# The Poverty Concentration Implications of Housing Subsidies:

# A Cellular Automata Thought Experiment

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**Abstract:**

*Looking at data from HUD's low income housing tax credit database from 1987 to 2001, we examine how the US tax credit program has concentrated poverty in neighborhoods by offering advantages to developing low income housing projects in low income census tracts. We then use a simple Cellular Automata model to explore how alternative programs structures could impact economic diversity and poverty concentration. This model suggests that many widely dispersed fixed location affordable housing projects increase local economic diversity over alternative housing allocation rules. If policymakers wish align the Low Income Housing Tax Credit program with the goal of promoting economic diversity in our neighborhoods, they should restructure the bonus to reward to projects in areas without a concentration of subsidized housing.*

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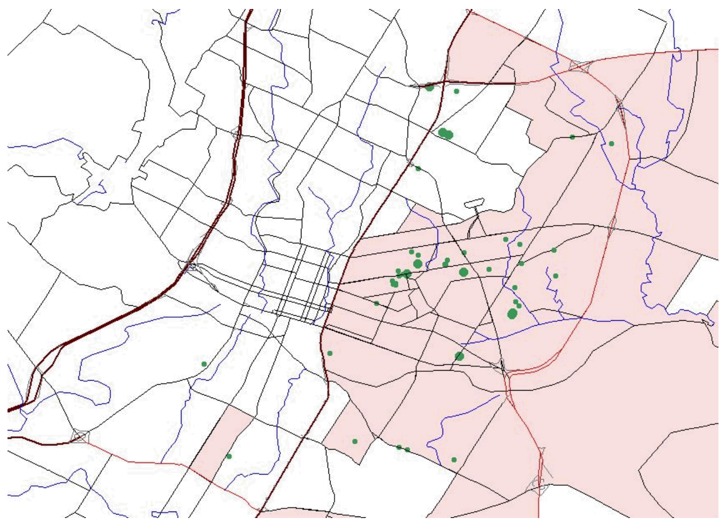
*This paper is a work in progress, so comments and suggestions from readers are encouraged. Send them via email to: Kevin.Jewell /at/ mba05.mccombs.utexas.edu.*
*I wish to extend thanks to Walter Moreau, Foundation Communities and James K. Galbraith, University of Texas, Austin for inspiration and ideas. The errors and shortcomings of this work, however, remain mine.*

## Introduction

Interstate highway 35 runs through the heart of downtown Austin, TX.  Like many urban interstates, it acts as both a physical and cultural barrier to the residents of the city.  West of I-35 sits the state capital complex and some of the highest income residential areas in the city. East of I-35 lays the city's historically black neighborhoods as well as some of the city's lowest income census tracts.

Of the 59 affordable housing projects funded by the Low Income Housing Tax Credit (LIHTC) program in Austin, 54 are tightly clustered on the east side of Interstate Highway 35.  Only 5 lie west of this divider.  Only seven are in non-majority-minority census tracts, and only two of the projects in the city were placed in affluent neighborhoods (defined here as census tracts that had household median incomes greater the median for the city at large.)[1]



LIHTC projects in this map of Austin are marked in green, Minority-majority tracts are shaded. I-35 is the north-south highway on right.
*Source: HUD Low Income Housing Tax Credit (LIHTC) Database, ESRI Data and Maps: Texas.*

[1] Source: Authors calculations from the HUD LIHTC Database and the City of Austin planning department's compilation of STF1A and STF3A 1990 Census; US Census Bureau..

The LIHTC program developed this concentrated spatial distribution because the program, through the Qualified Census Tract (QCT) bonus, directly rewards it. The original goal of the QCT program was to reward developers for their perceived higher risk of building new housing in tougher neighborhoods. HUD designates the lowest income tracts in a city as QCTs.[2] Projects in QCTs are offered a 30% bonus over non-QCT projects, and as of 2001, the majority of states also gave projects in these tracts preference in the proposal selection process (Gustafson and Walker, 2002).

Developers indicate that high land costs in central Austin make it difficult put together a deal without the 30% bonus, so they rarely consider land outside of the designated tracts for their deals.[3] As each developer individually focuses on QCT developments, projects only get done in QCT tracts.

This income segregation and LIHTC placement pattern isn't unique to Austin – it repeats itself in cities across the country. Appendix A lists the cities with the greatest percentage placement of LIHTC projects in the low income QCT tracts. We see that Austin while has placed over 75% of its projects in QTC tracts, it ranks only 14th in urban project QCT placement. Cincinnati tops the list, with every single one of its 26 LIHTC projects in low-income QCT neighborhoods.

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[2] A tract is eligible for QCT status if the majority of tract residents are eligible for HUD housing programs, but no more than 20% of the tracts in an MSA can be designated as QCTs and lower income tracts are given priority. Many of the large coastal metropolises (such as New York, Boston, and Los Angles) are designated "Difficult Development Areas" and are exempt from the QCT system, lowering the political profile of this issue.

[3] Interview with Walter Moreau, Executive Director, Foundation Communities

Buron (2000) also found in a study of 5 MSAs (Boston, Kansas city, Miami, Milwaukee, and Oakland), that only 14% pf projects were found in tracts with low poverty rates (defined as less than 10% of population living in poverty.) Buron also found that 88% of the LIHTC projects were found in majority-minority neighborhoods, highlighting possible the fair housing implications of this project concentration.

Yet since William Julius Wilson's seminal 1987 work *The Truly Disadvantaged,* a growing body of sociological literature has grown to document the hazards of concentrated poverty. Neighborhood income affects family income through vectors such as school quality, crime rates, density of social networks, and job opportunities (Goetz 2003). The clustering of low-income families reduces the opportunities available to these families to raise themselves out of poverty. See Goetz (2003), Rusk (1999), and Jargowsky, (1997), for an in-depth overview of the poverty concentration literature.

As an understanding of the feedback loop of concentrated poverty has developed, poverty concentration/de-concentration has emerged to be an important dimension of US housing policy. To many housing advocates, promoting racial and economic diversity in residential neighborhoods is one of the most important goals of housing programs (Katz et. al. 2003). After a series of lawsuits known as the *Gautreaux* cases in the 70s raised fair housing arguments against poverty concentration, HUD has recognized this goal in the implementation of some of its housing programs.

**Simulating the problem with Cellular Automata**

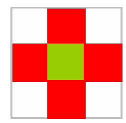
The Cellular Automata (CA) framework is well suited to examine the dynamics of spatial segregation and concentration. In cellular automata, many individual units (“cells”) are arrayed in a simple 1 or 2 dimensional field. Each cell exists in a simple state, such as on-off, or high-low (income). Over time, each cell implements its “automata” rule and changes its state based on the states of the cells in its immediate neighborhood. However, each of these individual state changes then alters the environment for the other cells in its neighborhood, and the next round they react in turn. As this process is iterated, simple local rules can result in broad patterns well beyond local neighborhoods.

The use of a CA-like framework to study the dynamics of segregation was pioneered in the economics literature by Schelling (1971, 1978). In his “Spatial Proximity Model of Segregation“ Schelling demonstrated a simple model that showed even slight preferences for like-neighbors would easily snowball into heavy segregation patterns across a city.

Albin (1975) refined Schelling ‘s model and placed it explicitly in the Cellular Automata framework. In Albin’s model, each family is a cell, and decides its location on a 2 dimensional space each timeframe using the information it knows about the state (i.e. race) of its neighbors the previous cycle. It is an modification of this framework that we will use to examine the dynamics of income concentration and the placement of LIHTC projects.

**The model:**

In our model, the city is represented as a 29x29 grid, resulting in 841 cells, each representing a residential property. For each property, a neighborhood is defined as each of its four fence line neighbors as well as itself. This is known as the Von Neumann neighborhood, after Von Neumann (1966). The model is begun with property values randomly distributed (on a uniform distribution) throughout the city.



The Von Neumann neighborhood of the green cell is the red area and itself.

In each round of the model, two dynamics are implemented. The first is a property value feedback rule. Each property's value is updated to reflect the average property value across its last round Von Neumann neighborhood. This reflects the interaction of property value, income, and neighborhood income feedback.[4]

Second, high income households move out of low income neighborhoods to higher income neighborhoods, and low-income households relocate to low land

[4] As an intuitive example of this three way interaction, imagine that higher income neighbors have security systems which reduce neighborhood crime. This both increases home values and decreased the income impacts of crime on neighbors. Alternatively, imagine higher income households are able to use increased political influence to bring economic development to the area. This raises land value and job opportunities for the neighborhood.

value cells. This is similar to the movement in the Schelling spatial proximity model. Both the Schelling and Albin models are explicitly closed neighborhood models, where the ratio of low-income and high income families are fixed, and the only outcome is the location of the families. The cellular automata model used here follows that tradition, but households decide their location based on property values rather than a like-neighbor rule. In this implementation, 17% if the cells are considered “low income,” and 83% are considered high or moderate income.

Finally, fixed location low-income housing projects are placed in the city. These cells are subject to a different rule set than other cells. The property value and household income in these properties set at the lowest end of the distribution., the property will always be occupied by low-income families, and its value is not subject to the feedback rule.

The model is examined under 3 variations of the rules defining project placement:

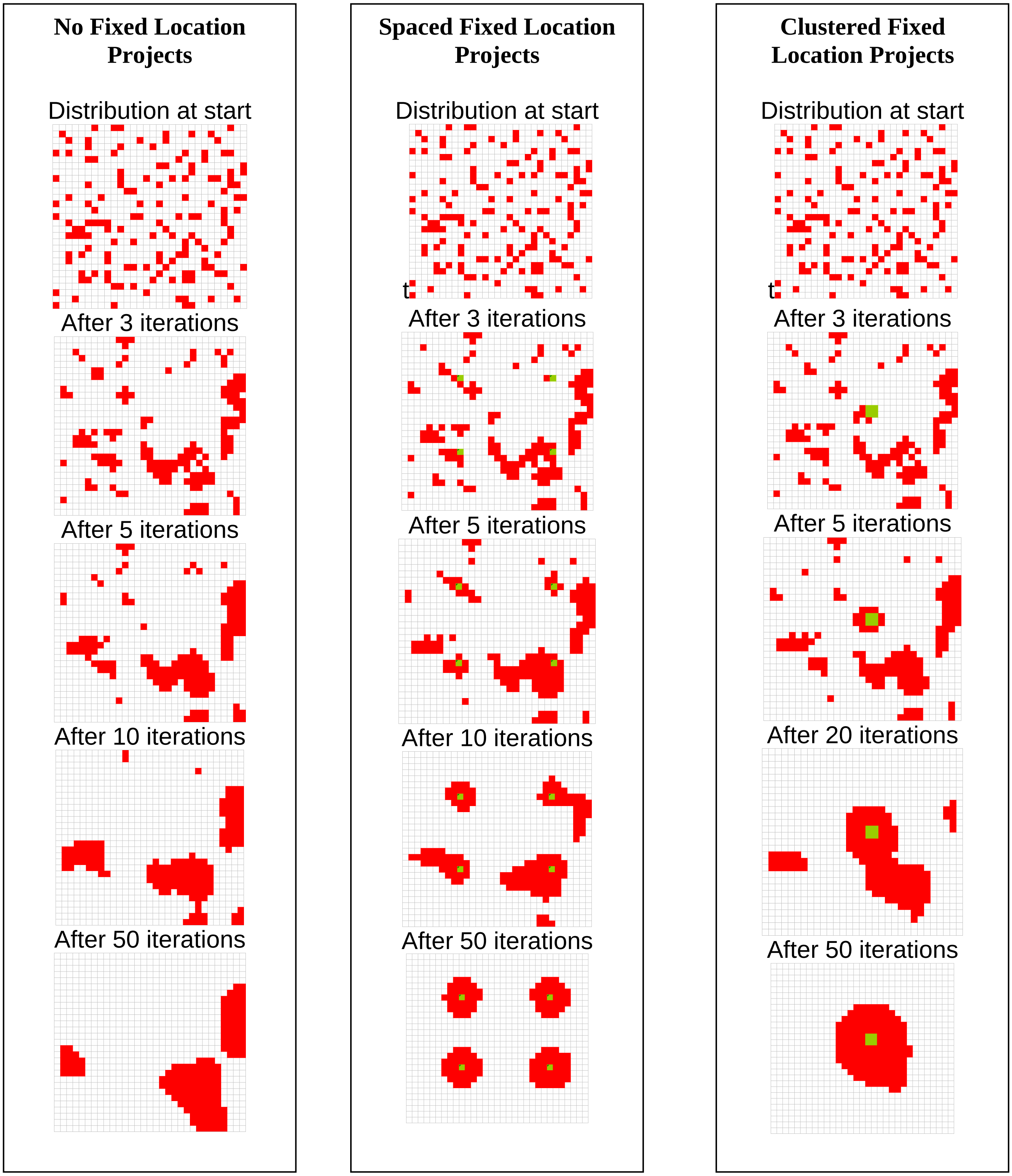
1) No fixed location affordable housing projects (open market or market based vouchers)
2) Projects are clustered (current QCT system)
3) Projects are located set distance from other projects (Alternative placement rule)

The outcome of each model is evaluated by examining the number of “concentrated poverty” neighborhoods. These are neighborhoods where every property in its Von Neumann neighborhood is in the lowest 17% income bracket. This reflects a household which is in poverty and all of its neighbors are in poverty as well.

**Results**:

Poverty clusters emerge over the long term regardless of the project allocation rules. This is due to the feedback rules that recognize high income families will move away from low income neighborhoods. Of interest, however, is that with no fixed location project, the location of these clusters varies by the initial conditions. With neighborhood feedback, fixed location projects always end up anchoring clusters of low income households. Diagram A shows cluster development over time under three project placement rules.

**Diagram A**




Result of three different project placement rules from the same initial conditions. Red indicates a household with income is in the lowest 17% of the cells, and green indicates a fixed location project.

In the run depicted in diagram A, the clustered fixed location projects result in a significantly higher proportion of concentrated poverty neighborhoods that the other rules. This result was found to be robust across 1,000 variations of the random initial conditions. Appendix B shows the distribution of the results of the simulations. Table A shows the average proportion of concentrated poverty neighborhoods for each project placement rule.

**Table A**

| Rule set | Average concentrated poverty neighborhoods as a percent of total poverty neighborhoods |
|---|---|
| Starting distribution | .08% |
| No fixed projects after 50 iterations | 58% |
| Clustered fixed projects after 50 iterations | 70% |
| Separate fixed projects after 50 iterations | 54% |

**Discussion and Recommendations**

Fixed projects anchor areas of concentrated poverty. Separating projects creates more interfaces between high and low income neighborhoods by splitting up poverty clusters. Dispersed fixed projects can lead to higher levels of economic diversity and lower levels of concentrated poverty than no fixed projects whatsoever.

This is due to natural Schelling-like “segregation” as upper-income households move away from low income neighbors. One can interpret the “no fixed project” runs as representing either no housing projects or market based subsidizes.

With demand side market based subsidies such as housing mobility vouchers, each household still responds to market pressures, and low-income household will still look for housing in less expensive neighborhoods to maximize the value of their voucher. The outcome of this model suggests that many dispersed small fixed affordable housing projects increase local diversity over even housing mobility vouchers, a program developed specifically to reduce the concentration of subsidized housing.

For practitioners, this model can be considered a thought experiment of the single minded pursuit of economic diversity. In practice, economic diversity is but one of many goals of housing policy. Placing fixed location low-income housing projects evenly distributed throughout a city conflicts with other goals such maximizing the supply of units under a fixed budget and spatially linking projects with supportive services. The political reality of placing subsidized housing in affluent neighborhoods should also not be discounted.

Nevertheless, this model suggests that the current QCT system contributes to poverty concentration and should be restructured to reduce project clustering. Without the QCT system developers already have two very strong incentives to build affordable housing in the same lower income census tracts that they have in the past. Land is significantly cheaper in low income census tracts than high income tracts, and there is less organized political resistance (NIMBYism) as well. The QCT structure merely re-enforces this existing incentive.

Giving a bonus to disperse projects should be considered. This could be structured by rewarding projects in neighborhoods inversely proportional to the tract project concentration. Projects in MSAs would be rewarded for placing projects in tracts without an existing LIHTC project concentration. This would help the program work towards the goal of increasing economic diversity, and reward developers for taking on the price of land costs and entrenched NIMBY resistance.

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**Appendix A**

## Top Concentration of Metro/Central City LIHTC Projects in QCTs

| City | metro/Central City QCT Projects | Percent Off All Metro Projects that are QCT |
|---|---|---|
| CINCINNATI | 26 | 100% |
| MIAMI | 21 | 91% |
| CINCINNATI | 53 | 85% |
| ST. LOUIS | 154 | 85% |
| CHICAGO | 200 | 84% |
| WASHINGTON | 21 | 84% |
| CLEVELAND | 55 | 82% |
| SAN DIEGO | 21 | 81% |
| OAKLAND | 37 | 80% |
| PROVIDENCE | 26 | 79% |
| LOUISVILLE | 61 | 77% |
| PHILADELPHIA | 303 | 77% |
| SEATTLE | 61 | 76% |
| AUSTIN | 42 | 75% |
| JACKSON | 78 | 72% |
| BALTIMORE | 72 | 70% |

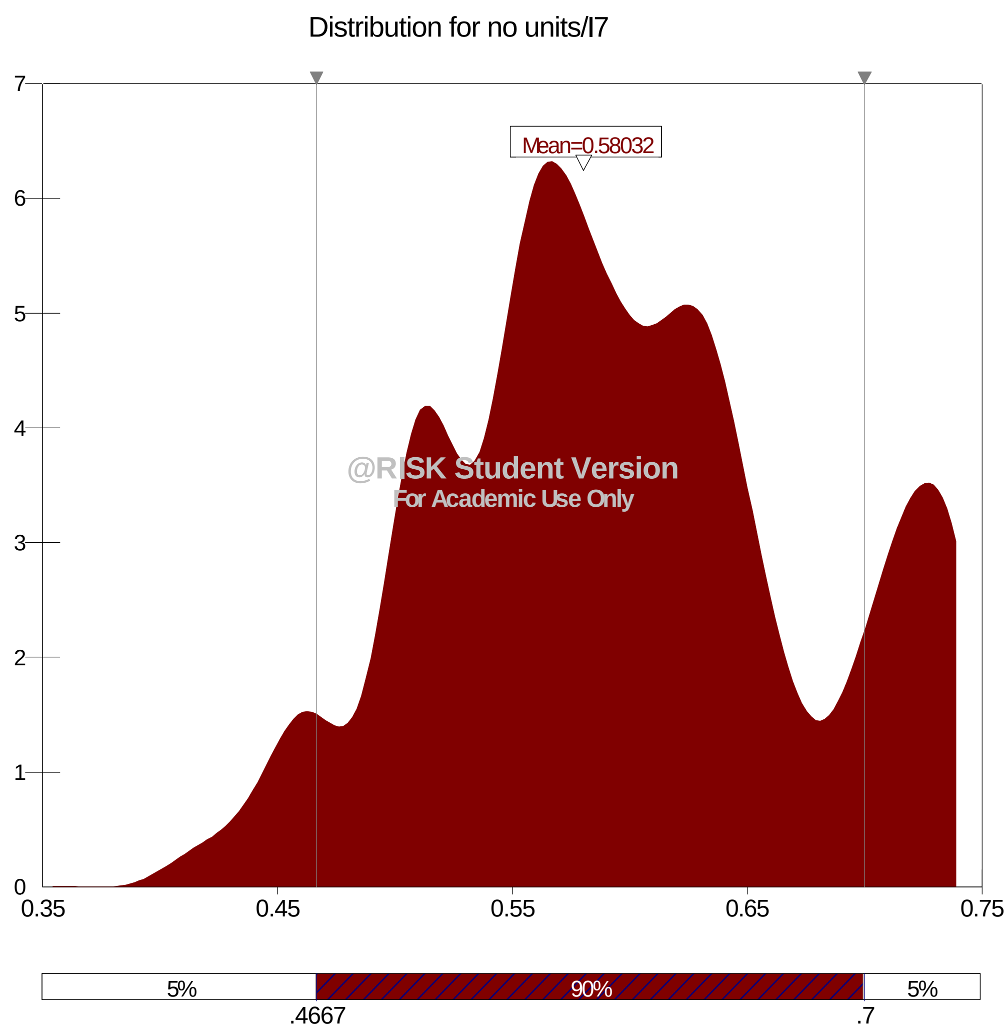
*** Citys with more than 20 Metro Projects and 70% or greater of their projects in QCTs.**

**Appendix B**

**Percent of Poverty Cells in a Concentrated Poverty Neighborhood**

**Results over 1,000 random initial conditions**

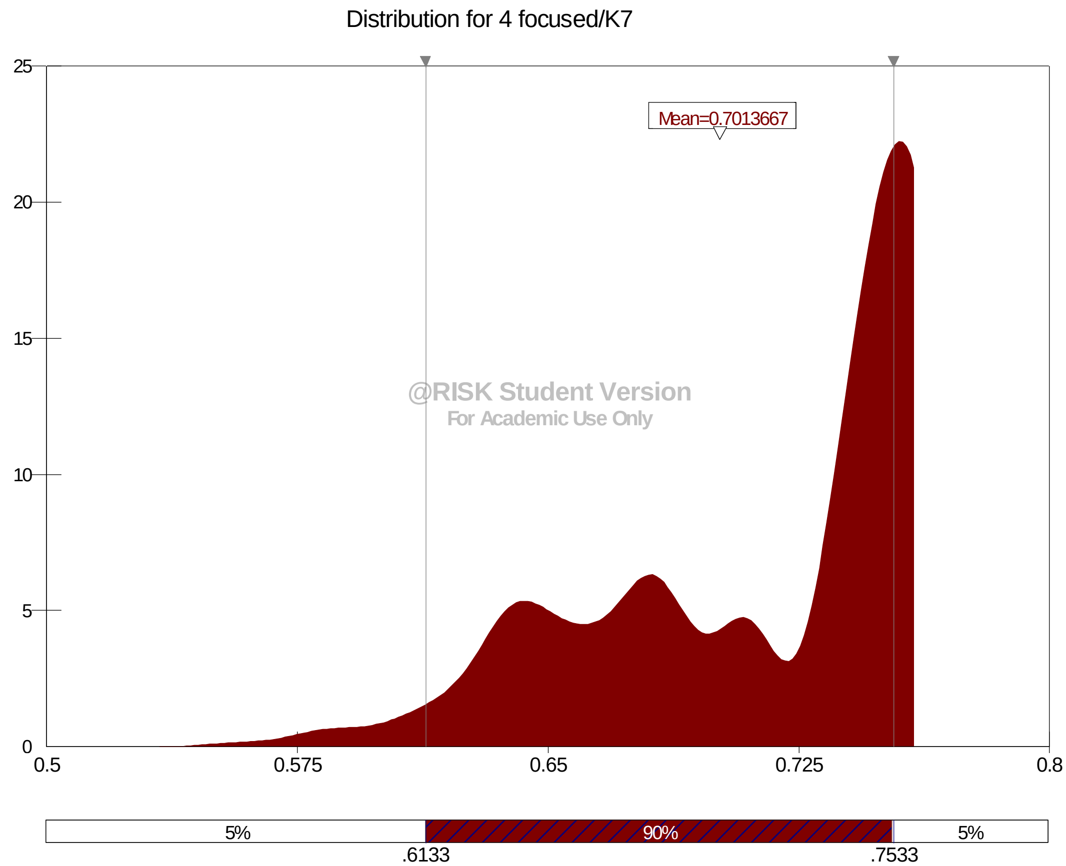
**No Fixed Location Low-Income Housing Projects**



**Percent of Poverty Cells in a Concentrated Poverty Neighborhood**

**Results over 1,000 random initial conditions**

**Four Clustered Fixed Location Low-Income Housing Projects**



**Percent of Poverty Cells in a Concentrated Poverty Neighborhood**

**Results over 1,000 random initial conditions**

**Four Separate Fixed Location Low-Income Housing Projects**