8-4-2020

# Will mandatory inclusionary housing create mixed-income communities? Evidence from London, UK

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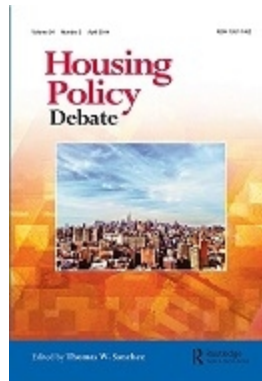Follow this and additional works at: https://scholarworks.gsu.edu/urban_studies_institute

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## Recommended Citation

Li, Fei and Guo, Zhan, "Will mandatory inclusionary housing create mixed-income communities? Evidence from London, UK" (2020). *USI Publications*. 73.
doi: https://doi.org/10.1080/10511482.2020.1787482

# Will Mandatory Inclusionary Housing Create Mixed-Income Communities? Evidence from London, UK

| Journal: | *Housing Policy Debate* |
|---|---|
| Manuscript ID | Draft |
| Manuscript Type: | Original Article |
| Keywords: | affordable housing, mandatory inclusionary housing, mixed-income communities, neighborhoods, London |
| Abstract: | Mandatory inclusionary housing, which requires market-rate housing developments to include a proportion of affordable housing units, has the potential of delivering affordable housing in high-cost areas, creating mixed-income communities, and mitigating socioeconomic segregation. This study evaluates this potential by examining residential development permits in London, UK, where affordable housing mandates have been in place in the past two decades. Between April 1st, 2004 and March 31st, 2014, we found more than 100,000 affordable units included in market-rate housing development permits in the greater London area. However, these "inclusionary" affordable units are more spatially concentrated than affordable units delivered by conventional means, i.e., in the public or nonprofit sector. Moreover, they are no less likely to be placed in deprived, low opportunity neighborhoods. The study then explores how neighborhood characteristics and local policy have influenced the decision to include affordable housing on-site. |
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# Will Mandatory Inclusionary Housing Create Mixed-Income Communities? Evidence from London, UK

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**ABSTRACT**

Mandatory inclusionary housing, which requires market-rate housing developments to include a proportion of affordable housing units, has the potential of delivering affordable housing in more affluent neighborhoods and creating mixed-income communities. This study evaluates this potential effect in London, UK, where mandatory inclusionary housing has been implemented in all local authorities since the early 2000s. Comparing the spatial concentration and average neighborhood characteristics of affordable housing delivered under inclusionary housing and those created via conventional means, i.e., in the public or nonprofit sector, we find that a higher percentage of "inclusionary" affordable units are concentrated in a small number of neighborhoods, and both types of affordable units are more likely to be placed in disadvantaged neighborhoods than market-rate units. We explore the ways in which local implementation of inclusionary housing could have allowed developers to shift some of the inclusionary affordable housing toward disadvantaged neighborhoods.

**Keywords**: affordable housing, mandatory inclusionary housing, mixed-income communities, neighborhoods, London

The spatial distribution of subsidized low-income or affordable housing can be closely associated with economic and/or ethnic segregation and exclusion in cities. Aimed at accommodating the urban poor (and often minorities), affordable housing is an important factor that shapes the sociodemographic composition of urban neighborhoods. A concentration of affordable homes therefore naturally leads to concentration of poverty or disadvantage, which may create negative neighborhood externalities and adversely affect residents both in and outside of affordable housing (Bolt, Phillips, & Van Kempen, 2010; Ellen & Turner, 2003; Galster, 2012). Moreover, subsidized housing is often disproportionately placed in poor and low opportunity areas (Massey & Kanaiaupuni, 1993), which reinforces existing inequalities and social divides. Early public housing projects in the United States, for example, have been criticized for aggravating segregation and the deterioration of impoverished urban neighborhoods (Crump, 2002; Goering, Kamely, & Richardson, 1997).

These concerns have contributed to a regime shift in government housing policies from large scale, public production of low-income housing to more decentralized, social-mix-oriented strategies, such as HOPE VI, Moving to Opportunity for Fair Housing (MTO), and the Low Income Housing Tax Credit (LIHTC) program in the U.S. (Hays, 2012; Owens, 2017) and urban regeneration in Europe (Kleinhans & Van Ham, 2013; Trillo, 2020b). Among these strategies, inclusionary housing explicitly requires the integration of affordable homes into market-rate housing developments. Mandatory inclusionary housing, in particular, has been regarded as a potentially effective way to both increase the production of affordable housing and create mixed-income communities (Jacobus, 2015; Lerman, 2006; Metzger & Khare, 2017). However, few have empirically examined the distribution of affordable homes provided through inclusionary housing, or the equity effects of mandatory inclusionary housing (Diagne, Kurban, & Schmutz,

2018; Kontokosta, 2014, 2015). We aim to bridge this research gap by exploring the potential of mandatory inclusionary housing in delivering affordable housing in high-cost areas, creating mixed-income communities, and subsequently mitigating socioeconomic segregation.

This study analyzes the inclusion of affordable housing in residential development permits in London, UK, where, during the study period of 2004/05—2013/14, over half of the new affordable homes were delivered in market-rate housing developments under mandatory inclusionary housing. It addresses three research questions: 1) Are affordable units produced via mandatory inclusionary housing more spatially dispersed than those produced by conventional means, i.e., in the public or nonprofit sector? 2) Do neighborhood characteristics affect the provision of affordable housing via mandatory inclusionary housing? In other words, have private developers produced affordable housing disproportionately in disadvantaged neighborhoods, or has mandatory inclusionary housing successfully delivered more affordable homes in neighborhoods that may offer low-income families better life opportunities? 3) If the placement of inclusionary affordable housing is associated with neighborhood characteristics, do local policies play a role in ensuring that mandatory inclusionary housing contributes to the creation of equitable, mixed-income communities? Being one of the first to examine the distribution and placement of affordable housing produced through mandatory inclusionary housing, the study makes an important contribution to the debate around inclusionary housing and mixed-income communities. The findings would help inform decision making in the design, adoption, and implementation of more equitable housing policy.

**Literature Review**

Plenty of research has shown that segregation and concentrated poverty can lead to worse life outcomes for the poor and contribute to the persistent inequalities in contemporary cities (Cutler & Glaeser, 1997; Cutler, Glaeser, & Vigdor, 2008; Lépore & Simpson Lapp, 2018; Musterd, 2005; South & Crowder, 1999; Valdez, Kaplan, & Curtis Jr, 2007; Williams & Collins, 2016; Wilson, 1987). The literature on how neighborhoods affect low-income households and individuals, despite some mixed evidence on the economic outcomes of adults, suggests that living among less disadvantaged neighbors may convey substantial health benefits, quality of life improvements, and better outcomes for children (Chetty, Hendren, & Katz, 2016; Ellen & Turner, 2003; Galster, Andersson, & Musterd, 2015; Galster, Santiago, & Lucero, 2015; Ludwig et al., 2013; Oakes, Andrade, Biyoow, & Cowan, 2015). These findings provide the evidence for policy programs that facilitate mixed-income housing, especially those providing low-income households with housing opportunities in low-poverty neighborhoods (Bolt et al., 2010; Hays, 2012; Musterd & Andersson, 2005; Owens, 2017; Park, 2013; Read & Sanderford, 2017; Tunstall & Lupton, 2010; van Kempen & Bolt, 2009).

Meanwhile, rising concerns over gentrification, especially as related to inner city new developments and redevelopments (Davidson & Lees, 2010; Immergluck, 2009), have brought public and political attention to the risk of subsequent displacement and loss of affordable housing. Researchers and policymakers have called for more proactive strategies, including inclusionary housing, to preserve affordable housing in neighborhoods with rising housing costs and to mitigate the displacement effects of gentrification (Freeman & Schuetz, 2017; Levy, Comey, & Padilla, 2006, 2007; Rose, 2002). The question of where affordable units are created under mandatory inclusionary housing, therefore, becomes a more prominent one than ever.

*Inclusionary Housing: An Overview*

Inclusionary housing emerged in the U.S. in the 1970s and subsequently spread to Europe, Canada and other parts of the world, though its popularity only substantially increased in the past few decades (Calavita & Mallach, 2010; Gurran et al., 2018; Hickey, 2014; Innovative Housing Institute, 2010; Mallach & Calavita, 2010; Schuetz & Meltzer, 2012). The increasing adoption of inclusionary housing coincided with an international trend of privatization and marketization in the housing sector, as national and local governments around the world shifted from direct involvement in the production and management of social housing to more market-driven, diversified affordable housing schemes (Clapham, 2006; Trillo, 2020a). With shrinking public funds on affordable housing and growing social inequalities, inclusionary housing stands out as a promising strategy to recapture the appreciation in land value, preserve housing affordability and create mixed-income communities by embedding affordable housing in market-rate developments (Jacobus, 2015; Trillo, 2020b).

Inclusionary housing can take varied forms in different countries due to the different planning systems (for an international survey of inclusionary housing policies, see Calavita & Mallach, 2010). In London the legal basis for local governments to require or negotiate on-site affordable housing provision in private developments stems from the "planning obligation" as defined by Section 106 (S106) of the *1990 Town and Country Planning Act*. Since the *1947 Town and Country Planning Act* has nationalized development rights (Gurran & Bramley, 2017), the approval of a development plan generates a "planning gain" to the developer, who is in turn expected to contribute to the public good in the form of "planning obligations," which often include affordable housing. This legal basis allows inclusionary housing to be implemented in larger scales and more consistently across jurisdictions as compared to the piecemeal adoption of inclusionary housing in the U.S. Along with the discontinuation of council housing construction

and the privatization of existing social housing under the right-to-buy policy, it has become increasingly popular for local governments in England to rely on the planning gain approach to add new affordable housing (Crook, Monk, Rowley, & Whitehead, 2006; Crook & Whitehead, 2002; Whitehead, 1993). By 2005, more than half of the new affordable housing units completed in the England were produced via S106 agreements (Whitehead, 2007).

In English cities that adopt the planning gain approach to inclusionary housing, the inclusion of affordable housing in private developments is typically mandatory. Sometimes variations may be granted such as providing affordable housing off-site instead of on-site, paying an in-lieu fee, or an exemption from the affordable housing obligation, usually when the developer could demonstrate financial hardship with independent viability assessments (McAllister, Street, & Wyatt, 2013). A S106 agreement defines the proportion of proposed units that will be designated as affordable housing, which traditionally include 1) social rented housing, with substantially below-market rents for low-income households, and 2) intermediate housing, which includes both rentals and shared ownership units that target moderate-income households. More recently, a third category "affordable rent housing" has been introduced, with rents higher than those of social rented housing and no more than 80% of the local market rents.

In Great Britain and continental Europe, inclusionary housing plays an integral role in the longstanding emphasis of housing policies on creating socially mixed housing and communities (Bolt et al., 2010; Calavita & Mallach, 2010; Musterd & Andersson, 2005; Trillo, 2020b; van Kempen & Bolt, 2009). The 2004 London Plan, for instance, states that "[a]ffordable housing should be integrated with the rest of the development and have the same external appearance as the rest of the housing" (Mayor of London, 2004, p. 65) and only "[i]n certain exceptional cases" (p. 66) the affordable housing requirement may be fulfilled by off-site provision or in-lieu

payments instead of on-site provision. Local planning documents also frequently include similar phrases to emphasis the importance of housing mix and on-site provision of affordable housing (e.g., London Borough of Camden, 2006; London Borough of Richmond upon Thames, 2014; Southwark, 2008), sometimes referring to the physical integration of affordable housing amongst market housing as "pepper-potting" (Southwark, 2008, p. 27). There is, however, a surprising scarcity of evidence or discussion on the spatial distribution of S106 affordable housing or the effectiveness of the planning gain approach in creating affordable housing in more affluent communities or preserving affordable housing in gentrifying areas, though reports have pointed out the case-by-case review process and the viability assessment approach can leave developers much flexibility to negotiate the planning obligations of individual developments (Crook, Henneberry, & Whitehead, 2015; McAllister et al., 2013). On both sides of the Atlantic, much of the research effort on inclusionary housing concerns the quantity of affordable housing created or the potential side effects on housing production or housing prices, rather than the location or distribution of the affordable units created or the implications of inclusionary housing for socioeconomic or racial segregation (Brunick, 2004; Calavita, Grimes, & Mallach, 1997; CCRH & NPH, 2007; Hickey, Sturtevant, & Thaden, 2014; Mukhija, Regus, Slovin, & Das, 2010; Powell & Stringham, 2004; Schuetz, Meltzer, & Been, 2009, 2011).

***The Placement of Affordable Housing Under Inclusionary Housing and Other Programs***
Only a few studies to date have empirically explored the spatial distribution of affordable housing delivered through inclusionary housing or the policy's implications on social mix, all of which are based on American cases. Ryan and Enderle (2012) examine a voluntary inclusionary housing law, California State Density Bonus Law, which requires local governments to offer density bonuses and other planning concessions to developments that designate 10% of the units

as low-income housing, or 5% as very low-income housing. In the City of San Diego, the authors find that the use of density bonuses is concentrated and correlated with the percentage of minorities (Black and Hispanic) and multifamily housing in neighborhoods. Schwartz, Ecola, Leuschner, and Kofner (2012) survey 11 inclusionary housing programs across the U.S. and find that these policies have delivered affordable homes in low-poverty neighborhoods with access to low-poverty schools. The study also shows, however, that neighborhoods with one or more inclusionary homes tend to have lower median household income than those without inclusionary homes (Schwartz et al., 2012, p. 16). It is also worth noting that 6 of the 11 surveyed programs have produced fewer than 500 affordable units by 2011, and that by simply comparing neighborhoods with and without inclusionary units, the study does not account for the distribution of market-rate housing developments, the quantity of the inclusionary units, or the share of the new housing units are that affordable. Still, the authors suggest that inclusionary housing can be a more promising strategy in promoting inclusion as compared to other affordable housing programs, such as the Low-Income Housing Tax Credit (LIHTC) program and traditional public housing.

Kontokosta (2014) examines the effects of inclusionary housing developments on the racial and economic diversity in census tracts in two counties, Montgomery, Maryland and Suffolk, New York. In Montgomery County, the placement of any inclusionary housing units is associated with a decline in the percentage of middle-income families (between 80% and 120% of AMI), though the quantity of inclusionary housing units built is positively related to the percentage of middle-income families. In Suffolk County, in contrast, the presence of any inclusionary housing units is associated with an increase in the percentage of middle-income families. Inclusionary housing developments are associated with lower percentages of non-

Hispanic Whites in both counties, but the implications are probably different for Suffolk County, where inclusionary housing units are more concentrated in neighborhoods with higher percentages of minorities.

Realizing that the integration effects of inclusionary housing depend on where inclusionary housing units are located, Kontokosta (2015) further compares the location of inclusionary housing units in these two counties. As hinted in the previous study, inclusionary housing units in Montgomery County have been more dispersed and less located in neighborhoods with concentrated poverty or minorities than those in Suffolk County. The interpretation can be difficult due to the many differences between the counties and their inclusionary housing programs. Kontokosta (2015) explains the different distribution of inclusionary housing units by the fact that Montgomery County has regional control over inclusionary housing, while Suffolk County relies on a number of varied local programs. A probably more important factor that the author has failed to address is that Montgomery County has had a mandatory inclusionary housing scheme since the 1970s (Trombka et al., 2004), while the inclusionary housing programs in Suffolk County were all voluntary until 2009 (New York General Municipal Law, Article 16-A).

From a slightly different angle, Diagne et al. (2018) examine the experience of African American beneficiaries of the Moderately Priced Dwelling Unit (MPDU) ownership program in Montgomery County, MD, one of the earliest and the most long-lasting inclusionary housing programs in the U.S. The authors find that African American applicants were less likely to be selected until a later stage of the program (around and after 2000), that those who were selected tended to purchase MPDUs in cheaper neighborhoods, and that the African American purchasers of MPDUs were somewhat concentrated at the municipality and neighborhood levels but more

scattered at the development level (Diagne et al., 2018). The study, however, does not directly address the distribution of the MPDUs or the effects of neighborhood characteristics.

Research on the spatial distribution and integration effects of other types of low-income housing is arguably better established, especially with regard to LIHTC, which has a much wider application in the U.S. Majority of the evidence suggests that LIHTC projects tend to cluster in neighborhoods with higher poverty and higher concentration of minorities, though less so than other federal housing projects (Dawkins, 2013; Freeman, 2004; Oakley, 2008; Van Zandt & Mhatre, 2009). Some further examine the implications of LIHTC on poverty deconcentration and desegregation, and find limited or modest effects (Ellen, Horn, & O'Regan, 2016; Owens, 2015). These studies may have limited generalizability to mandatory inclusionary housing due to the different designs and structures between LIHTC and inclusionary housing programs, but they present useful questions and perspectives for future research on the social integration effect of inclusionary housing. One may expect mandatory inclusionary housing to have a more substantial effect on the dispersal of low-income housing and beneficiaries, as the policy is explicitly designed to create mixed-income housing and applies more broadly to market-rate housing developments.

In sum, the question of how inclusionary housing can disperse and provide affordable housing in less deprived areas remains little discussed. Empirical studies are rare and concentrated in the U.S., and their policy implications are limited by the varied features and outputs of local programs examined (Kontokosta, 2015; Schuetz et al., 2009; Schwartz et al., 2012). The lack of strong evidence on how such programs promote mixed-income communities makes it more

difficult to advocate mandatory inclusionary housing as an effective tool to counter residential segregation and improve the quality of life for low-income households.

## Case, Data and Methods

### *Case and Data*

London, with its pressing demand for affordable and overall housing (Mayor of London, 2019), has been a leader in producing affordable housing via S106 agreements. Following the national policies that specifically enabled local governments to require affordable housing in the planning review process (DETR, 1998; ODPM, 2000), all 33 local authorities in the greater London area have formally incorporated the affordable housing requirement into their local plans by 2004, most of which require at least 30%-50% of the housing units in a new development to be made affordable. In the 2008 London Plan, the Greater London Authority (GLA), the regional planning authority that oversees the 33 local authorities in greater London, further extended the coverage of mandatory inclusionary housing, requiring all developments with 10 or more units to include an affordable housing contribution (from a threshold of 15 or more units in the 2004 London Plan).

We use the London Development Database (LDD), a database maintained by the GLA that contains all planning permits in the greater London area since April 1st, 2004, to examine the placement of affordable housing in London. The study period is the first decade after the establishment of the GLA and the formal adoption of mandatory inclusionary housing in the 2004 London Plan, from April 1st, 2004 to March 31st, 2014. During this period, the majority of new affordable housing consisted of social rented housing and intermediate housing. We select

this study period because the introduction and the rapid increase of affordable rent housing, which is at arguably lower affordable levels than social rented or intermediate housing, could have substantially changed the affordability and distribution of new affordable housing after the financial year 2013/14 (Mayor of London, 2019).

Between April 1st, 2004 and March 31st, 2014, the LDD recorded 44,090 planning permits that involve the creation of new housing. 72% of the developments (31,547) had been completed or started by the end of 2014, totaling 353,058 housing units, including 239,769 market-rate units and 113,289 affordable units (63,933 of which are social rented units). Among these new affordable units, 74,755 were delivered on development sites with a mix of affordable and market-rate units. We classify these developments as "*S106 sites*," or market-rate developments that included a proportion of affordable housing via S106 agreements. The rest 38,534 affordable units were built on sites that contain 100% affordable housing. We classify these as "*conventional sites,*" presumably developed by nonprofit housing associations or (to a lesser extent) local authorities.[2]

In additional to the LDD, this paper also utilizes qualitative data collected from local planning documents between 2000 and 2014 and personal interviews with local authority officials, planners and developers in 2015. The qualitative phase of the study helps the authors understand the context, frame the research hypotheses, and interpret findings from quantitative analysis.

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[2] Since we do not know the exact developer of each site, this approach could misclassify some developments. For example, a site specifically used to provide the off-site affordable housing for another site would be classified as a "conventional site." Considering that developers are more likely to provide off-site affordable housing in low-cost areas, this potential misclassification will probably bias our results toward finding fewer S106 affordable units and more "conventional" affordable units in these areas, i.e., we may underestimate the spatial concentration of S106 affordable units in less desirable neighborhoods.

***Hypotheses***

To explore the effectiveness of mandatory inclusionary housing in promoting mixed-income communities and creating affordable housing in more desirable neighborhoods, we develop three sets of hypotheses regarding 1) the spatial concentration of S106 affordable housing; 2) the neighborhood characteristics of S106 affordable housing; and 3) the role of local policies. We use conventional affordable housing and market-rate housing as comparisons for the first two hypotheses.

*Spatial Concentration*

We expect the affordable housing units created under inclusionary housing to be more spatially dispersed across neighborhoods than those created via conventional means. Considering that S106 affordable units are embedded in new market-rate developments, we also expect these units to be concentrated in fast-growing developments with more residential developments. We hence hypothesize:

> *H1a: S106 affordable units are less spatially concentrated than conventional affordable units.*

> *H1b: The level of spatial concentration of S106 affordable units is closer to that of market-rate units than that of conventional affordable units.*

*Neighborhood Characteristics*

Similarly, we expect the distribution of S106 affordable units to be more similar to that of market-rate units than that of conventional affordable units. Therefore:

> *H2a: The average neighborhood characteristics of S106 affordable units are more desirable than those of conventional affordable units.*

Meanwhile, as local authorities have the flexibility to grant variations in circumstances where the affordable housing requirement is deemed infeasible (Crook et al., 2015; McAllister et al., 2013), developers may exploit such opportunities to minimize the provision of S106 affordable units in highly desirable locations and to shift some or all of the S106 affordable housing toward more disadvantaged neighborhoods. We identify three possible ways for developers to do so:

1. For development sites close to the threshold size of the affordable housing requirement (e.g., 10 or more units), developers may deliberately build under the threshold to avoid providing affordable housing. Alternatively, developers may break a larger site into two or more smaller sites to keep the size of each individual development under the threshold. According to local developers, however, this strategy could result in rejection of the planning application. A logistic regression analysis on developments just above and below the inclusionary housing threshold finds no evidence that developers use this strategy more often in affluent neighborhoods.[3]

2. Developers may be more likely to negotiate for an exemption or reduction of on-site affordable housing provision by demonstrating financial hardship in high-cost areas.

3. Developers may negotiate to transfer some of the required affordable housing from a site in a high-cost area to a site in a low-cost area.

We derive the following sub-hypotheses from the latter two scenarios:

*H2b: Private developments in more desirable locations are less likely to include affordable housing on-site than those in less desirable locations.*

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[3] Results are available upon request.

> *H2c: When private developments in more desirable locations provide affordable housing on-site, they tend to include a smaller percentage of affordable housing than those in less desirable locations.*

*Local Policies*

While inclusionary housing in London stems from national and regional policy frameworks, the local implementation could lead to different outcomes regarding the placement of S106 affordable housing. Although local planning documents and officials pose the two objectives of inclusionary housing – producing affordable housing and creating mixed-income communities – as equal priorities, it frequently comes up in interviews that the affordable housing requirement can be an undue burden in high-cost areas. Local planners sometimes face trade-offs between securing housing supply and promoting mixed-income housing, especially in local authorities with pressing housing shortages. The political make-up of local councils can also play a role; Labour councils tend to implement inclusionary housing more aggressively and be stricter in granting variations. We therefore hypothesize:

> *H3a: S106 affordable units are more likely to be placed in disadvantaged neighborhoods in local authorities with more urgent housing needs.*

> *H3b: S106 affordable units are less likely to be placed in disadvantaged neighborhoods in local authorities with a Labour council.*

**Methods**

We employ neighborhood, development, and housing-unit-level analyses to test the hypotheses defined above. *H1a* and *H1b* are explored in neighborhood-level analysis that compares the

percentages of housing units (S106 affordable housing, conventional affordable housing, and market-rate housing) located in a small number of most concentrated neighborhoods. *H2a* is examined in a housing-unit-level comparison of the average neighborhood characteristics of the three types of units. *H2b*, *H2c*, *H3a*, and *H3b* are tested in development-level analyses that regress the on-site provision of affordable housing on neighborhood characteristics.

*The Neighborhoods*

We use middle layer super output areas (MSOAs) from the UK Census as a proxy for neighborhoods.[4] To extract the main characteristics describing a neighborhood, we use principal component analysis to reduce a wide range of demographic, socioeconomic, labor market, education, quality of life, and housing market statistics to three indices. Table 1 shows the eigenvectors of the three components, which jointly explain 71% of the total variation between MSOAs. The distribution of principal component scores across London neighborhoods are shown in Figure 1. The first principal component (PC1) is strongly correlated with neighborhood variables that indicate poverty and low quality of life (unemployment and poverty rates, lowest grade workers, existing social housing and low-value properties, non-whites, crimes and traffic accidents, and mortality) and negatively correlated with variables indicating higher socioeconomic status (managerial & professional workers, education, income and housing values). This is an obvious indicator for disadvantaged neighborhoods, and, as Figure 1 shows, scores highest in parts of East London and the south bank. We therefore define PC1 as the index of "poor neighborhoods."

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[4] An average London MSOA has 7,296 residents. Greater London had 983 MSOAs in the 2001 UK Census,

The second component (PC2), in contrast, represents the "elite center" of London: it highly correlates with density, working age population, proximity to work, high educational levels, managerial & professional workers, and higher housing prices. This elite center, nevertheless, is also exposed to greater crime or accident hazards and poor environmental quality due to its central location. The third component (PC3) is more mixed and only explains 7% of the total variation, though it clearly captures some demographic variations that do not necessarily correlate with socioeconomic status. PC3 is dominated by retired population, whites, and high housing values, but also the proportion of on benefit, unemployed, and lowest grade workers. The strong loading of job density, which is measured by the ratio of jobs to working age population, more likely reflects the lack of working age people rather than the concentration of jobs in this neighborhoods. High scores in PC3 are found in the suburbs and parts of inner London (Figure 1). The pattern clearly matches the distribution of white-majority neighborhoods. We hence refer to this component as indicating the traditional "white enclaves."

Table 1. Principal components extracted from the neighborhood variables

| Variable | PC1 | PC2 | PC3 |
|---|---|---|---|
| Population density (persons per hectare) | .1370 | .3146 | -.0351 |
| % aged 16-64 | -.0711 | .3875 | -.2381 |
| % aged 65+ | -.1547 | -.2904 | .3859 |
| % non-white | .2174 | .1139 | -.2882 |
| Job density (jobs per person aged 16-64)[+] | -.0410 | .0971 | .3442 |
| % of works commuting 20km or longer | -.1046 | -.2863 | .0743 |
| % managerial & professional employees | -.2655 | .2580 | -.0432 |
| % on state benefit, unemployed, or lowest grade workers (age 16+) | .2939 | -.0422 | .3734 |
| Unemployment rate | .3079 | .1425 | .1225 |
| Median household income[++] | -.3085 | .1815 | .1063 |
| Poverty rate (adjusted for housing costs)[+++] | .3229 | -.0030 | .0508 |
| % of people with college or higher degrees (age 16-74) | -.1603 | .3918 | -.0176 |
| Average GCSE scores[++] | -.2121 | -.0685 | -.2314 |
| Deprivation index: crime & traffic accidents[++] | .2178 | .2053 | .0302 |
| Deprivation index: environment & housing quality[++] | .1250 | .3865 | .0995 |
| Standard mortality ratio[++] | .1898 | -.0087 | -.0507 |

| | | | |
|---|---|---|---|
| Median housing price[++] | -.2285 | .2157 | .3150 |
| % of low-value dwellings[a] | .2984 | -.0170 | .0190 |
| % of high-value dwellings[b] | -.2222 | .1750 | .4022 |
| % of social rented or intermediate dwellings | .2842 | .1158 | .2956 |
| *Proportion of total variation* | *41%* | *23%* | *7%* |

Unless otherwise specified, all neighborhood variables are derived from 2001 Census.
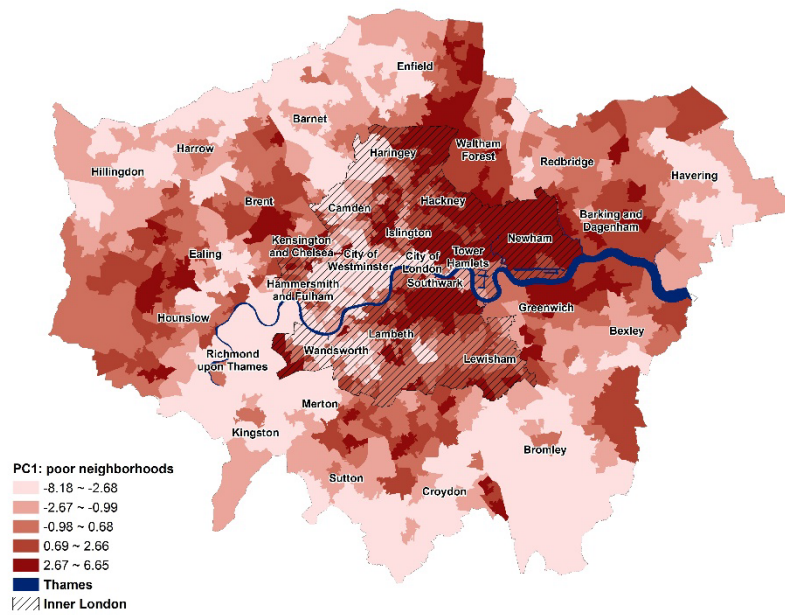
[+] Annual Business Inquiry employee analysis, 2005.
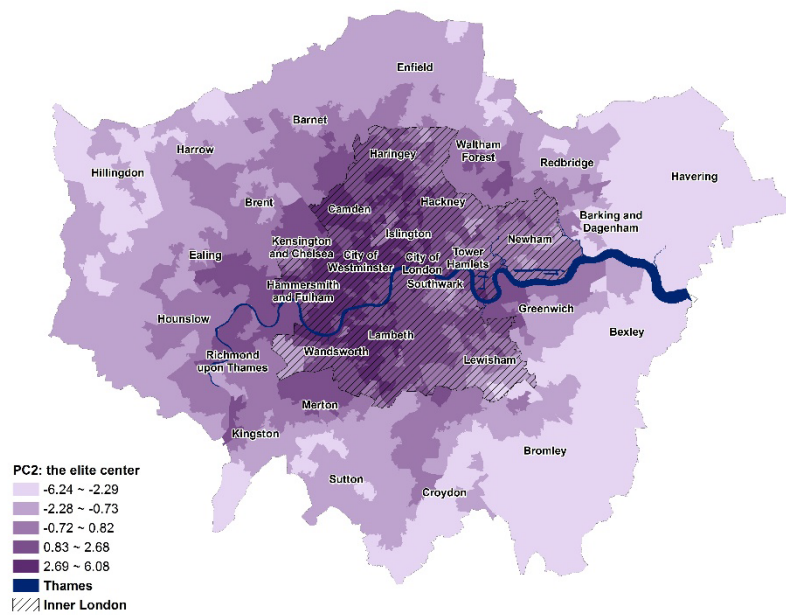
[++] Greater London Authority, 2004.

[+++] Office for National Statistics, 2007.

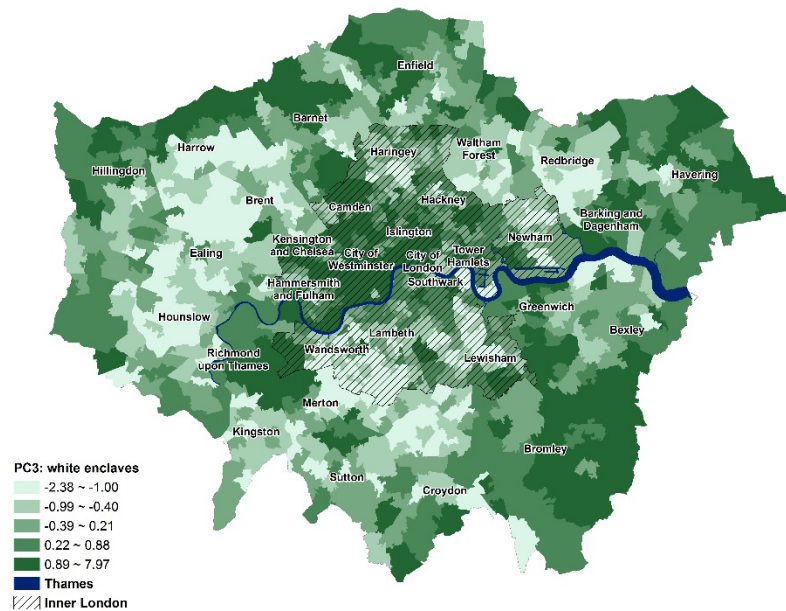[a] Council tax bands A, B and C, up to £68,000.

[b] Council tax bands G and H, more than £160,000.



(a) Principal component 1: poor neighborhoods

(b) Principal component 2: the elite center



(c) Principal component 3: white enclaves

Figure 1. Principal component scores in London neighborhoods

*Development-Level Models*

The development-level analysis tests whether and to what extent neighborhood characteristics, measured by the three principal components, and local policy explain the on-site inclusion of affordable housing among private developments. Since we are interested in the extent to which the flexible implementation of inclusionary housing may lead to less equitable placement of S106 affordable units, conventional sites and developments smaller than the inclusionary housing threshold are excluded from this analysis.

The dependent variable – the percentage of affordable housing in a development – has a value between 0 and 1, with a non-negligible amount of zeros for developments exempted from on-site affordable housing provision. We use zero-inflated beta (ZIB) regression to account for the distribution of the dependent variable. ZIB is a statistical procedure that consists of 1) a logit model on the probability of a development including any affordable housing, and 2) a beta regression model on the percentage of affordable housing included, when the percentage is greater than zero. We use the ZOIB module developed by Buis (2012) to estimate the model in Stata. See Appendix 1 for more details.

The key independent variables are the three indices of neighborhood characteristics. Other control variables include *development size* (log-transformed number of housing units), an indicator of direct redevelopment—*whether the site has any existing housing units on it at the time of approval*, and *local authority* and *year fixed effects* to control for unobserved policy and market factors. Local policies are measured by 1) the *annual housing target* in local plans per 1,000 residents and 2) the *share of Labour party council members* in the local council.

**Findings**

*Spatial Concentration and Neighborhood Characteristics*

Table 2 compares the percentages of market-rate, S106, and conventional affordable units started or completed by 2014 in the most concentrated 5%, 10%, and 20% of the MSOAs. The higher the percentage, the more spatially concentrated the specific type of housing is. As new developments naturally congregate in certain fast-growing neighborhoods, some level of concentration is expected. However, the accompanying S106 affordable units are more concentrated than both market-rate units and conventional affordable units. Over half of the S106 affordable units are located in only 5% of the MSOAs, as compared to 36% of the market-rate units and 35% of the conventional affordable units (Table 2).

To get a better idea of the spatial distribution of different types of affordable housing, we also include the subset of affordable housing that targets the lowest-income group – social rented housing – in this and the following analyses. The pattern for social rented housing is pretty similar to that of S106 affordable housing in general. The top 20% MSOAs contain 85% of all S106 affordable units and 87% of the S106 social rented units. The higher concentration of S106 affordable housing than that of conventional affordable housing, despite the smaller number of the latter, runs contrary to *H1a* and *H1b* and suggests that inclusionary housing in London has not necessarily led to more spatial dispersal of affordable housing than the conventional approaches.

Table 2. Percentages of housing units in the most concentrated MSOAs

| Housing Type | Market-Rate | S106 Affordable | S106 Social Rented | Conventional Affordable | Conventional Social Rented |
|---|---|---|---|---|---|
| % in top 5% MSOAs | 36% | 51% | 54% | 35% | 34% |
| % in top 10% MSOAs | 50% | 68% | 70% | 53% | 50% |
| % in top 20% MSOAs | 65% | 85% | 87% | 73% | 72% |
| N | 239,769 | 74,755 | 40,921 | 38,534 | 23,012 |

Table 3 further compares the average neighborhood characteristics of market-rate, S106 affordable, or conventional affordable units assessed at or close to the beginning of the study period (2004/05). Social rented units are omitted here, as they face very similar neighborhood characteristics with affordable units in general. Both types of affordable units are consistently found in less white, less employed, poorer MSOAs than market-rate units, with statistically significant differences ($p < .05$). The average neighborhood statistics of S106 affordable units are not substantially better than those of conventional affordable units, if not worse. On some aspects the S106 approach seems to perform better, such as delivering affordable homes in areas with higher job density, slightly higher housing values and better educational levels. However, the average S106 affordable unit sees even higher unemployment and poverty rates, a higher percentage of minorities, and greater concentration of existing social housing stock in its neighborhood than the average conventional affordable unit does. S106 affordable units see higher growth in neighborhood housing price between 2005 and 2014 compared to conventional affordable units, which is consistent with the theory that inclusionary housing helps preserve affordable housing in gentrifying neighborhoods. Still, the average housing price growth in an S106 affordable unit's neighborhood is substantially lower than that of a market-rate unit's.

Table 3. Neighborhood characteristics of the average market-rate, S106, or conventional affordable unit

| Average Neighborhood Statistics | Market-Rate | S106 Affordable | Conventional Affordable |
|---|---|---|---|
| Population density (persons per hectare) | 73 | 75 | 80 |
| % non-white | 33% | 37% | 35% |
| % managerial & professional employees | 34% | 30% | 30% |
| % on state benefit, unemployed, or lowest grade workers (age 16+) | 17% | 19% | 18% |
| Unemployment rate | 8.0% | 9.1% | 8.7% |
| Job density (jobs per person aged 16-64)[+] | 0.87 | 0.57 | 0.40 |
| Median household income[++] | £29,684 | £27,750 | £27,149 |
| Poverty rate (adjusted for housing costs)[+++] | 29% | 33% | 32% |
| % of people with college or higher degrees (age 16-74) | 33% | 30% | 28% |
| Average GCSE scores[++] | 344 | 336 | 332 |
| % of low-value dwellings[a] | 52% | 59% | 60% |
| % of high-value dwellings[b] | 7.2% | 4.3% | 3.5% |
| % of social rented or intermediate dwellings | 36% | 44% | 40% |
| Housing price growth (nominal), 2005-2014 | 72% | 66% | 64% |

Unless otherwise specified, all neighborhood variables are derived from 2001 Census. All differences are statistically significant (p < .05).
[+] Annual Business Inquiry employee analysis, 2005.
[++] Greater London Authority, 2004.
[+++] Office for National Statistics, 2007.
[a] Council tax bands A, B and C, up to £68,000.
[b] Council tax bands G and H, more than £160,000.

In short, we find affordable units delivered on S106 sites to be more spatially concentrated than market-rate units or affordable units created on conventional, 100% affordable sites. The average neighborhood statistics of S106 affordable units, moreover, is closer to that of conventional affordable units than that of market-rate units. It seems that, despite the explicit objective of mandatory inclusionary housing to integrate affordable housing in market-rate developments, developers in London still have some flexibility to shift the affordable housing obligation toward poorer neighborhoods, either to reduce costs or to prevent the potential adverse effects on the values of the market-rate housing (assuming affluent homebuyers are more sensitive to low-income neighbors, such effects will be least felt in neighborhoods with low- to

moderate-income levels). These findings contradict the objective of mandatory inclusionary housing to create mixed, balanced communities, and necessitate further investigation into how the affordable housing requirement works at the development level.

### *On-Site Inclusion of Affordable Housing*

The development-level analysis includes 1,961 developments above the threshold size and subject to the affordable housing requirement. Roughly a third (678) provided no affordable housing on-site, and the rest included varied percentages of affordable housing. Figure 2 shows the percentages of affordable and social rented housing among S106 developments. While many developments include around 30% affordable housing and 15–25% social rented housing, there is considerable variation in the on-site provision of affordable housing, ranging from below 15% to above 50%.

Table 4 shows the effects of neighborhood characteristics on the on-site inclusion of affordable housing, and social rented housing specifically. The first two columns under each model are the regression coefficients from the zero-inflated part of the model (whether a development includes any on-site affordable housing) and the proportion part of the model (the percentage of affordable housing, conditional on the inclusion of some affordable housing). To help intuitive interpretation, we flipped the signs of the zero-inflated coefficients so they represent the effects on the probability of a development *including* any affordable housing or social rented housing on-site.
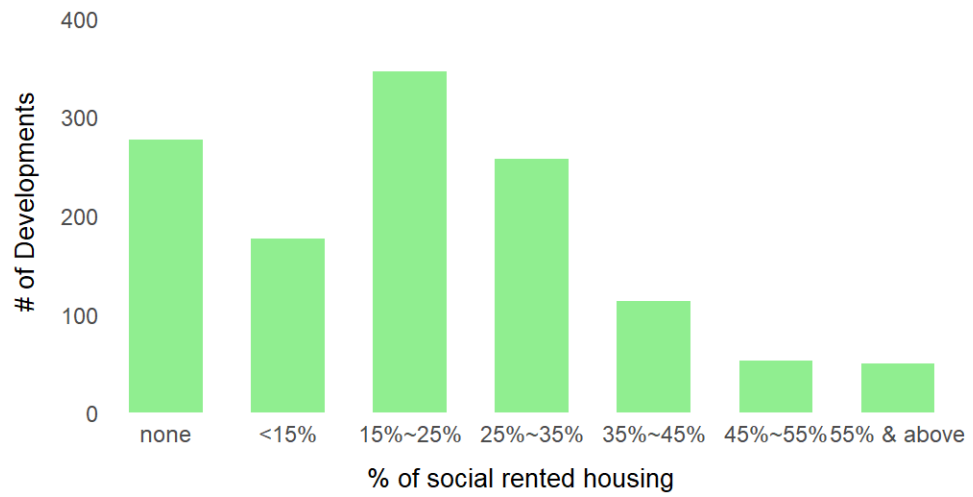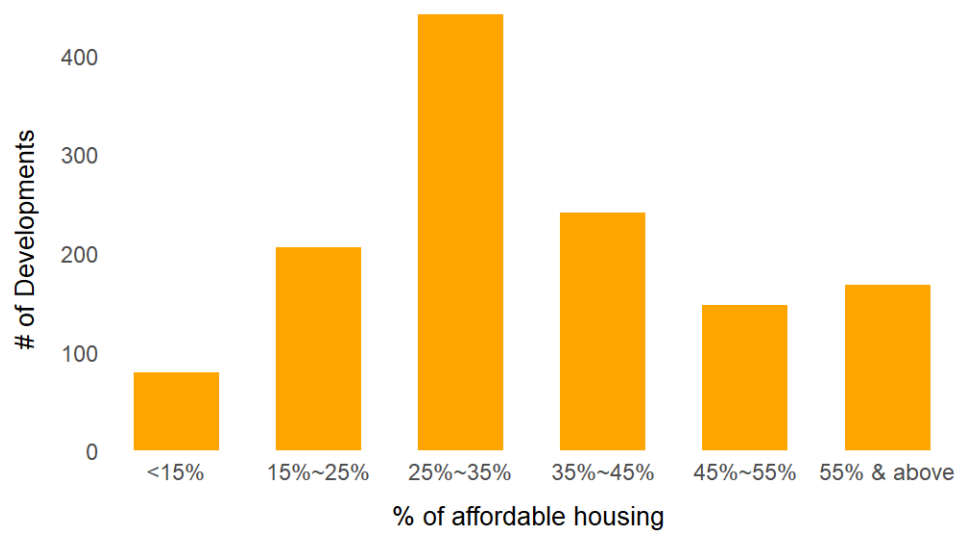
Figure 2. S106 developments by on-site affordable housing provision

Table 4. The effects of neighborhood characteristics on the on-site provision of affordable housing

(a) Overall affordable housing

| ZIB Regression | Model 1 | | | Model 2 | | |
|---|---|---|---|---|---|---|
| | Including affordable housing on-site | % affordable (if any) | Marginal effects (total proportion) | Including affordable housing on-site | % affordable (if any) | Marginal effects (total proportion) |
| Log(size of development) | 1.4873*** | -0.0501*** | 0.0845*** | 1.5790*** | -0.0483*** | 0.0853*** |
| | (0.0876) | (0.0182) | (0.0056) | (0.0952) | (0.0180) | (0.0056) |
| Existing housing on the development site | -0.3037** | 0.3349*** | 0.0401*** | -0.2522* | 0.3179*** | 0.0399*** |
| | (0.1338) | (0.0565) | (0.0125) | (0.1380) | (0.0547) | (0.0121) |
| PC1 - poor neighborhoods | 0.1601*** | 0.0338*** | 0.0064*** | 0.0799** | 0.0228** | 0.0035*** |
| | (0.0210) | (0.0074) | (0.0008) | (0.0319) | (0.0102) | (0.0010) |
| PC2 - the elite center | 0.0302 | -0.0184* | -0.0008 | -0.0836 | -0.0663*** | -0.0103*** |
| | (0.0280) | (0.0110) | (0.0016) | (0.0622) | (0.0242) | (0.0035) |
| PC3 - white enclaves | -0.1722*** | -0.0337* | -0.0071*** | -0.1106* | -0.0517** | -0.0065*** |
| | (0.0415) | (0.0183) | (0.0018) | (0.0595) | (0.0215) | (0.0022) |
| Year fixed effects | | + | | | + | |
| Local authority fixed effects | | | | | + | |

***: p<.01; **: p<.05; *: p<.1. Figures in parentheses are robust standard errors.

(b) Social rented housing

| ZIB Regression | Model 3 | | | Model 4 | | |
|---|---|---|---|---|---|---|
| | Including social rented housing on-site | % social rented (if any) | Marginal effects (total proportion) | Including social rented housing on-site | % social rented (if any) | Marginal effects (total proportion) |
| Log(size of development) | 0.9305*** | -0.1442*** | 0.0419*** | 1.0797*** | -0.1440*** | 0.0405*** |
| | (0.0604) | (0.0198) | (0.0040) | (0.0717) | (0.0202) | (0.0041) |
| Existing housing on the development site | 0.0497 | 0.3756*** | 0.0416*** | 0.0910 | 0.3741*** | 0.0425*** |
| | (0.1178) | (0.0587) | (0.0087) | (0.1294) | (0.0577) | (0.0083) |
| PC1 - poor neighborhoods | 0.1506*** | 0.0118 | 0.0040*** | 0.0404 | 0.0241** | 0.0017** |
| | (0.0187) | (0.0074) | (0.0005) | (0.0298) | (0.0112) | (0.0007) |
| PC2 - the elite center | -0.0055 | -0.0194* | -0.0015 | -0.1637*** | -0.0276 | -0.0070*** |
| | (0.0262) | (0.0113) | (0.0012) | (0.0599) | (0.0257) | (0.0025) |
| PC3 - white enclaves | -0.0532 | -0.0515*** | -0.0036*** | -0.1296** | -0.0501** | -0.0049*** |
| | (0.0363) | (0.0155) | (0.0012) | (0.0577) | (0.0199) | (0.0015) |
| Year fixed effects | | + | | | + | |
| Local authority fixed effects | | | | | + | |

***: p<.01; **: p<.05; *: p<.1. Figures in parentheses are robust standard errors.

The third column shows the marginal effects on the total proportion in semi-elasticities[5] at the mean of all predictors. In model 2 with both local authority and year fixed effects, for example, 10% increase in PC1 from its mean is associated with 3.5 percentage point increase in the proportion of affordable housing included. For PC2 and PC3, the corresponding changes in the proportion of affordable housing are 10.3 and 6.5 percentage point decreases, respectively.

(Table 4 about here)

All four models in Table 4 suggest a clear linkage between neighborhood characteristics and the on-site provision of affordable or social rented housing. Developments in neighborhoods with higher scores on PC1, the "poor neighborhood" index, are more likely to include affordable housing on-site and, when they do so, tend to include higher proportions of affordable or social rented housing. PC2 and PC3, which indicate proximity to job centers, higher income, skilled labor, higher housing values, and whiter neighborhoods, in contrast have strong negative effects on the probability of including affordable or social rented housing on-site and the proportions included. The effects of PC2 become more prominent when local authority fixed effects are included in the model, suggesting that the association is stronger with neighborhood variations within local jurisdictions.

The two development-level variables have somewhat mixed effects on the provision of affordable or social rented housing. Larger developments are more likely to include affordable or social rented housing on-site, which corroborates the accounts we collected from local planners that it can be harder for small developments to conform to mandatory inclusionary housing

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[5] $dy/(dx/x)$, except for the binary variable *existing housing on the development site*, for which the marginal effect is $dy/dx$.

requirements due to the additional costs. However, development size also has a negative effect on the proportion of affordable or social rented housing included on-site if any, indicating that developers with larger projects may have more bargaining power in negotiations with local authorities over the percentage of affordable housing to include. The presence of existing housing units on the site, on the other hand, is associated with a lower probability of including any affordable housing on-site (but not social rented housing in specific) but a higher proportion of affordable or social rented housing when they are included. This could reflect both the physical or financial restraints with redevelopment sites and the more pressing need for preserving affordable housing in those cases where it is feasible. Both development-level variables have significant positive marginal effects on the unconditional proportion of affordable or social rented housing, indicating that larger developments and redevelopments tend to provide more affordable housing via S106 agreements overall.

### *The Role of Local Policy*

Table 5 shows the modeling results with the two moderating variables, local housing target and the share of Labour Party seats in the local council. Results for the on-site inclusion of social rented housing are omitted as they are very similar to those presented. As expected, developments in Labour jurisdictions tend to include more affordable housing, though the housing target *per se* has only marginally significant effect on the inclusion of affordable housing on-site and no significant effect on the percentage included or the overall proportion. Nevertheless, both variables strongly interact with PC3 (white enclaves) in determining whether a development would include any affordable housing. Figure 3 plots the marginal effects of PC3 on the probability of a development including on-site affordable housing over the range of the two moderating variables. As the local authority's annual housing target per 1,000 residents

increases, the negative linkage between PC3 and on-site affordable housing inclusion grows

stronger, confirming the hypothesis that local authorities with more pressing housing needs are

more likely to relent on the social mix objective of mandatory inclusionary housing. The share of

Labour council members has exactly the opposite effect. Actually, PC3 only negatively affects

the probability of on-site affordable housing inclusion when the council has less than half Labour

seats. When the share of Labour seats approaches 100%, the marginal effect of PC3 on the

probability of on-site affordable-housing provision becomes significantly positive. Controlling

for local policy and politics, however, does not explain away the strong association between PC1

and on-site inclusion of affordable housing.

Table 5. The moderating effects of local government policy and political landscape

| ZIB Regression | Including affordable housing on-site | | % affordable (if any) | | Marginal effects (total proportion) | |
|---|---|---|---|---|---|---|
| *Model 1: Annual housing target per 1,000 residents* | | | | | | |
| Log(size of development) | 1.5075*** | (0.0898) | -0.0449** | (0.0180) | 0.0838*** | (0.0060) |
| Existing housing | -0.3057** | (0.1332) | 0.3299*** | (0.0563) | 0.0404*** | (0.0125) |
| Housing target | 0.0718* | (0.0382) | -0.0183 | (0.0121) | -0.0078 | (0.0113) |
| PC1 - poor neighborhoods | 0.1054*** | (0.0388) | 0.0339** | (0.0144) | 0.0064*** | (0.0008) |
| PC2 - the elite center | 0.0777 | (0.0597) | 0.0171 | (0.0205) | -0.0018 | (0.0021) |
| PC3 - white enclaves | 0.0411 | (0.0751) | -0.0203 | (0.0378) | -0.0076*** | (0.0018) |
| Housing target * PC1 | 0.0079 | (0.0083) | 0.0018 | (0.0031) | | |
| Housing target * PC2 | -0.0180 | (0.0174) | -0.0079 | (0.0055) | | |
| Housing target * PC3 | -0.0544*** | (0.0167) | -0.0034 | (0.0085) | | |
| *Model 2: % of Labour seats in local council* | | | | | | |
| Log(size of development) | 1.5020*** | (0.0893) | -0.0542*** | (0.0183) | 0.0813*** | (0.0059) |
| Existing housing | -0.2968** | (0.1331) | 0.3387*** | (0.0566) | 0.0424*** | (0.0124) |
| % Labour seats | 0.1484 | (0.3226) | 0.3008** | (0.1246) | 0.0320** | (0.0128) |
| PC1 - poor neighborhoods | 0.1339*** | (0.0469) | 0.0141 | (0.0161) | 0.0045*** | (0.0009) |
| PC2 - the elite center | -0.0019 | (0.0504) | -0.0051 | (0.0215) | -0.0010 | (0.0019) |
| PC3 - white enclaves | -0.3799*** | (0.0767) | 0.0110 | (0.0393) | -0.0045** | (0.0020) |
| % Labour seats * PC1 | -0.0351 | (0.0971) | 0.0204 | (0.0330) | | |
| % Labour seats * PC2 | 0.1417 | (0.1360) | -0.0545 | (0.0580) | | |
| % Labour seats * PC3 | 0.7338*** | (0.1998) | -0.1172 | (0.1006) | | |

***: $p<.01$; **: $p<.05$; *: $p<.1$. Figures in parentheses are robust standard errors. Both models include year fixed effects but not local authority fixed effects, as the local policy/politics indicators vary at the local authority level.
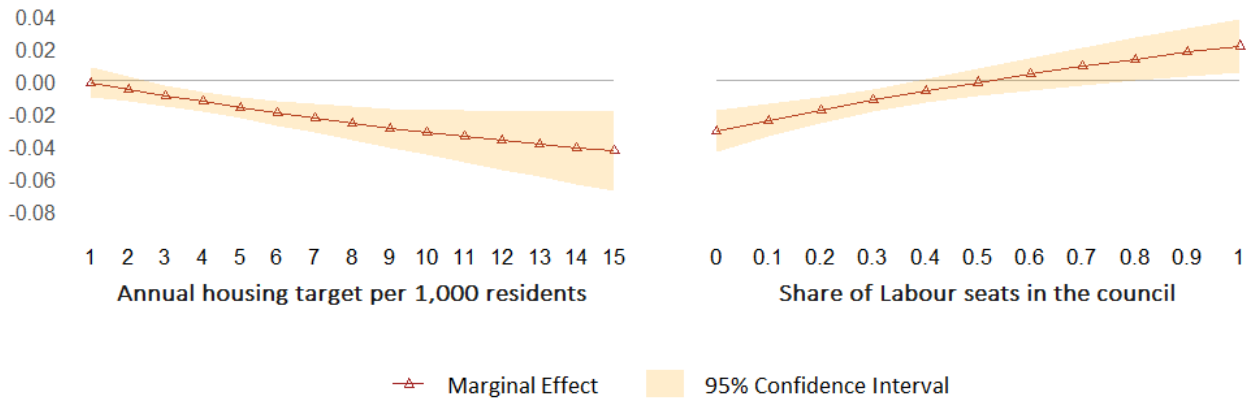
Figure 3. Marginal effects of PC3 on the probability of including affordable housing on-site

## Discussion

This paper examines the extent to which mandatory inclusionary housing in London, UK,

sometimes referred to as the "planning gain" approach, has delivered affordable housing in a

more dispersed, equitable manner compared to conventional affordable housing projects. We

find that affordable housing delivered under inclusionary housing, or "S106" affordable units,

are more spatially concentrated in a small number of neighborhoods as compared to conventional

affordable housing or market-rate housing. The average neighborhood statistics of S106

affordable housing are more similar to those of conventional affordable housing than those of

market-rate housing. That is, both types of affordable housing are more likely to be placed in

disadvantaged neighborhoods with higher poverty rates, fewer job opportunities, and more racial

minorities.

The development-level analysis shows that neighborhood characteristics systematically

influence the on-site inclusion of affordable housing, or deeply affordable social-rent housing in

particular. Developments in more desirable locations that are above the threshold size and

subject to inclusionary housing requirements are less likely to provide affordable housing on-site

and, when they do so, tend to include a smaller proportion of affordable housing. Local housing policy and the political make-up of local councils play a role in the uneven distribution of S106 affordable housing. However, controlling for these factors do not explain away the strong association between neighborhood characteristics and the on-site inclusion of affordable housing.[6]

These findings, although contrary to some of our hypotheses, are consistent with the observation that the local implementation of planning gain and the use of viability appraisals can give developers in the UK much leeway in negotiating the planning obligations (Crook et al., 2015; McAllister et al., 2013). Albeit in a much different policy context, they are also consistent with the findings in some U.S. case studies where inclusionary housing policies are found with limited success in dispersing affordable housing or placing them in low-poverty neighborhoods (Kontokosta, 2015; Ryan & Enderle, 2012; Schwartz et al., 2012). We do find, for example, that S106 affordable housing experiences greater neighborhood housing price appreciation on average than conventional affordable housing, which appears to support the argument that mandatory inclusionary housing can be an effective policy instrument in preserving housing affordability in gentrifying neighborhoods. Nevertheless, there remains a sizeable gap between the average neighborhood characteristics of S106 affordable housing and market-rate housing units, including housing price appreciation, indicating that S106 affordable housing is disproportionately delivered in disadvantaged, less desirable neighborhoods.

The reason for this uneven distribution of inclusionary affordable housing can be multifold. It could be that developments in highly desirable locations face disproportional

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[6] It should be noted that, due to our omission of off-site affordable housing provided under S106 agreements (see footnote 1), which are more likely located in low-cost areas, the results here can be a conservative estimate of the uneven distribution of S106 affordable housing.

difficulties in fulfilling the affordable housing requirement and are more often granted variations. Meanwhile, developers may have an incentive to pursue these variations more aggressively in these locations, either because the affordable housing obligation is costlier in prime locations, or because the on-site inclusion of affordable housing can be perceived undesirable by the potential affluent buyers or renters in these neighborhoods.

Literature has suggested that while mixed-income housing does not necessarily engender social interaction across classes, more substantial benefits may accrue to lower-income families from living in less deprived neighborhoods with better social services and resources (Musterd & Andersson, 2005; Tunstall & Lupton, 2010). While mandatory inclusionary housing has arguably increased housing mix at the development level, it is worth questioning the extent to which low-income families benefit from living in the same building with market-rate tenants or homeowners versus living in a desirable neighborhood, especially when the tenants of inclusionary affordable units are often excluded from the commune space and amenities in private developments, such as swimming pools, gyms and lounges, that are available to their more affluent neighbors. Inclusionary housing programs that aim to create mixed-income communities, therefore, may need to pay more attention to the neighborhood-level distribution of affordable housing.

The inclusionary housing scheme in London has been in general a success in delivering affordable housing. As our data shows, the planning gain approach has contributed the majority of new affordable housing as national and local governments withdrew from direct involvement in housing construction. Our findings suggest, nevertheless, that it should not be automatically assumed that the affordable housing created under inclusionary housing is more spatially dispersed or more equitably distributed than traditional public or social housing. Instead of

killing two birds with the same stone, local governments could face tradeoffs between creating affordable housing and ensuring housing mix in more desirable neighborhoods when implementing inclusionary housing policies, especially in weaker market conditions or jurisdictions with greater housing shortages.

In communities where poverty deconcentration and mixed-income housing are a higher priority, a more tailored approach may be necessary for inclusionary housing policies to achieve an equitable distribution of the resultant affordable housing. Within the S106 framework, for example, local governments may want to designate high opportunity areas with low poverty, low unemployment and low housing affordability, encourage greater provision of affordable housing in these areas, and apply more scrutiny to proposals in these areas that request a variation or exemption of the inclusionary housing requirement. In other countries that adopt inclusionary housing policies with a more voluntary/incentive-based approach, or cities that only apply inclusionary housing requirements to certain areas, we recommend focusing the inclusionary housing effort in similar, more desirable neighborhoods that enhance the housing and life opportunities of low-income households. Wherever possible, planning or financial incentives should be used to direct the production of affordable housing toward these neighborhoods. Cities should also conduct ongoing evaluations of how their inclusionary housing policies have shaped the overall distribution of affordable housing and their beneficiaries.

This paper studies an under-researched aspect of mandatory inclusionary housing and provides valuable evidence for policymakers not only in the UK, but in other parts of the world that utilize inclusionary housing policies to tackle housing affordability crisis and residential segregation. It raises important questions regarding the effectiveness of inclusionary housing in both producing affordable housing and ensuring an equitable distribution of the affordable

housing created, as well as the notion that inclusionary housing strategies are necessarily more effective than conventional public housing in dispersing poverty and creating mixed-income communities. These findings, however, should not be taken out of the unique policy context of the British planning system and the planning gain approach to inclusionary housing. More research is needed to better understand the implementation of inclusionary housing in different contexts and its implications on desegregation and mixed-income communities.

## Acknowledgements

## Disclosure Statement

The authors declare that we have no competing interests.

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# Appendix 1. Zero-Inflated Beta (ZIB) Regression

Zero-inflated beta regression is a statistical procedure that deals with dependent variables that are continuous proportions and contain zeros. In the development-level analysis, the dependent variable, the percentage of housing units on a development site that are affordable ($A$) is on the interval $[0,1)$ (note that conventional sites with $A = 1$ are excluded from the analysis; otherwise a zero-one-inflated beta regression model may be more appropriate). It may be conceived that fundamental differences exist between market-rate developments ($A = 0$) and S106 developments ($A > 0$), and $A$ should not be simply modelled as a continuous variable. The zero-inflated beta regression therefore treats the two subsets of observations separately. The probability function of $A$ can be defined as:

$$Pr(A; \mu, \phi) = \begin{cases} \delta, & if\ A = 0, \\ (1 - \delta)f(A; \mu, \phi) & if\ A \in (0,1). \end{cases} \tag{1}$$

and

$$f(A; \mu, \phi) = \frac{\Gamma(\phi)}{\Gamma(\mu\phi)\Gamma((1-\mu)\phi)} A^{\mu\phi-1}(1 - A)^{(1-\mu)\phi-1}, \quad 0 < \mu < 1, \ \phi > 0 \tag{2}$$

where $\Gamma(.)$ is the gamma function. The unconditional and conditional mean of $A$ can then be expressed as:

$$E(A) = (1 - \delta)\mu \tag{3}$$

$$E\big(A|A \in (0,1)\big) = \mu \tag{4}$$

and its variance is given by:

$$Var(A) = (1 - \delta)\left(\frac{\mu(1-\mu)}{1+\phi} + \delta\mu^2\right) \tag{5}$$

For a given set of predictors $X$, use the logit link function for $\delta$ and $\mu$:

$$g(\delta) = \log\left(\frac{\delta}{1-\delta}\right) = X\gamma + \varepsilon_\delta \tag{6}$$

$$h(\mu) = \log\left(\frac{\mu}{1-\mu}\right) = X\theta + \varepsilon_\mu \tag{7}$$

$\gamma = (\gamma_1, \gamma_2, \ldots, \gamma_k)^T$ and $\theta = (\theta_1, \theta_2, \ldots, \theta_k)^T$ are the unknown parameters that indicate how the predictors affect the probability of a development being exempt from on-site provision ($A = 0$), and the percentage of affordable housing it provides if any ($0 < A < 1$). For more discussion on beta regression and zero-inflated beta regression, see Ferrari and Cribari-Neto (2004) and Cook, Kieschnick, and McCullough (2008).