)	Disabled (%)	Minority (%)	Household size	Neighborhood quality	Neighborhood poverty rate	In less affordable market (%)
<b>Share or average of characteristic within</b>							
PBA	21.80	16.40	55.64	1.92	22.67	32.85	42.51
TBA	18.80	8.30	62.67	2.38	27.78	26.26	45.42
LIHTC-only	27.70	4.40	45.27	2.09	29.17	25.95	39.64
<b>All LIHTC</b>	23.80	9.90	52.46	2.07	26.56	28.54	41.58
<b>All HCV</b>	13.40	31.10	63.01	2.32	27.26	24.34	35.50

Source: LIHTC data is from the Ohio Housing Finance Agency and represents about 71% of the total LIHTC households in Ohio in 2011. 2012 HCV data is from the Public Use Microdata Sample. Income and rent data are from the American Community Survey 2009-2013. Neighborhood quality measured as quantiles of first principal component of census tract level variables from Census 2010. We include %poor, %employed, %in labor force, %high school, %bachelors. We identify counties as "less affordable markets" if they are at or above the 80th percentile of an index measuring the share of low-income renter households who pay more than 30% of their income in rent.

## 5.1 Characterization of the HCV and LIHTC Populations in Ohio

Among all LIHTC households in our data, 15% are TBA users and 37% are PBA users. Our comparisons are limited to those characteristics collected in both LIHTC and HCV data sets. Table 3 shows a higher incidence of elderly (62 and older) among LIHTC users as compared to the entire HCV population. However, non-elderly head of households with a disability are clearly more represented in the HCV program than in any of the LIHTC categories.

The income distribution of subsidized households across programs shows that TBA users are very similar to the overall population of HCV users with a median income of about \$10,000 (Figure 2). On the other hand, PBA users tend to be poorer, with a median income under \$8,000 and about 10% of its population receiving no income at all. Other characteristics of the PBA population suggest this group may lack family support. Over fifty percent of PBA users have a household size of 1, compared to a larger household size, on average, for all HCV users. Accordingly, PBA users also tend to live in much smaller

units—nearly fifty percent are one or zero bedroom apartments. As expected, LIHTC dwellers with no additional housing subsidies are less needy. In Ohio, the median income for this group was about \$20,000 in 2011.

We also look at the distribution of households by race under each subsidy combination (Table 3). Issues such as discrimination in the private rental market could lead to a higher share of African-American households using their HCVs in LIHTC units when compared to the HCV holder population as a whole, but we see that the minority head of households in the HCV population and the population of TBA holders is comparable, at about 63%.

Previous work comparing neighborhood quality under place- and tenant-based programs has not identified neighborhood quality for the group of households subsidized under both programs. There is no way of uncovering the complex decision making process by which individuals decide where to locate with a voucher. However, we can see whether those selecting into a LIHTC unit using a voucher experience better neighborhood quality as compared to the entire population of HCV users. Table 3 shows that in Ohio, 2011, HCV users experienced an average level of neighborhood quality just slightly above the bottom quartile with no advantage for TBA users in LIHTC.

Neighborhood quality is measured at the census tract level and it is relative to all tracts in the United States in 2010. We use quantiles of the first principal component estimated from the following variables: percent poverty, percent in the labor force, percent with a high school diploma, percent with a bachelor's degree, and percent employed.<sup>8</sup> Thus, the highest quality neighborhood in the US would have an index of 100 and the median quality neighborhood according to our measure would have an index of 50. For each subsidy group the average neighborhood quality to which users are exposed is a weighted average of tract neighborhood quality, where the weights are given by the share of users residing in the tract. Counts of HCV holders within each tract are from the Picture of Subsidized Households, 2011 and counts for TBA and PBA holders are from 2011 LIHTC

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<sup>8</sup>The first component explains 67% of the variation in the 2010 data.

data provided by OHFA. Similarly, average poverty rates experienced by HCV and TBA users at the county level are presented in Figure 4.

We present a more localized comparison of neighborhood quality. Figure 3 shows the average neighborhood quality for subsidy users in select Ohio counties by subsidy type<sup>9</sup>. By focusing on the bottom left quadrant of Figure 3, we see that on average, HCV holders in Ohio counties live in neighborhoods of below median quality; and for those voucher holders living in a LIHTC unit, neighborhood quality tends to remain below the median. There are, however, a few counties in which both HCV and TBA households experience above the median neighborhood quality (upper-right quadrant). To complement the rank-based analysis of neighborhood quality we provide graphs using actual neighborhood poverty rate averages experienced by the subsidized populations within counties. Here, we divide the plots into four quadrants to mark average poverty rates below and above 0.2 or 20%. It is worth noting that the average neighborhood poverty rate for the HCV population is above 10% for all counties studied and TBA households do not appear to benefit from living in less poor neighborhoods relative to the overall HCV population (Figure 4). There are only a few Ohio counties—Clermont (Cincinnati MSA) and Delaware (Columbus MSA)—where TBA users, on average, reside in better neighborhoods than the HCV population as a whole, and at the same time, experience above median neighborhood quality.

Finally, we compare market characteristics according to a measure of affordability in the rental housing market. Affordability is calculated as a rank index of counties according to the share of low-income renter households who pay more than 30% of their income in rent<sup>10</sup>. We identify counties as "less affordable markets" if they are at or above the 80th percentile of the index. While 35.5% of HCVs in Ohio are used in less affordable

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<sup>9</sup>Counties included in our study had a population greater than 50,000 and greater than 50 PBA & 50 TBA holders. The first conditions allows us to primarily capture urban areas, per US Census Bureau definition, while the second condition ensures that low voucher populations aren't given undue weight.

<sup>10</sup>Income and rent data are from the American Community Survey 2009-2013. This index of market strength or unaffordability is similar to a reverse-ranking based on a regional affordability measure (Richter et al., 2013) and is also used in our model estimation of Section 5.2.

markets, close to half (45%) of all Ohio TBAs are used in these markets, reflecting a higher incidence of TBA use under such market conditions (Table 3).

## 5.2 Characterizing voucher use within LIHTC

While we are limited in our comparison of HCV users in and out of LIHTC units, the data does allow for a richer comparison of HCV users within LIHTC. Based on the stylized model described in Section 4, we would expect to see a concentration of type  $T_4$  households in PBA units and TBA units. Given the higher degree of coordination involved in allocating PBAs, we expect to see a higher proportion of type  $T_4$ 's among PBAs than among TBAs. Since only about a quarter of all income-eligible households receive rental housing assistance, we expect there may be highly rent-burdened type  $T_4$  households in LIHTC-only units. According to our model, type  $T_3$  households would also occupy LIHTC-only units, and the low-income rental market would accommodate the needs of type  $T_1$  households without a subsidy and those of type  $T_2$  households through tenant-based vouchers. However, type  $T_2$  households may decide to use their vouchers in LIHTC units or apply for a PBA subsidy, and type  $T_1$  households may also freely rent in a LIHTC-only unit. These patterns would signal an inefficient allocation of resources, particularly if housing markets are soft and there are no gains in neighborhood quality from living in a LIHTC versus a market unit.

We first approximate the model classification of household types with tenant characteristics and then proceed to account for market and neighborhood characteristics that may influence LIHTC use. Tenant data includes income, age, household size, number of children, and indicators for disability and having previously been homeless. Tenants are classified by income into 'poor' and 'very poor' if their incomes, adjusted for household size, are above and below 50% AMI in their county of residence, respectively. They are classified as 'hard to house' if they meet any of the following criteria: are 62 year of age and older; are disabled; were previously homeless; are in the top tercile relative to the number of children in the household.

Table 4: Households by Type and Subsidy use in LIHTC, Ohio 2011.

	Typology				Total
	1	2	3	4	
PBA	0.49	35.12	1.34	63.05	100
TBA	1.33	34.38	2.90	61.38	100
LIHTC-only	10.51	23.41	26.71	39.37	100
<b>Total</b>	5.24	29.61	13.28	51.87	100
PBA	3.56	45.17	3.84	46.28	38.08
TBA	4.04	18.40	3.46	18.75	15.85
LIHTC-only	92.4	36.43	92.7	34.97	46.07
<b>Total</b>	100	100	100	100	100
Elderly (%)	0	0	41.25	58.75	100
Disabled (%)	0	0	5.46	94.54	100
Homeless at application (%)	0	0	1.89	98.11	100
Average household size	1.86	1.75	2.31	2.24	2.07
Annual median income	\$28,805	\$9,620	\$28,773	\$11,514	\$12,480

Source: Data is from the Ohio Housing Finance Agency and represents about 71% of the total LIHTC households in Ohio in 2011.

Table 4 provides a cross tabulation of households by type and subsidy use in LIHTC. According to the model, we expect that most households would classify into Type 3 and Type 4 with a smaller share classifying into Type 2 households if the market or neighborhood characteristics reduce the value of market rentals relative to LIHTC units. We see that Type 4 households constitute the largest share of the population at 52%, although only 65% of this group receives rental assistance. Type 3 households, those that are hard to house but are not very poor, make up 13% of the population and most of this group (93%) is not housed with a voucher or additional rental assistance, as expected. Type 1's constitute 5% of the population and most of these households (92%) are not PBA or TBA users. Technically, Type 1 and Type 3 households should not receive vouchers according to program rules, as their household income is greater than 50% of AMI. The fact that some show up as voucher users in the data could be due to a change in income status since receiving the voucher. Type 2's constitute the other 30% of the population, with about 64% of them receiving rental assistance through a TBA or PBA. Guided by the model, any inefficiencies in the allocation of subsidies would be mainly concentrated in this group since these households should be able to find housing in the local rental market without the need of additional project-subsidized units. At the same time, it is possible that some

households classified as Type 2 face unobserved circumstances that would actually define them as hard to house in their local rental market, or given the quality of their surrounding neighborhoods.

In order to account for neighborhood or rental market characteristics, we specify a multinomial logit model for the probability that LIHTC households belong to one of the three categories of users in question: PBA holders, TBA holders and other LIHTC users.

$$P(y_i = j) = \frac{\exp(x'_{ij}\beta_j)}{1 + \exp(x'_{i2}\beta_2) + \exp(x'_{i3}\beta_3)}, \quad j = 1, 2, 3 \quad (4)$$

The multinomial logit is derived from the underlying assumption that to each LIHTC household corresponds a random variable taking one of three possible user-category values, and these random variables are independent from each other. That is, each individual  $i$  has probabilities  $P(y_i = 1)$ ,  $P(y_i = 2)$ ,  $P(y_i = 3)$  of belonging to one of the three user categories: PBA, TBA, LIHTC-only, respectively. The three categories are mutually exclusive and exhaustive. The log odds ratio for category  $j$  relative to the baseline category (LIHTC-only) is set to be a linear function of households characteristics ( $x_{ij}$  vector), and this relation leads to equation 4.<sup>11</sup>

We provide two specifications. Model 1 estimates user category probabilities given the following household characteristics: age, race, gender of household head, household with at least one child, homelessness status, disability status, and an income from employment dummy. Finally, we include our two contextual variables for affordability in the rental market and neighborhood quality: (1) a dummy for living in a county with a less affordable rental market. Recall that these are counties above the 80th percentile of an index measuring the share of low-income renter households that pay more than 30% of their income in rent. (2) we also include a dummy equal to one if the neighborhood quality (poverty) for the LIHTC unit is above (below) the average neighborhood quality experienced by HCV users in that county. Results are presented in the form of marginal effects.

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<sup>11</sup>Note that the purpose of this model is to describe user categorization based on household covariates. We are not estimating a conditional logit model of consumer choice.



Table 5: Marginal Effects on Probability of Using a Voucher in LIHTC

<b>Model 1</b>	with nbhd quality	with nbhd poverty	<b>Model 2</b>	with nbhd quality	with nbhd poverty
Elderly	-0.051*** (0.005)	-0.056*** (0.005)	Very poor	0.150*** (0.003)	0.151*** (0.003)
Female household head	0.065*** (0.004)	0.064*** (0.004)	Hard-to-house	0.002 (0.003)	0.003 (0.003)
Household with children	0.080*** (0.005)	0.082*** (0.005)	Less affordable market	0.024*** (0.003)	0.019*** (0.003)
Head or spouse w/ disability	-0.022*** (0.006)	-0.019*** (0.006)	Neighborhood quality	0.008** (0.003)	--- ---
Homeless at application	-0.003 (0.010)	0.014 (0.010)	Neighborhood poverty	--- ---	0.055*** (0.003)
No income from employment	0.066*** (0.004)	0.071*** (0.004)			
Less affordable market	0.025*** (0.004)	0.019*** (0.004)			
Neighborhood quality	0.026*** (0.004)	--- ---			
Neighborhood poverty	--- ---	0.079*** (0.004)			

Source: Estimates based on data from the Ohio Housing Finance Agency representing about 71% of the total LIHTC households in Ohio in 2011. Standard errors in parentheses.

For each covariate and category combination, the marginal effect estimates the change in probability of belonging to the specific category due to a unit change in the covariate.

The second model estimates user category probabilities given previously derived indicator variables for ‘very poor’ and ‘hard-to-house’ that define household types, as well as the indicator for less affordable rental market. Note that, unlike with linear models, marginal effects in nonlinear models are non-constant even in the absence of interaction terms(Karaca-Mandic et al., 2012).

Table 5 presents the average marginal effects (AME) estimates derived from the multinomial logit of equation 1 under models 1 and 2, using either an index of neighborhood quality or neighborhood poverty rate. The AME is the average change in probability of being a TBA user—given LIHTC residence—due to a one unit increase in the explanatory variable. All models point to TBA use as a response to very low income conditions but not to household characteristics that make tenants hard-to-house.

It is also observed that the probability of being a TBA user in LIHTC increases by about two and one-half percent if tenants are located in less affordable housing markets<sup>12</sup>. Similarly, we see that there is a higher chance of being a TBA tenant in LIHTC when the neighborhood quality (poverty) experienced in the LIHTC project is higher (lower) relative to what is accessible to the average HCV household. Altogether, the data suggests a pattern of allocation somewhat consistent with the stylized model presented in Section 4, in which hard-to-house, very low-income households conform a large part of double subsidy users. However, the analysis also suggests a less than efficient allocation of the dual subsidy applied to low-income tenants that could possibly be housed through a rental subsidy in the local market.

## 6 Conclusions

In Ohio, during 2011, approximately 37% of LIHTC households received project-based rental assistance and another 15% of LIHTC dwellers made use of their tenant-based rental voucher to live in a tax-credit unit. Clearly, the overlap in subsidy program use is not at all insignificant while at the same time, only 25% of eligible households are granted a housing subsidy. Thus, the issue of what does or does not constitute an efficient allocation of housing subsidies is quite relevant. As an initial step in framing this issue, we develop a basic model of optimal subsidy allocation and compare its features with actual rental subsidy use in LIHTC.

Evidence from Ohio suggests that HCV and LIHTC programs exhibit some degree of complementarity, particularly, when serving very poor households with special housing needs or to some extent, attracting very low income voucher holders who face a less affordable market or a potential gain in neighborhood quality. Simultaneously, our analysis finds about 30% of households in LIHTC units that could seemingly be housed in the private rental market, signaling some degree of inefficient allocation of subsidies.

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<sup>12</sup>This estimate corresponds to an increase in the likelihood of a LIHTC user being a TBA voucher holder when the market is less affordable. Also, note that this result is only indicative of housing market conditions in Ohio in 2011.

Though coordination between planned construction and rental housing programs is limited at the state and federal levels, more intentional planning among housing administrators at the local level leads in some cases to rental subsidy use in LIHTC for the most vulnerable households. This is important in that the deep subsidy of the HCV provides access to LIHTC units that otherwise might not be affordable and which could convey certain benefits—e.g. supportive services, newer housing that incorporates universal design principles, etc.—compared to the rest of the low-income rental housing stock. We also find that the population of TBA users, who freely choose to live in LIHTC units, represents a larger share of all LIHTC users in less affordable rental markets, which we interpret as a response to limited supply of private market rental units that meet FMR standards relative to demand.

While our analysis of HCV users in LIHTC points to benefits of the overlap for certain populations under certain market conditions, there is very little evidence to support that TBA usage enables access to significantly better quality neighborhoods relative to other HCV users. We do find evidence of higher TBA use in LIHTC when a LIHTC unit represents gains in neighborhood quality (or a reduction in neighborhood poverty) relative to that which is experienced by the median HCV user in the region. However, in the Ohio counties studied, the average HCV user and the average voucher holder living in LIHTC units, occupy neighborhoods which are below the 50% median neighborhood quality index, with poverty rates of above 20%. In fact, TBA users actually live in higher poverty neighborhoods in the most urban counties when compared to the HCV population as a whole.

The use of coordinated subsidies for planned units and rents can be perceived as beneficial insofar as the lowest income and hardest to house population are provided access to quality rental units that would otherwise not be available. However, it is important for housing administrators and policy makers to identify and address potential inefficiencies in program use in order to extend coverage to qualifying families that currently receive no subsidies and improve the living conditions and opportunities for a larger number of low-income households.

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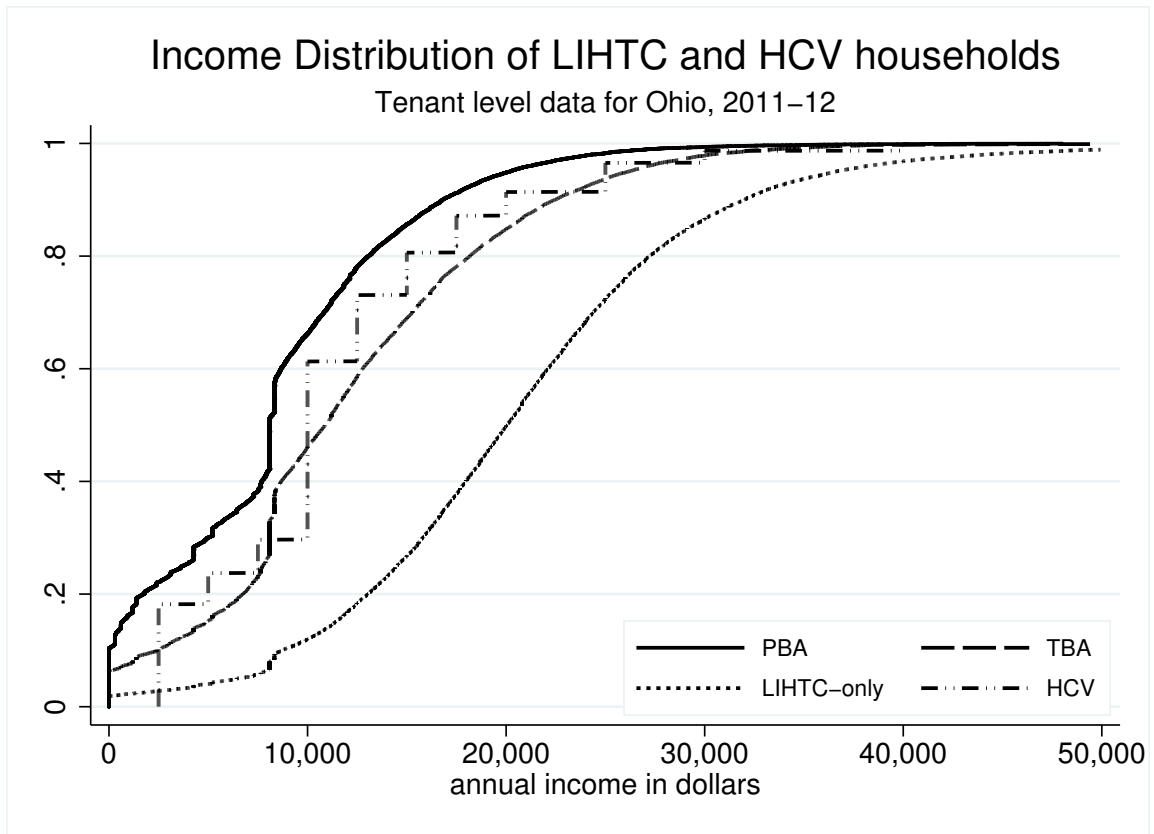


Figure 2: Income Distribution of Rent-subsidized Households. LIHTC data is from the Ohio Housing Finance Agency and represents about 71% of the total LIHTC households in Ohio in 2011. 2012 interval income data of HCV users is from the Public Use Microdata Sample.

Average Neighborhood Quality for HCV and TBA households  
County averages – Ohio, 2011

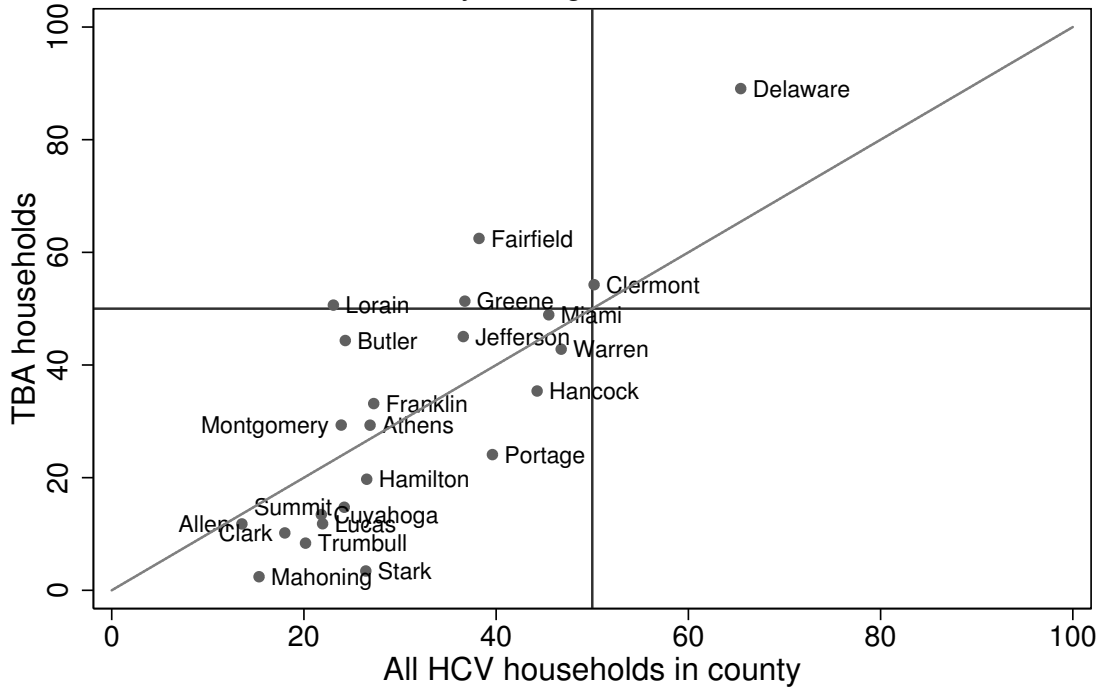


Figure 3: Average Neighborhood Quality for HCV (x-axis) and TBA households (y-axis). Neighborhood quality measured as quantiles of first principal component of census tract level variables from Census 2010. We include %poor, %employed, %in labor force, %high school, %bachelors. LIHTC data is from the Ohio Housing Finance Agency and represents about 71% of the total LIHTC households in Ohio in 2011. 2011 HCV data is from Picture of Subsidized Households.



Average Neighborhood Poverty Rate for HCV and TBA households  
County averages – Ohio, 2011

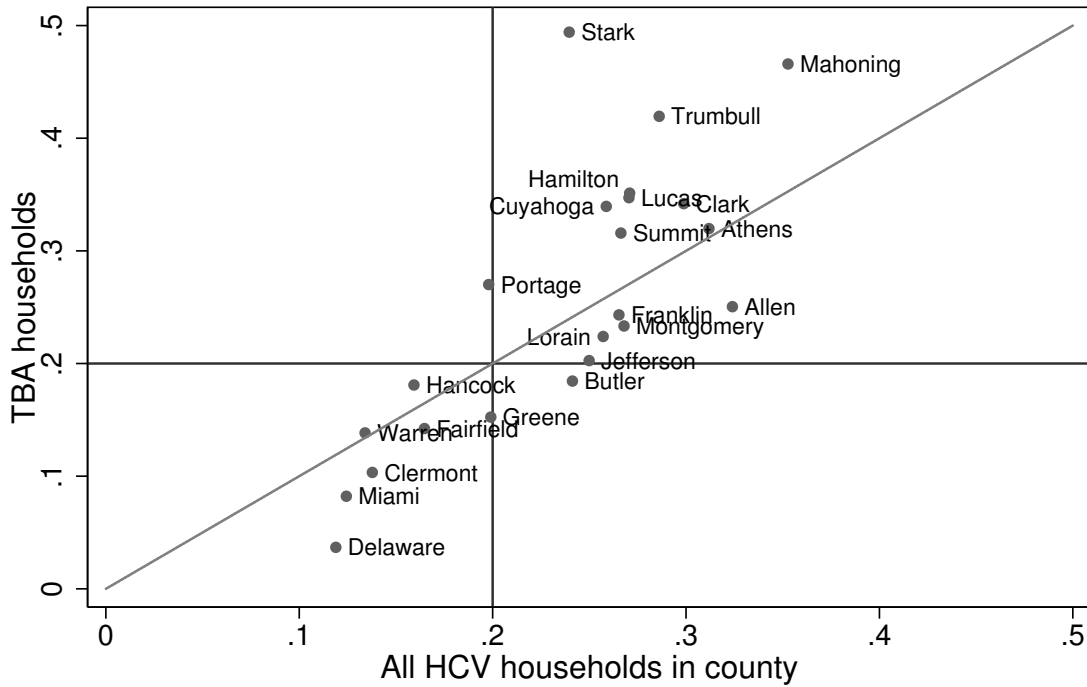


Figure 4: Average Neighborhood Poverty Rate for HCV and TBA households. Census tract neighborhood poverty rates are from the Census 2010. LIHTC data is from the Ohio Housing Finance Agency and represents about 71% of the total LIHTC households in Ohio in 2011.