Cost Inefficiency in The Low-Income Housing Tax Credit: Evidence from Building Size

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Abstract

The Low-Income Housing Tax Credit subsidizes the non-land construction costs of low-income housing units. Because land costs are not subsidized, it may incentivize developers to produce buildings with too much capital from the viewpoint of efficient production. Using data on construction in Los Angeles County between 1993 and 2007, this paper estimates how the Low-Income Housing Tax Credit subsidy affects the size of newly constructed apartment buildings. Holding land area constant, I compare building square footage in subsidized and unsubsidized buildings built in the same year and zip code. Subsidized buildings are 33 percent larger than unsubsidized buildings on average, although the difference is only found in the bottom half of the market rent distribution. The size difference is the result of buildings with more housing units and additional space within those units. This result provides additional evidence that housing subsidies that build low-income housing may be less cost-effective than providing subsidies directly to low-income tenants.

Keywords: housing; subsidies; efficiency

JEL Classification: R, H2

1 Introduction

Through the Low-Income Housing Tax Credit (LIHTC), private housing developers are subsidized with tax credits in exchange for the construction of low-income housing. Currently, LIHTC is the second largest housing subsidy in the United States and the largest of the project-based programs that fund the construction of new apartments. The largest program is the tenant-based Section 8 Housing Voucher, which gives families a voucher to supplement rent payments in the housing unit of their choice. The LIHTC program is the fastest growing subsidy in the United States and is quickly approaching the voucher program as the highest funded housing subsidy in the country (Desai 2009).

The growth in LIHTC is surprising, given the substantial evidence that tenant-based subsidies provide the same quality of housing services at a lower cost (HUD 1974, Mayo et al. 1980, Olsen and Barton 1981, Olsen 2000, GAO 2001, GAO 2002, Dipasquale et al. 2003, Deng 2005, Olsen 2008). One reason that LIHTC may be less cost-effective than vouchers is that it only subsidizes the non-land costs of construction. From the viewpoint of efficient production, this subsidy imbalance incentivizes developers to construct buildings with too much capital relative to other inputs (Olsen 2000, Olsen 2009, Eriksen 2009). This paper estimates the degree to which this distortion affects the construction of housing using data in Los Angeles County between 1993 and 2007.

Controlling for land area, I find the average LIHTC apartment building has 33 percent more square footage than unsubsidized buildings that are constructed in the same year and zip code. Further analysis shows that the size difference is isolated to census tracts that fall in the bottom half of the 1990 market rent distribution. This pattern suggests that the subsidy encourages capital-intensive construction, but developers reduce building size in response to more restrictive rent ceilings in locations with high market rent.

While previous results find that LIHTC is more expensive per square foot to build than unsubsidized construction (Eriksen 2009), it has been difficult to confirm if the cost difference is the result of higher quality or less efficient construction methods. In this paper, I examine the quality of housing units in terms of square footage, finding that about half of the increase in building size is due to larger housing units. The other half is the result of developers constructing additional units within the building. Like the effect on building square footage, the effects on unit size are only found in the bottom half of the rent distribution.

These results provide new evidence in the debate between the relative merits of project and tenant-based housing subsidies. Estimates indicate that some portion of the higher total and average costs found in previous research for LIHTC are the result of the subsidy incentivizing developers to create larger, more capital-intensive buildings. While there is some evidence that LIHTC developers provide larger housing units than the private market in low-rent locations, it is unclear if it justifies the additional costs of construction. In either case, this paper indicates that LIHTC creates a market distortion in construction decisions, which supports the notion that the US may be able to provide low-income housing more efficiently by reallocating funding from project-based subsidies to housing vouchers.

2 The Low-Income Housing Tax Credit

The government has been funding the construction of low-income housing since it created the Public Housing Program in 1937. Since that time, many housing subsidies have been instituted in a variety of formats. The first tenant-based housing program was created in 1965 and in the years that followed, economists provided ample evidence that tenant-based housing assistance was more cost-effective than subsidies that funded the construction of housing. In response to these studies, the government reduced the number of new apartment units built with government funding. That money was reallocated to maintaining existing units and expanding the housing voucher program. This pattern continued until the Tax Reform Act of 1986, when the Low-Income Housing Tax Credit was instituted into the U.S. tax code.[1] From 1986 to 2006, LIHTC units accounted for approximately one-third of new multi-family rental construction with nearly 1.6 million new housing units (Eriksen 2009, Eriksen and Rosenthal 2010).

The LIHTC program is federally funded, but private developers apply for the subsidy through state housing finance agencies each year.[2] These agencies create a systematic process to determine which proposals receive the award (Gustafson and Walker 2002). If a proposal is selected for funding, the developer is awarded a ten-year stream of tax credits to reduce tax liability. New construction proposals with limited financial support from other sources receive credits equal to approximately nine percent of the non-land construction costs for each of the ten years.[3]

In exchange for the subsidy, the developer must build and manage an apartment complex that will rent for no more than a program-designated rent ceiling for at least 30 years.[4] Because the tax

[1]For a more comprehensive history of subsidized housing programs in the United States, see Olsen (2003).

[2]Some states, including California, also supplement the subsidy with state tax credits.

[3]Projects with less than $3,000 of development cost per unit or projects that receive certain federal subsidies are awarded approximately four percent of the construction costs each year. The IRS publishes the actual rate of subsidy each month. A more detailed explanation of the credit calculation is found in Schwartz (2006).

[4]The federal requirement has been increased since the inception of the program and states can require longer compliance periods. In California, the compliance period was increased to 55 years in 1996 (CTCAC Compliance Manual 2013).

credits are nonrefundable and most developers do not have sufficient tax burden to utilize them, the future credit stream is usually sold to investors to raise the necessary capital for construction. This process is called syndication and there is a substantial literature dedicated to assessing its efficiency (Eriksen 2009, Case 1991, Stegman 1991).

In California, demand for tax credits has outweighed the supply by a factor of three to one since the year 2000 (CTCAC Annual Report 2012). To determine which proposals receive the subsidy, the California Tax Credit Allocation Committee (CTCAC) has developed a point system based on project attributes. In cases where proposals receive the same number of points, the CTCAC uses a tie-breaker system based on housing goals, location, and the proposal's ability to acquire external funds. In 2012, only 17 of the 236 new construction proposals did not receive the maximum number of points and 102 projects received the subsidy (CTCAC Regulations 2012; CTCAC Applicant List 2012).[5]

Unlike most housing subsidies, LIHTC rents are not determined by an individual tenant's income. Instead, the developer chooses the rent ceiling by designating the income of the tenant he would like to "target". If the targeted tenant is a household that makes 50 percent of the Area Median Gross Income (AMGI), as reported by HUD, then the LIHTC rent level is determined by multiplying 50 percent of AMGI by 0.3. The goal of this calculation is to ensure that the targeted household pays no more than 30 percent of income on housing. In reality, a household living in a LIHTC unit may earn much less than 50 percent of AMGI, but the rent level will not be adjusted to their income. Consequently, up to 45 percent of LIHTC tenants need housing vouchers to afford

[5] California has "set-asides" for projects that meet certain requirements like being partnered with a non-profit or being located in a rural area. Because of this, a project may receive the subsidy even if its point total is lower than another proposal.

the rent (Williamson 2011, O'Regan and Horn 2013).

In the CTCAC point category meant to minimize the rent charged in LIHTC units, Developers receive points by proposing different fractions of units and the affordability of those units. For example, a developer could receive the maximum possible points by making 50 percent of units affordable to tenants who earn 50 percent of AMGI and dedicating the other 50 percent to tenants who earn 45 percent of AMGI. A different developer can receive the same number of points by dedicating 30 percent of units to tenants who earn 30 percent of the AMGI, 50 percent of units to tenants who earn 50 percent of AMGI and having no rent restriction on 20 percent of units. The CTCAC reports the points awarded to projects between 2003 and 2008 and these documents demonstrate that the majority of proposals receive the maximum points in this category.[6]

Because Area Median Gross Income is reported on a county and MSA level, the rent ceilings are the same for all units with the same number of bedrooms within a county or MSA. In locations where the market rent is high, the county rent ceiling can be quite restrictive. In low-rent locations, however, the rent ceiling may not be binding. This fact is an important part of the theoretical and empirical analysis that follows.

3 Model Specification

To characterize how the LIHTC subsidy affects the relative inputs of capital and land, I characterize a general profit function for housing development. The number of units is determined by a function $f(K, L)$, where K is capital inputs and L is land inputs. Assume that the production function is

[6] The subsidy is reduced by one percent for every one percent of units that do not conform to the rent ceiling. Consequently, most buildings dedicate nearly all units to low-income use.

non-decreasing in K, because it takes more capital to build a taller building when land is fixed. The profit function takes the following form,

$$\pi = R(s) \cdot f(K, L) - p_K(s) \cdot K - p_L \cdot L. \tag{1}$$

In the expression above, the discounted expected market rent stream per unit is $R(s)$, where s represents whether or not the building is subsidized. For simplicity, assume s is binary and equal to one if the building is subsidized. If $s = 1$, then the price of apartment units must be reduced to the county or MSA rent ceiling, meaning that $\frac{\partial R}{\partial s} < 0$. In locations where the market rent is less than the program designated rent ceiling, developers must charge 10 percent less than comparable market rate units (CTCAC Regulations 2012) The unit cost of capital is $p_K(s)$, which also decreases in response to subsidization, or $\frac{\partial p_K}{\partial s} < 0$. The unit cost of land is p_L and is not dependent on the subsidy.

To isolate the decision of the developer to invest in capital, I assume that the land input is fixed, or the parcel of construction has already been chosen. This assumption simplifies the characterization and requires capital investment to be the primary determinant of building size once a parcel of land is purchased. Assuming land is fixed, maximize expression (1) with respect to capital. Solving for K^* yields a function that determines optimal capital investment,

$$K^* = g(R(s), p_K(s), \bar{L}, p_L). \tag{2}$$

The function $g()$ calculates the optimal capital investment, where $\frac{\partial g}{\partial R} > 0$, $\frac{\partial R}{\partial s} < 0$, $\frac{\partial g}{\partial p_K} < 0$, $\frac{\partial p_K}{\partial s} < 0$, $\frac{\partial g}{\partial \bar{L}} > 0$ and $\frac{\partial g}{\partial p_L} > 0$. When a building is subsidized, the effect on capital investment is determined by

$$\frac{\partial K^*}{\partial s} = \left[\frac{\partial g}{\partial R} \cdot \frac{\partial R}{\partial s}\right] + \left[\frac{\partial g}{\partial p_K} \cdot \frac{\partial p_K}{\partial s}\right] \tag{3}$$

In equation (3), the first bracketed term is negative. The first term in the bracket, $\frac{\partial g}{\partial R}$, indicates that the optimal capital investment is positively related to the price at which the constructed units can be rented. The second term, $\frac{\partial R}{\partial s}$, indicates that subsidization decreases the price at which units are rented. The first term in the second bracket, $\frac{\partial g}{\partial p_K}$, represents the negative relationship between the price of capital and the optimal capital investment. The second term, $\frac{\partial p_K}{\partial s}$, represents the reduction in the price of capital that is associated with the subsidy. Both of these terms are negative and the second bracket is positive.

The opposite signs of the two terms in (3) demonstrates that the subsidy creates a trade-off. The subsidy should increase building size because it decreases the marginal cost of capital. It also decreases building size because it reduces the rental price of housing units. In locations where the rent ceiling and market rent are nearly equal, the negative term in the first set of brackets will be small. This may result in relatively larger subsidized buildings in locations with low market rent, a hypothesis I will test in the empirical analysis.

An empirical model that estimates the effect of the subsidy on building size uses expression (2) as its foundation, with buildings as the unit of observations. Because I cannot measure the price of capital, I include zip code and year fixed effects to capture that effect. This assumes that within the same zip code and year, the capital costs of construction will be equal. These fixed effects, along with a fixed effect for zoning classification will also control for other market conditions in the location and time period of construction. The resulting log-linear specification is,[7]

$$\ln K^*_{itzc} = \beta_0 + \beta_1 \ln R_{itzc} + \beta_2 LIHTC_{itzc} + \beta_3 \ln R_{itzc} \cdot LIHTC_{itzc} + \beta_4 \ln L_{itzc} + \beta_5 \ln p_{L,itzc} + \tau_t + \zeta_z + \lambda_c + \gamma_i. \tag{4}$$

[7] I use a log-linear specification because taking the natural log of equation (2) is necessary to separate the effects.

In specification (4), the dependent variable is square feet of building space in building i. The coefficient β_1 estimates how square footage increases in response to increases in market rent. The coefficient β_2 is the effect of the subsidy on square footage, which is expected to be positive. The term associated with β_3 is an interaction between market rent and the binary LIHTC variable. For subsidized buildings, increases in market rent should not affect building size because the rent charged in subsidized units is always equal to the rent ceiling. Therefore, β_3 should be negative, cancelling out some portion of the effect of β_1. The effect of land area and the cost of land per square foot is measured by β_4 and β_5 and both should be positively related to building square footage. The fixed effects τ_t, ζ_z and λ_c represent the year of construction, zip code and zoning, respectively.

Specification (4) assumes that a unit of capital investment always results in the same amount of housing production that can be rented at R(s). In reality, developers may alter the size or quality of housing units in response to the subsidy. The effect of the subsidy on unit size is difficult to predict. When an unsubsidized developer reduces the size or quality of an apartment unit, he faces a possible reduction in the price at which he can rent the unit. Holding number of bedrooms constant, the price of smaller subsidized housing units will be the same as larger units. Assuming vacancy rates of subsidized units are not sensitive to marginal changes in size, the subsidy may create an incentive to reduce the number of square feet per apartment unit.

Subsidized units could be larger if the LIHTC regulations require specific unit sizes that are larger than the units that would have been built without the subsidy. In California, LIHTC three-bedroom units are required to include at least 1,000 square feet of living space (CTCAC Regulations 2012). Requirements like these may limit the amount that developers can decrease the size of housing units. To examine how the subsidy alters building composition, I use a specification similar to (4) to also estimate the effect of the subsidy on square footage per housing unit and number of housing units in the building.

4 Data and Results

Assessment data from the Los Angeles County Tax Assessor for the 2013 tax year identifies each apartment building in Los Angeles County that includes at least five housing units. The data also report square footage, the number of housing units, land value, the year the building was constructed, the size of the parcel in square feet and the county zoning classification.

The Department of Housing and Urban Development (HUD) publishes a LIHTC database that describes every LIHTC project placed in operation since the beginning of the program until 2007. Each LIHTC new construction project is linked to a parcel within the tax assessor data. Data for rehabilitation projects are not used because the size is likely restricted by the existing structure.

In the data, I identify every subsidized and unsubsidized multi-family residential building constructed between 1993 and 2007.[8] To measure land value per square foot, I divide the land value reported in the 2013 assessor roll by the size of the parcel in square feet. To ensure that the relative land valuation is representative of the value at the time of construction, buildings are excluded from the analysis if they were sold after the year of construction. Growth of property value is fixed in California, except for when a property is sold, which is when the property is reassessed for tax purposes.[9]

[8]Much of the assessor data before 1993 is incorrect or does not report square footage. After 1993, there are approximately 80 parcels that are not properly reported and those observations are dropped from the analysis.

[9]Proposition 13 was enacted in 1978. Under this proposition, property taxes cannot exceed more than one percent of property value. Property value is assessed at the time of sale and then grow by two percent every year.

I also collect the average rent by census tract for Los Angeles County, as reported by the 1990 Decennial Census. This is not the ideal measurement of rent, as it is not measured in the year of construction and housing units with different numbers of bedrooms are subject to different rent levels and distribution. The assumption is that the ordering of the average rent variable properly ranks census tracts in terms of the rent that a unit would expect to collect, regardless of the number of bedrooms within that unit. Another assumption is that the rank ordering in 1990 is representative of the ordering in the year of construction.

The final data set includes 1,107 buildings, of which 253 are subsidized by the tax credit. These buildings house 31,933 unsubsidized and 16,356 subsidized housing units. Table 1 reports the descriptive statistics, dividing observations into subsidized and unsubsidized buildings. The statistics in Table 1 show that the average LIHTC building is twice as large as an unsubsidized building and includes twice as many housing units. Subsidized buildings are also constructed on larger and less expensive parcels. For every variable in Table 1, the mean for subsidized buildings is statistically different from unsubsidized buildings at the one percent level.

Among LIHTC buildings, about half receive additional subsidies, called a "basis increase" because of their location. The qualified census tract (QCT) incentive is a policy within LIHTC where developers have access to a 30 percent increase in the subsidy if the project is located in a designated, high-poverty census tract. The same subsidy boost is available to projects built in areas designated as difficult to develop. Because Los Angeles is designated as difficult to develop, location in a QCT does not necessarily determine access to the additional subsidy. Instead of controlling for a building being located in a QCT, I include whether or not the LIHTC project received the basis increase, which is reported in the HUD data.

The LIHTC database also reports the population that the LIHTC building is built to serve. The majority of buildings are created for families. Other types include senior, special needs, and single room housing. I include all LIHTC buildings in the analysis but control for the targeted population with two additional categories: senior and "at-risk". Because unsubsidized buildings are less likely to be targeted towards subsets of the population, I focus on subsidized construction that is built for families.

Table 1
Descriptive Statistics

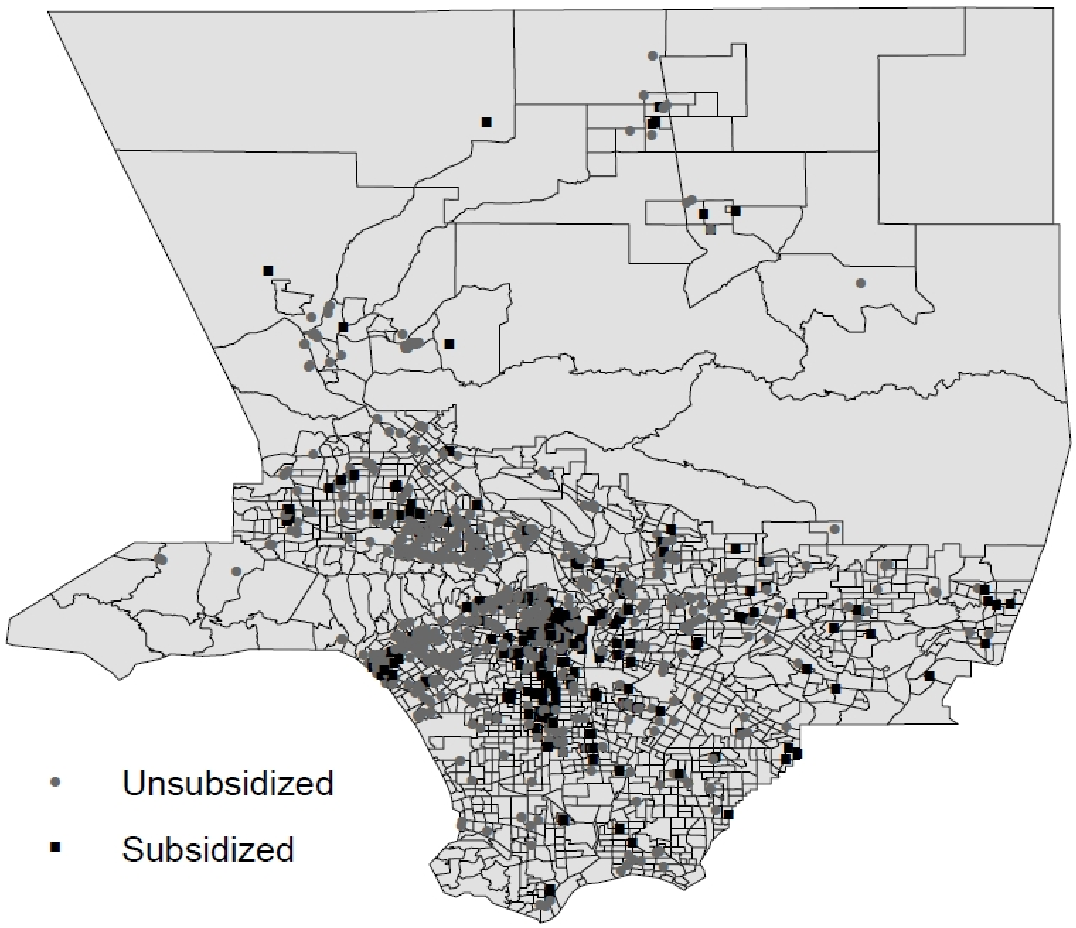
Variable	Unsubsidized	LIHTC
Building Square Footage	41,341	59,499
Number of Housing Units	37	65
Square Footage Per Unit	1,114	1,017
Parcel Square Footage	36,169	55,926
Land Value per Square Foot (2013 $)	82	42
Mean Year Built	2001	2000
1990 Census Tract Average Rent (1990 $)	685	568
Basis Increase Indicator	–	0.45
Senior Housing Type	–	0.24
At-risk Housing Type	–	0.14
Building Observations	854	253

All means are significantly different from each other at the one percent level. "Basis Increase Indicator" equals one if LIHTC building received a 30 percent subsidy increase because of its location in a QCT of a difficult to develop area. "At-risk Housing Type" includes special needs and single room housing. Family Housing is omitted category.

Ideally one could compare two buildings, one subsidized and one unsubsidized, each constructed on the same piece of land. Because it is impossible to observe two different buildings on the same parcel, I compare parcels that are similar but house the two different construction types. To do this, it is necessary to accurately control for the market conditions at the time and location of construction.

To capture local market conditions, I include a zip code fixed effect. The observations are located in 192 unique zip codes and 86 zip codes include both subsidized and non-subsidized buildings. Of the 253 LIHTC buildings, 227 are in a zip code with at least one unsubsidized apartment building for comparison. Figure 1 is a map of the 1990 census tract boundaries in Los Angeles County that shows the locations of subsidized and unsubsidized buildings. The figure illustrates that subsidized housing construction is often located near unsubsidized construction.

Figure 1
Multifamily Housing Construction in Los Angeles: 1993-2007



A zoning fixed effect is included to control for local restrictions on development, which is reported by the Los Angeles County assessor. The zoning classification includes 230 unique zoning categories. There is at least one unsubsidized building with the same zoning classification for 197 of the LIHTC buildings in the sample.[10] A yearly fixed effect is included to control for market conditions at the

[10]Thirty percent of building observations are coded as LAR3, which indicates a "limited multiple residence".

time of construction. Table 2 reports the observations by year of construction, demonstrating that LIHTC construction is evenly distributed over the time period.

Table 2
Building Construction by Year

Variable	Unsubsidized Buildings	LIHTC Subsidized Buildings	Total
1993	64	15	79
1994	27	19	46
1995	37	22	59
1996	32	20	52
1997	27	15	42
1998	33	16	49
1999	61	15	76
2000	38	20	58
2001	73	18	91
2002	81	16	97
2003	95	18	113
2004	98	20	118
2005	79	18	97
2006	68	12	80
2007	41	9	50

Even with these control variables, other issues may confound the estimation of how the subsidy affects building size. The most obvious is the possibility of unobserved differences between developers that do and do not receive the subsidy. If developers who receive the subsidy use less expensive production methods and materials, it will result in larger buildings and the empirical analysis may assign that effect to the subsidy itself. While the LIHTC program monitors the quality of materials used, this and other cases of unobserved differences may occur.

The average effect of the LIHTC subsidy on building size across the entire rent distribution is presented in Table 3. To obtain the average effect, I estimate specification (4), but do not interact the LIHTC variable with market rent. The first column of Table 3 reports regression estimates where the dependent variable is the natural log of building square footage. The coefficients indicate that LIHTC buildings are 33 percent larger than unsubsidized buildings. The coefficients on market rent, parcel size and land value are all positive, although only the coefficients on parcel size and land value are statistically significant.

The next two columns of Table 3 examine if larger buildings are a result of additional housing units or more space within those units. If units are larger, it may represent higher quality housing for low-income tenants that would not be available without the subsidy. The estimates in the second column, where the dependent variable is the natural log of square feet per unit, indicate that LIHTC buildings provide units that are 17 percent larger than unsubsidized buildings. The coefficient on market rent is positive and significant at the 10 percent level, suggesting that unsubsidized and subsidized units are bigger in higher-rent locations. The coefficients on parcel size and land cost are positive, but not statistically significant.

In the third column, the dependent variable is the natural log of housing units, which increases by 16 percent with the subsidy. The coefficients on the control variables are similar to the estimates in the first column. The second and third columns suggest that larger LIHTC buildings are the result of both more units and larger units, with each effect being about half of the total size difference.

Estimates in Table 3 also indicate that the basis increase does not significantly affect building size, even though it represents a substantial increase in the subsidy. Because the basis increase is not awarded before the developer proposes the building, developers may not respond to the incentive. Additional research using a more diverse geography may be able to address this question more fully.

Finally, the results in Table 3 suggest that LIHTC buildings that serve the elderly or at-risk populations provide smaller units than LIHTC units for families. An F-test indicates that LIHTC units for the elderly are significantly smaller than unsubsidized units, although there is no significant difference between at-risk and unsubsidized units. Buildings for the elderly also include an additional 40 percent more housing units.

Table 3
Average LIHTC Subsidy Effect on Building Size

Dependent Variables	(1) ln(Square Footage)	(2) ln(Sq Ft. per Unit)	(3) ln(Housing Units)
β_1: ln(1990 Census Tract Average Rent)	0.34	0.20*	0.13
	(0.23)	(0.11)	(0.20)
β_2: LIHTC Indicator	0.33***	0.17***	0.16**
	(0.07)	(0.052)	(0.067)
β_4: ln(Parcel Square Footage)	0.92***	0.021	0.90***
	(0.04)	(0.017)	(0.041)
β_5: ln(Land Value per Square Foot)	0.14***	0.015	0.12***
	(0.03)	(0.011)	(0.028)
QCT Increase Indicator	0.037	-0.044	0.081
	(0.12)	(0.056)	(0.11)
LIHTC Senior Housing	-0.06	-0.46***	0.40***
	(0.13)	(0.058)	(0.14)
LIHTC At-risk Housing	-0.07	-0.25***	0.18
	(0.15)	(0.069)	(0.13)
Constant	-2.19	5.28***	-7.47***
	(1.48)	(0.79)	(1.41)
R^2	0.89	0.68	0.90

***p<0.01, **p<0.05, *p<0.1. Standard errors in parentheses, clustered on zip code. Omitted LIHTC housing category is housing for families. All regressions include 1,107 building observations with zip code, year of construction and zoning fixed effects.

The results in Table 3 show that LIHTC buildings are larger than unsubsidized buildings on average, but the theoretical model suggests that the size differences should vary based on the market rent. Table 4 reports the results for the full specification, including the interaction between LIHTC and market rent. Like Table 3, each column reports a regression with a different dependent variable related to building size.

Table 4 is divided into two panels, Panel A and Panel B. Panel A reports the regression coefficients from specification (4). Panel B reports linear combinations of the coefficients at the 25th, 50th and 75th percentiles of census tract average rent in the dataset. The numbers in Panel B represent the estimated size difference between subsidized and unsubsidized buildings at those rent levels.

The first column of Panel A reports the estimates for the coefficients when the dependent variable is the log of building square footage. The LIHTC subsidy coefficient is 2.68 and not significantly different from zero. The point estimate is larger than the coefficient in Table 3 because it measures the size difference between subsidized and unsubsidized buildings when the market rent hypothetically equals zero.

The other coefficients in the first column suggest that as the average market rent increases, unsubsidized building size will increase faster than subsidized building size. When market rent increases by one percent, unsubsidized building square footage increases by 42 percent and is significant at the 10 percent level. For subsidized buildings, however, the effect of changes in rent on building size is the sum of the coefficients β_1 and β_3. Based on these coefficients, subsidized buildings are similarly sized across the rent distribution.

Panel B of the first column reports that at the 25th percentile, or $535, a subsidized building has 32 percent higher square footage than an unsubsidized building. That difference is significant at the one percent level. The size difference is still statistically significant at the 50th percentile, but by the 75th percentile of rent, $776, the point estimate is 0.18 but not statistically different from zero. The estimates suggest that as construction moves to locations with higher rent, subsidized and unsubsidized buildings look more similar in terms of square footage.

The second and third columns of Table 4 investigate if buildings are larger because of more units or additional space within those units. The coefficients for a regression where the dependent variable is the log of housing unit size is reported in Panel A of column (2). These coefficients have the same sign as the coefficients when the dependent variable is the log of square footage in column

(1). Panel B of the second column indicates that the difference in unit size decreases rapidly with rent. Subsidized units are 16 percent larger and significant in the 25th rent percentile. The estimate decreases to two percent and is no longer significant by the 75th percentile.

Table 4
Linear LIHTC Subsidy Effect on Building Size

Panel A: Regression Estimates Dependent Variables	(1) ln(Square Footage)	(2) ln(Sq Ft. per Unit)	(3) ln(Housing Units)
β_1: ln(1990 Census Tract Average Rent)	0.42*	0.28**	0.14
	(0.24)	(0.11)	(0.21)
β_2: LIHTC Indicator	2.68	2.50***	0.18
	(2.06)	(0.94)	(1.74)
β_3: ln(1990 Tract Average Rent)·LIHTC	-0.38	-0.37**	-0.0037
	(0.33)	(0.15)	(0.28)
β_4: ln(Parcel Square Footage)	0.92***	0.023	0.90***
	(0.041)	(0.018)	(0.041)
β_5: ln(Land Value per Square Foot)	0.14***	0.014	0.12***
	0.033	-0.047	0.081
R^2	0.89	0.68	0.90
Panel B: Linear Combinations of Estimates Size Difference Between Subsidized and Unsubsidized Buildings at Various Rent Levels			
At 25th Percentile of Average Rent ($535)	0.32***	0.16***	0.16***
	(0.07)	(0.05)	(0.07)
At 50th Percentile of Average Rent ($643)	0.25***	0.09	0.16*
	(0.09)	(0.06)	(0.08)
At 75th Percentile of Average Rent ($776)	0.18	0.02	0.16
	(0.14)	(0.08)	(0.12)

***p<0.01, **p<0.05, *p<0.1. Standard errors in parentheses, clustered on zip code. Omitted LIHTC housing category is housing for families. All regressions include 1,107 building observations, the control variables in Table 3 and zip code, year of construction and zoning fixed effects.

The log of number of units is the dependent variable in column (3). The linear estimates in Panel B show that subsidized buildings include 16 percent more housing units than unsubsidized units. The estimate is is significant at the 25th percentile of rent and becomes less significant as rent increases.

Table 4 indicates that subsidized building square footage decreases relative to unsubsidized buildings as the market rent increases. The reduction in building size is driven by decreases in the size of housing units, while the relative number of units in subsidized buildings does not change with market rent. This occurs because unsubsidized buildings offer larger housing units as the market rent increases but subsidized buildings offer similarly sized units across the entire market rent distribution.

The estimates in Table 4 indicate that the LIHTC subsidy alters construction decisions, but the specifications assume that rent will have a log-linear effect on the dependent variables. To explore an alternate possibility, I estimate a non-linear relationship between the subsidy, rent and building size. To do this, I split the sample into two groups, based on whether a census tract's average rent falls above or below the sample median of \$643. There are 554 buildings in census tracts with average rent less than the median, 194 of which are subsidized. There are 553 buildings in census tracts with average rent greater than the median and 59 of those buildings are subsidized.

Specification (4) is altered to allow for a non-linear relationship between building size and rent,

$$\ln K^*_{itzc} = \phi_0 + \phi_1 HIGH_{itzc} + \phi_2 LIHTC_{itzc} + \phi_3 HIGH_{itzc} \cdot LIHTC_{itzc} + \phi_4 \ln L_{itzc} + \phi_5 \ln p_{L,itzc} + \tau_t + \zeta_z + \lambda_c + \varepsilon_i,$$

where $HIGH_{itzc}$ is an binary indicator that equals one if the market rent in the census tract of building i is above the sample median. Each column of Table 5 reports a regression that uses a different dependent variable. In the first column, the dependent variable is the natural log of building square footage.

The estimates in the first column of Table 5 indicate that unsubsidized buildings in high-rent locations are 19 percent larger than unsubsidized buildings in low-rent locations. Within low-rent locations, subsidized buildings have 38 percent more square footage than unsubsidized buildings. In high-rent locations, however, there is no significant difference in square footage between subsidized and unsubsidized buildings. The effect of the subsidy appears to be offset by the requirement to conform to the rent ceiling.

Table 5
Nonlinear LIHTC Subsidy Effect on Building Size

Dependent Variables	(1) ln(Square Footage)	(2) ln(Sq Ft. per Unit)	(3) ln(Housing Units)
ϕ_1: High Rent Indicator	0.19**	0.084	0.10
	(0.083)	(0.051)	(0.087)
ϕ_2: LIHTC Indicator	0.38***	0.19***	0.19***
	(0.072)	(0.052)	(0.070)
ϕ_3: High Rent · LIHTC Indicator	-0.42***	-0.20***	-0.21
	(0.14)	(0.056)	(0.14)
ϕ_4: ln(Parcel Square Footage)	0.93***	0.024	0.90***
	(0.040)	(0.017)	(0.041)
ϕ_5: ln(Land Value per Square Foot)	0.13***	0.013	0.12***
	(0.026)	(0.011)	(0.028)
Basis Indicator	0.030	-0.047	0.077
	(0.12)	(0.055)	(0.11)
LIHTC Senior Housing	0.018	-0.42***	0.43***
	(0.14)	(0.055)	(0.15)
LIHTC At-risk Housing	-0.019	-0.22***	0.20
	(0.14)	(0.071)	(0.12)
Constant	-0.036	6.58***	-6.63***
	(0.43)	(0.32)	(0.61)
R^2	0.890	0.684	0.900

*** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses,clustered on zip code. Omitted LIHTC housing category is housing for families. All regressions include 1,107 building observations, yearly, zoning and zip code fixed effects. High rent indicator equals one if 1990 average census tract rent > \$643.

Regressions that estimate the non-linear effect on housing unit size and number of units produce similar results. Subsidized buildings in low-rent locations hold 19 percent more housing units and those units are 19 percent larger than units in unsubsidized buildings. In high-rent locations, there is no significant difference between subsidized and unsubsidized buildings for either variable.

Table 5 shows that the reduction is subsidized building size in high-rent areas is driven by both smaller housing units and fewer housing units. In Table 4, the reduction in size was only driven by smaller units. The results in Tables 4 and 5 suggest that the relative size of subsidized units is significantly smaller high-rent locations. The effect from the number of units in subsidized buildings is not as strong, but plays a role in the relative size reduction in Table 5.

The empirical analysis supports the theoretical prediction that there is a positive relationship between building size and receiving the LIHTC subsidy. The largest effects are found in locations where the market rent is low. The following section discusses the implications of these findings in more detail.

5 Discussion

This paper provides evidence that a LIHTC building in a low-rent location is larger than the unsubsidized building that may have been built in its place. In high rent locations, LIHTC buildings and unsubsidized buildings are similarly sized. Additional regressions indicate that the effect on total building size is equally driven by additional units within those buildings and more space in those units.

Olsen (2000, 2009) identifies corruption, distortions and profits as potential sources of inefficiency for project-based housing subsidies. The results of this paper provide insight about the role of distortions and profits causing inefficiencies. A subsidy may create distortions in the inputs of construction, leading to higher costs of production. Because LIHTC awards funding based on non-land construction costs only, developers have a strong incentive to shift production away from land and toward capital and labor inputs. Previous research has found evidence that project-based housing is more expensive to produce (HUD 1974, Mayo et al. 1980, Olsen and Barton 1981, Olsen

2000, GAO 2001, GAO 2002, Deng 2005, Olsen 2008, Eriksen 2009) and my results suggest that for LIHTC, increased costs may result from more capital-intensive construction.

Private developers may receive excessive profits for participating in housing subsidies. The results from this study indicate that, compared to unsubsidized buildings, LIHTC buildings are larger in low-rent locations but similarly sized in high-rent locations. This outcome is consistent with subsidized developers reducing their optimal capital input in response to more restrictive rent ceilings. If larger buildings result from increased profit expectations (Dipasquale and Wheaton 1995), the size discrepancy in low-rent locations may suggest over-subsidization. There is already research that suggests that the majority of LIHTC housing would have been built without the subsidy (Malpezzi and Vandell 2002, Sinai and Waldfogel 2005, Baum-Snow and Marion 2009, Eriksen and Rosenthal 2010). Further evidence of this possibility is provided by Burge (2011), who estimates that less than half of the government cost of the LIHTC program is captured by tenants in the form of rent savings.

As Burge argues, it is possible that LIHTC provides benefits to tenants that justify additional costs. Research has found evidence that LIHTC construction increases property value (Schwartz et al. 2006, Baum-Snow and Marion 2009), reduces poverty concentration (McClure 2006, Ellen et al. 2009, Horn and O'Regan 2011, Freedman and McGavock 2013), provides access to better schools (Horn, Ellen and Schwartz 2014, Di and Murdoch 2013) and decreases local crime rates (Freedman and Owens 2011). My results suggest that for some tenants, LIHTC offers larger housing units that may not be available through demand-side subsidies. Even if potential benefits are considered enough to justify the additional costs of the program, focusing on reducing the cost and improving the efficiency of the program should be a focus for policy-makers going forward.

This research implies some ways to potentially improve the efficiency of the LIHTC program.

Subsidizing non-land construction costs incentivizes developers to produce capital-intensive buildings. Awarding the subsidy in proportion to total construction costs may eliminate this incentive and reduce the average costs of construction. Efficiency could also be improved by allocating tax credits through a process where developers compete for the subsidy by bidding down the subsidization rate.

Another potential solution is to make rent ceilings dependent on local rental markets, instead of county or MSA markets. This would eliminate the opportunity to receive subsidization in exchange for only minimal reductions in revenue streams. Alternatively, as some economists have argued (Olsen 2008), the simplest answer may be to phase out project-based housing subsidies in favor of housing vouchers, which are arguably more cost-effective.

6 Conclusion

As research on LIHTC progresses, attention to what causes the outcomes observed in previous research will determine how to improve the program. This paper provides evidence that a developer responds to the subsidy by altering the size of the building he constructs. In low-rent locations, subsidized buildings are larger in number and size of housing units. There is no significant difference between subsidized and unsubsidized buildings in high-rent areas.

The building size effect may signal potential inefficiencies in the LIHTC program, through construction input distortions or oversubsidization of private developers. If developers are subsidized to build in low-rent locations, but the rent ceiling is not restrictive, developers may receive the bulk of the subsidy in the form of profit. Burge (2011) provides convincing evidence of this possibility.

Subsidized developers in low-rent locations may need to be compensated more than the LIHTC developers in high-rent locations to participate in the program, which could lead to larger buildings in low-rent locations. Even if that is true, the LIHTC program allocates billions of dollars to fund the construction of low-income housing (Eriksen and Rosenthal 2010). A program that uses funding at such a large scale should be critically examined for inefficiencies. Subsidized buildings that are significantly larger than the surrounding unsubsidized buildings may be an indication that the LIHTC program is paying developers too much or that low-income tenants are receiving too little of the subsidy.

References

[1] Baum-Snow, N., Marion, J., 2009. The Effects of Low Income Housing Tax Credit Developments on Neighborhoods. *Journal of Public Economics*, 93(5-6), 654-666.

[2] Burge, G. S. 2011. Do Tenants Capture the Benefits from the Low-Income Housing Tax Credit Program?. *Real Estate Economics*. 39: 71–96.

[3] California Tax Credit Allocation Committee Annual Report. 2012. Accessed online at http://www.treasurer.ca.gov/ctcac/compliance/manual.asp on January 6, 2014.

[4] California Tax Credit Allocation Committee Applicant List. 2012. Accessed online at http://www.treasurer.ca.gov/ctcac/2012/application.asp on January 6, 2014.

[5] California Tax Credit Allocation Committee Compliance Manual, Introduction. 2013. Accessed online at http://www.treasurer.ca.gov/ctcac/2012/annualreport.pdf on January 6, 2014.

[6] California Tax Credit Allocation Committee Regulations. 2012. Accessed online at http://www.treasurer.ca.gov/ctcac/2012/annualreport.pdf on January 6, 2014.

[7] Case, K. 1991. Investors, developers and supply-side subsidies: How much is enough? *Housing Policy Debate* 2: 341-356.

[8] Cummings, J. L. and D. DiPasquale. 1999. The Low-Income Housing Tax Credit An Analysis of the First Ten Years. *Housing Policy Debate*.10:251 - 307.

[9] Deng, L. 2005. The cost-effectiveness of the low-income housing tax credit relative to vouchers: Evidence from six metropolitan areas. *Housing Policy Debate*, 16(3-4), 469-511.

[10] Desai, M., Dharmapala, D., & Singhal, M. 2010. Tax Incentives for Affordable Housing: The Low Income Housing Tax Credit. In Tax Policy and the Economy, Volume 24 (pp. 181-205). The University of Chicago Press.

[11] Di, W. and J. C. Murdoch. 2013. The impact of the low income housing tax credit program on local schools. *Journal of Housing Economics* 22 (4): 308-320.

[12] DiPasquale, D. and W. Wheaton. 1995. *Urban Economics and Real Estate Markets*. Prentice-Hall; Englewood Cliffs.

[13] DiPasquale, D., Fricke, D., & Garcia-Diaz, D. 2003. Comparing the costs of federal housing assistance programs. Federal Reserve Bank of New York Economic Policy Review, 9(2), 147-169.

[14] Ellen, I. G., O'Regan, K. and I. Voicu. 2009. Siting, Spillovers, and Segregation: A Reexamination of the Low Income Housing Tax Credit Program. In *Housing Markets and the Economy*, Edited by Edward Glaeser and John Quigley. Cambridge, MA: Lincoln Institute of Land Policy.

[15] Eriksen, M. D. 2009. The market price of Low-Income Housing Tax Credits, *Journal of Urban Economics* 66: 141-149.

[16] Eriksen, M. D. and S. S. Rosenthal, Stuart S., 2010. "Crowd out effects of place-based subsidized rental housing: New evidence from the LIHTC program," *Journal of Public Economics* 94 (11-12): 953-966.

[17] Freedman, M. and T. McGavock. 2013. Low-Income Housing Development: Poverty Concentration and Neighborhood Inequality. Working Paper.

[18] Freedman, M. and E. G. Owens. 2011. Low-income housing development and crime. *Journal of Urban Economics* 70 (2): 115-131.

[19] Gustafson, J. and J. C. Walker. 2002. Analysis of State Qualified Allocation Plans for the Low-Income Housing Tax Credit Program. Prepared by the Urban Institute for the U.S. Department of Housing and Urban Development.

[20] Horn, K. E., I.E. Gould and A.E. Schwartz. 2014. Do Housing Choice Voucher holders live near good schools? *Journal of Housing Economics* 23: 28-40.

[21] Horn, K. E. and K. O'Regan. 2011. The Low Income Housing Tax Credit and Racial Segregation. *Housing Policy Debate* 21 (3): 443-473.

[22] Malpezzi, S. and K. Vandell. 2002. Does the Low-Income Housing Tax Credit Increase the Supply of Housing. *Journal of Housing Economics* 11: 360–380.

[23] Mayo, S. K., Mansfield, S., Warner, D., & Zwetchkenbaum, R. 1980. Housing Allowances and Other Rental Assistance Programs-A Comparison Based on the Housing Allowance Demand Experiment, Part 2: Costs and Efficiency. Cambridge, Mass.: Abt Associates.

[24] McClure, K. 2006. The Low-Income Housing Tax Credit Program Goes Mainstream and Moves to the Suburbs. *Housing Policy Debate* 17 (3): 419-446.

[25] McClure, K. 2010. Are low-income housing tax credit developments locating where there is a shortage of affordable units? *Housing Policy Debate* 20 (2): 153-171.

[26] Murray, M., 1999. Subsidized and unsubsidized housing stocks 1935 to 1987: Crowding Out and Cointegration. *Journal of Real Estate Finance and Economics* 18: 107–124.

[27] Olsen, E. O. 2000. The cost-effectiveness of alternative methods of delivering housing subsidies. Thomas Jefferson Center for Political Economy, Working Paper, 351.

[28] Olsen, E. O. 2008. *Getting more from low-income housing assistance*. Brookings Institution.

[29] Olsen, E. O. 2009. Revision of The cost-effectiveness of alternative methods of delivering housing subsidies. Working Paper for presentation at Thirty-First Annual APPAM Research Conference.

[30] Olsen, E. O., & Barton, D. M. 1983. The benefits and costs of public housing in New York City. *Journal of Public Economics*, 20(3), 299-332.

[31] O'Regan, K. M. and K. M. Horn. 2013. What can we learn about the Low-Income Housing Tax Credit Program by looking at the tenants? Housing Policy Debate 23 (3): 597-613.

[32] Sinai, T., Waldfogel, J., 2005. Do low-income housing subsidies increase the occupied housing stock? *Journal of Public Economics* 89, 2137-2164 .

[33] Stegman, M. 1991. The Excessive Costs of Creative Finance: Growing Inefficiencies in the Production of Low-Income Housing. *Housing Policy Debate*. 2 (2): 357-373.

[34] Schwartz, A. E., Ellen, I. G., Voicu, I., & Schill, M. H. 2006. The external effects of place-based subsidized housing. *Regional Science and Urban Economics*, 36(6), 679-707.

[35] Schwartz, A. 2006. Housing Policy in the United States: An Introduction. Routledge: New York , NY.

[36] U.S. Department of Housing and Urban Development. *Housing in the Seventies*. Washington, D.C.: Government Printing Office, 1974.

[37] U.S. General Accounting Office, Federal Housing Programs: What They Cost and What They Provide. GAO-01-901R, July 18, 2001

[38] U.S. General Accounting Office, Federal Housing Assistance: Comparing the Characteristics and Costs of Housing Programs. GAO-02-76. Washington, D.C.: GAO, 2002.