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Gentrification and displacement in English cities

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Gentrification and displacement in English cities*

Abstract: This paper uses the British Household Panel Survey (1991-2008) and the UK Census (waves 1991, 2001 and 2011) to examine the association between gentrification and displacement in English cities. Gentrification is the phenomena of a large and relatively sudden in-migration of wealthy or middle class residents into a previously poor or working class neighbourhood. I measure this using the change in share of neighbourhood population that holds a degree certificate conditional on the initial share. The effect is found to depend crucially on household income and homeownership status as well as how gentrified the initial share. In a ward with an initial degree share of 5%, a renter household with an income of 0.5 times travel-to-work-area (TTWA) median is found to be 1.5 percentage points more likely to exit for each percentage point increase in degree share, after controlling for other factors. However, if the household income is 1.5 times the TTWA average then this effect becomes statistically insignificant. For homeowners, on the other hand, the effect remains stable at around 1pp across all income levels. This result may be explained by institutional context since, in the UK, property tax is only applied at the point of sale. This means that a low-income homeowner facing increasing property value is not forced to sell due to escalating tax assessments, as may be the case in the US. So whilst the rising housing costs associated with gentrification do induce homeowners to sell, there is no income dimension to this effect as there is with rising rental costs. These results provide a significant contribution to the literature on displacement, which has previously found little evidence for the effect.

Keywords: Gentrification, Displacement, Neighbourhood change, Residential mobility

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Introduction

This paper uses the British Household Panel Survey (1991-2008) and the UK Census (1991, 2001 and 2011) to examine the association between gentrification and displacement in English cities. Gentrification is the phenomena of a large and relatively sudden in-migration of wealthy or middle class residents into a previously poor or working class neighbourhood. I measure this using the change in share of neighbourhood population that holds a degree certificate conditional on the initial share. The effect is found to depend crucially on household income and homeownership status as well as how gentrified the neighbourhood already is. In a ward with an initial degree share of 5%, a renter household with an income of 0.5 times travel-to-work-area (TTWA) median is found to be 1.5 percentage points more likely to exit for each percentage point increase in degree share, after controlling for other factors. However, if the household income is 1.5 times the TTWA average then this effect becomes statistically insignificant. For homeowners, on the other hand, the effect remains stable at around 1pp across all income levels. This result may be explained by institutional context since, in the UK, property tax is only applied at the point of sale. This means that a low-income homeowner facing increasing property value is not forced to sell due to escalating tax assessments, as may be the case in the US. So whilst the rising housing costs associated with gentrification do induce homeowners to sell, there is no income dimension to this effect as there is with rising rental costs. Further the paper makes a number of methodological advances on previous work.

This new evidence gives a different picture than that given by the prevailing literature that has found little evidence for displacement. It is also in line with the theoretical understanding of gentrification as process of outbidding (e.g. Brueckner and Rosenthal 2009). This finding has two important implications for policy. Firstly, policymakers wishing to improve the outcomes for low income households should implement measures to reduce the impact of gentrification on displacement. This may be achieved, for example, by following policies from Germany that prevent the rent eviction of tenants for up to 7 years after newly purchasing a property. The second implication is that more general policies that aim to improve outcomes for the poor may be mis-targeted as a result of displacement process. For example, spatially-targeted policies to help the poor miss their target if improvements in local amenities are followed by an in-migration of wealthier households and displacement of pre-existing residents. Furthermore policies aimed at mixing neighbourhoods may be misguided if they too lead to displacement. Policy-makers wishing to improve outcomes for low-income households they may be better off directly targeting incomes and sources of poverty or by combining neighbourhood improvement policies with incentive for low-income renters to become homeowners.

Empirical Literature

Empirical studies into whether gentrification is associated with displacement typically define gentrification based on increases in a measure of neighbourhood income or educational attainment. It is then examined whether there is a statistical relationship between this measure and the mobility rates of existing residents. Freeman (2005) points out that earlier studies tended to suffer from methodological flaws such as failing to include in the analysis a counterfactual group of neighbourhoods that did not gentrify. This means that it is impossible to tell whether the observed displacement rates in gentrifying neighbourhoods is in fact any higher than the rate in non-gentrifying neighbourhoods. Freeman (2005) and Vigdor (2002) both provide good reviews of these early empirical studies. In this literature review I focus on

four of the most recent studies that make methodological advancements on earlier studies. These are Vigdor (2002), Freeman and Braconi (2004), Freeman (2005) and McKinnish et al. (2010). From this review I will identify both key results, particularly regarding whether gentrification leads to displacement, and key empirical issues such as important control variables identification strategies.

Typically, studies into gentrification and displacement make use of two data sources. One for households that gives a dependent variable relating to exit or mobility rates, and one for neighbourhoods that allow for characterising gentrification, usually in terms of income growth or educational attainment growth. Vigdor (2002), for example, makes use of the American Housing Survey (AHS) for 1985-89 and 1989-93 and the Public Use Microdata Sample (PUMS) for the Census (1980-1990). The dependent variable is whether a housing unit from the AHS still holds the same household at the end of the period that it did in the beginning. Gentrification is then defined as neighbourhoods that experience an increase in the share of population that hold a degree of more than 50% above the average for the Metropolitan Statistical Area (MSA).

The mobility variable is then regressed on the gentrification variable usually in either a logit or a probit model. This empirical strategy¹ is intended to address the difficulty involved with showing actual displacement rather than simply mobility. If it can be shown that the mobility rates are higher in the gentrifying neighbourhoods than in the other neighbourhoods, and that the higher rates can be attributed directly to the gentrification, then this can be taken as evidence for displacement. The important caveat is that it must be shown that the higher rates are due to the gentrification and not to other factors that may be different between neighbourhoods. Neighbourhoods that gentrify are likely to be different from neighbourhoods that do not gentrify, for example, they may have fewer social housing units. Social housing units have different characteristics to other units that will directly affect the exit rates of the households that live in them. Also, different housing characteristics will attract different types of individuals who have different baseline mobility rates. Therefore a lower exit rate in a non-gentrifying tract may not be directly related to the fact that the neighbourhood is not gentrifying but to something else entirely, such as the proportion of social housing in that neighbourhood.

Important controls for differences in householder characteristics are things such as age, education, income, tenure, number of years at current residence, ethnicity, nationality, marital status and employment status. Household and neighbourhood characteristics that have been shown to be important factors related to mobility are household size (particularly in relation to number of rooms), maintenance deficiencies, rent subsidies, rent control, public housing complexes and vacancy rates (Vigdor 2002, Freeman and Braconi 2004, Freeman 2005). Vigdor (2002) also controlled for the householder's own rating of the neighbourhood and particular housing unit they live in.

Another important empirical issue is to compare gentrifying neighbourhoods to similar neighbourhoods that did not gentrify. Vigdor (2002) and Freeman and Braconi (2004) control for various household characteristics, but they compare mobility in gentrifying neighbourhoods to mobility in all other neighbourhoods. On the other hand, Freeman (2005) and McKinnish et al (2010) provide more plausible counterfactuals by first selecting a sample of neighbourhoods

¹ Vigdor (2002) was one of the first empirical studies on gentrification and displacement to compare mobility rates in gentrifying neighbourhoods to a counterfactual group of non-gentrifying neighbourhoods.

that might have potentially undergone gentrification and then comparing the ones that did to the ones that didn't. For Freeman (2005) the neighbourhoods must be central city areas, with a comparatively (compared to MSA median) low median income and a comparatively low share of housing built in the last 20 years. The gentrifying neighbourhoods are then the ones that experienced a comparatively large increase in educational attainment and an increase in real housing prices. For McKinnish et al. (2010) the potential neighbourhoods must be both urban and in the bottom quintile in terms of median household income. The gentrifying ones are defined as those that experience at least a \$10,000 dollar increase in mean household income.

A further issue is that unit of analysis. If *households* are observed, as in Freeman (2005), it is possible to examine whether they exit the neighbourhood that is gentrifying. However, if *housing units* are observed (Vigdor 2002, Freeman and Braconi, 2004) then it is only possible to say if the household left the unit and nothing about how far it went. This makes it impossible to tell whether the household actually exited the area that is gentrifying. Hence, the claim that empirical analysis is testing the relationship between gentrification and displacement is made weaker by this fact. Finally, McKinnish et al. (2010) only use one data source (confidential US Census data) to characterise both exits and gentrification. As a result they are neither able to say where households move to, or in fact, whether any specific household has moved at all. Instead they use a less reliable cohort analysis that looks at the populations and characteristics of individuals who report to have stayed in the neighbourhood for at least ten years compared to groups from the previous census with similar characteristics who are ten years younger, with the intention that they are the same people. Thus when they find that the income of a particular group tends to increase more in gentrifying neighbourhoods than in non-gentrifying neighbourhoods they are not able to say whether this is because the households toward the lower income distribution in this group left the area or because there has been a general increase in income across all the households of this group.

Also important is the size of the areas used to classify gentrification. In the two earlier papers by Vigdor (2002) and Freeman and Braconi (2004), the areas used are too large to be referred to as neighbourhoods. Vigdor (2002) looks at AHS Zones in Boston, which are of around 100,000-200,000 people in size. The city of Boston itself is made up of only 5 zones. Freeman and Braconi (2004), in their study of New York also use areas of around 100,000 in population. These large areas are problematic for several reasons. Gentrification is an urban phenomenon and if there are since there were only 5 areas for the city of Boston, Vigdor (2002) is forced to expand his analysis to the surrounding suburbs and county. Even including these, the spatial variation in the gentrification variable is rather coarse. In Vigdor's (2002) 'exclusive' definition, only one area is defined as gentrifying and in his 'inclusive' definition there are only a few more. Freeman and Braconi (2004) have only seven gentrifying areas (selected using anecdotal evidence) from a total of 55 areas. Since gentrification is a highly localised phenomenon, using large areas means that for any household the gentrification indicator for their area may not be a very reliable reflection of whether they are in a gentrifying neighbourhood or not. Also, these aggregate areas has important implications for the standard errors of the estimates, that should be clustered at the area level (this was correctly implemented only by McKinnish et al. 2010). Finally, using smaller areas allows for a more precise indication of whether a household move actually exits the area that is gentrifying (if one is using a household survey). Freeman (2005) and McKinnish et al (2010) both use much smaller Census tracts of around 1,000-8,000 people and their samples also cover the whole of the US.

Before turning to review the results of these papers, I examine one last empirical issues that is the conditioning of the gentrification effect on other factors. It is not simply good enough to control for factors if they are thought to have a significant effect on the relationship between gentrification and displacement. For example in gentrifying areas, particular groups such as renters or the low income may be more susceptible to being displaced than other groups. Homeowners are protected from the escalation of rent prices that accompanies gentrification and an increase in the price of their home brings no extra costs until the point of sale², where the costs will only represent a fraction of the overall benefits associated with selling at a higher price. Hence the gentrification variable can be interacted with various household characteristics to reveal conditional effects. Vigdor (2002) looks at the effect conditional on educational attainment (high school diploma) of the head of household. Freeman and Braconi (2004) do not estimate an interacting variable but restrict their sample to either low income or low education householders. Freeman (2005) looks at the effect for a group defined as 'poor renters', who have both a low income and are renters.

The results of the papers I examine here are generally against there being a relationship between gentrification and displacement. Vigdor (2002), in fact, finds after introducing controls that households are *more likely* to stay say in their housing unit if they live in gentrifying areas in Boston. In another specification he finds this to be true only for low educated householders. There is no evidence found for displacement for any group. Freeman and Braconi (2004) for New York in the 1990s also find slower residential turnover for poor and less educated households in areas that are undergoing a process of gentrification compared to other areas. Freeman (2005) is the only paper in this review that does find evidence for displacement, but not a significantly higher effect for the poor renter group. Finally, McKinnish et al. (2010) do not claim to find evidence for displacement although admit that there is some ambiguity in the interpretation of their results due to the methods used. The overall empirical evidence is not in favour of gentrification being associated with displacement. However, the analyses do have a lot of empirical problems and therefore something new may be learned from an analysis that improves in the highlighted areas. Also, the paper that appear to suffer the least from methodological issues, Freeman (2005), does find some evidence for displacement suggesting that there may indeed be an effect.

Table 1 below also provides a summary of the literature I have reviewed here in terms of all the important aspect identified. I will now recap the important issues learnt from the review of the literature and therein lay out the criteria that this paper should meet. Firstly, the analysis must include appropriate control variables. This paper therefore matches the controls used in all the previous paper and adds some further controls. The identification strategy in general will be improved by implementing ward fixed effects. This specification will eliminate the unobservable bias due to fixed difference in wards by estimating the examined effect using only time variation in gentrification in each ward. Secondly, the areal unit must be sufficiently small. Hence I will work with Census wards, which have a population of around 6,000-7,000 and are roughly comparable to smallest neighbourhoods used in previous analyses. Thirdly, it is best to work with household data. Hence I use the BHPS to identify household exits from neighbourhoods over the period 1991-2008. Fourthly, it is important to identify an appropriate control group of

² In the UK, a tax called stamp duty is applied at the point of sale and represents a percentage of the transaction price. There are no increased costs in terms of tax assessment associated with owning a property of a higher value; therefore, there may be less displacement pressure on low income homeowners in gentrifying areas.

Table 1: Review of literature

	Vigdor (2002)	Freeman and Braconi (2004)	Freeman (2005)	McKinnish et al. (2010)
Case	Boston (1985-93)	New York City (1991-1999)	U.S. (1986-1998)	U.S. (1990-2000)
Regression type	Probit	Logit	Logit	Logit
Households data	1. American Housing Survey (AHS)	1. NYC Housing and Vacancy Survey (NYCHVS)	1. Panel Study of Income Dynamics (PSID)	(Cohort analysis)
Neighbourhoods data	2. Public Use Microdata Sample (PUMS)	(Gentrifying areas selected anecdotally)	2. U.S. Census	2. U.S. Census
Unit of observation	Housing unit	Housing unit	Heads of households	Synthetic cohorts
Dependent variable	Binary variable:	Binary variable:	Two alternatives (binary):	Two alternatives:
	Same household in unit at end of period	Same household in unit at end of period	Displaced	Population change
			Exits	Income change
Neighbourhoods	AHS Zone (100,000-200,000)	Community Board Districts (46,000)	Census Tracts (1,000-8,000)	Census Tracts (1,000-8,000)
Neighbourhood sample	All areas	All areas	Must be all of: 1. Central City 2. Low income 3. Old housing	Must be all of: 1. Urban 2. Low income
Gentrification variable	Two alternatives (binary): 1. 'Exclusive' - from Wyly and Hammel (1990) 2. 'Inclusive' - increase in education	Binary variable chosen based on familiarity with areas	Two alternatives (binary): 1. increase in education 2. increase in real house prices	Binary variable: \$10,000 increase in household income

Review of literature (continued)

Conditional relationships	High school diploma	Poor and Non-college grad (restricted samples)	Poor renters	Ethnicity x Education x Age
Controls	Age High school diploma Income Own house rating Own neigh rating Owner Public complex Rent control Subsidized	Age Education Employment Ethnicity Income Maintenance deficiencies Marital Native Neighbourhood rating Other regulation Overcrowded Rent-controlled Rent-stabilised Sex Year Years in residence	Age Assisted Housing Education Employment Ethnicity Household composition Immigrant Income Marital status Region /Year Renter Sex Unit crowded Vacancy rate Years in residence	CSMA fixed effects Lag of tract income Marital status Marital status x race Immigrant Immigrant x race race
Main findings	Less educated householders <i>more likely</i> to stay in unit if in gentrifying areas.	Low income and less educated are less likely to exit gentrifying areas than other areas.	Displacement occurs but not at a higher rate for poor renters.	No evidence for displacement.

potentially gentrifying neighbourhoods. I intend to build on this further by introducing a flexible definition of gentrification that compares the effect of increases in degree share conditional on the initial level of degree share. This is advantageous in that it measures the effect with respect to the magnitude of the gentrification (rather than a binary variable) and also conditions the effect on how gentrified the neighbourhood is already. Fifthly, further interacting relationship may yield interesting insights. I therefore intend to interact the main relationship with both tenure and income as well and tenure interacted with income. In the next section I examine the data that will be used in the analysis.

Data

The data used in this study come from two sources; the British Household Panel Survey (BHPS) and the UK Census (1991, 2001 and 2011). The UK Census is conducted decennially for the entire UK population. The Census is used in this study to characterise the extent of gentrification in neighbourhoods using 10-year changes in the share of individuals in a census ward that hold degree certificate or higher. Further, the UK Census will provide some of the ward level control variables for the analysis. The BHPS is a longitudinal survey of households that was conducted annually for 18 waves (1991-2008). It provides home location identifiers as well as a very rich set of household characteristics. Head of household-years are the unit of analysis for this paper and whether or not they exit their neighbourhood is the outcome variable. Household heads must be observed one period ahead in order to know if they exited their neighbourhood or not. Because of this, exits cannot be observed in the last wave of the BHPS (2008). The BHPS household-years will be merged with the census data at the neighbourhood (CAS Ward) level, with BHPS observations from 1991-2000 being merged with changes over the intercensal period 1991-2001 and BHPS observations from 2001-2007 with the intercensal period 2001-2011.

Gentrifying neighbourhoods (UK Census)

In order to characterise neighbourhoods in terms of their gentrification status I use the share of population that holds a degree, provided by the UK Census. Educational status has been used in previous literature to measure gentrification, along with measures of income. However, educational attainment is a more stable personal characteristic than income and therefore serves as a more reliable measure of inflow of different demographic group rather than simply changes in the characteristics of existing groups. Nevertheless, for robustness I also conducted a similar analysis using earnings data from the Annual Survey of Hours and Earnings that is moved to the appendix.

The degree share variable was obtained from the 1991, 2001 and 2011 Censuses at the ward level. The exact ward definitions differ from census to census and so the figures were converted to comparable geographical units using conversion tables downloaded from geoconvert.mimas.ac.uk. The resulting data are defined according to the 2001 Census Area Statistics (CAS) Wards for which there are 7,969 covering England. These wards have an average population of 6,669 individuals and an average size of 16.7km². These are more suitable for an analysis at the neighbourhood level than the more aggregated areas (over 100,000 people) used in similar studies (Vigdor 2002, Freeman and Braconi 2004). They are

comparable to more recent studies that make uses of non-public census data³ for the US (McKinnish et al. 2010 and Freeman 2005).

Table 2: Wards by initial degree share quintiles (1991-2001)

Quintile	N	Mean	Min	Max
1 st	1,593	25.6%	20.3%	59.9%
2 nd	1,594	17.8%	15.5%	20.3%
3 rd	1,594	13.4%	11.4%	15.5%
4 th	1,594	9.6%	7.6%	11.4%
5 th	1,594	5.2%	0.5%	7.6%
Total	7,969	14.3%	0.5%	59.9%

Table 3: Wards by initial degree share quintiles (2001-2011)

Quintile	N	Mean	Min	Max
1 st	1,594	34.4%	27.1%	72.5%
2 nd	1,594	23.9%	21.1%	27.1%
3 rd	1,594	18.6%	16.3%	21.1%
4 th	1,593	13.9%	11.4%	16.3%
5 th	1,594	8.8%	3.1%	11.4%
Total	7,969	19.9%	3.1%	72.5%

Gentrifying wards are those that have a low initial degree share followed by a large over the intercensal period (1991-2001 or 2001-2011). Table 2 and Table 3 illustrate the initial degree share variable by quintiles for the two intercensal periods. The initial degree share for 2001-2011 has a higher mean, min and max in every quintile and in total than for 1991-2001. This is consistent with a general 'upgrading' of human capital in England over the period 1991-2011. Further the tables illustrate that degree shares in 1991 range from 0.5% to 59.9% with a mean of 14.3% and in 2001 range from 3.1% to 72.5% with a mean of 19.9%. The intercensal change in degree share is given in Table 4 and Table 5. Again, 2001-2011 has the highest mean (a 7.8% increase compared with a 5.6% increase over 1991-2001) but it does not have the highest max (only 22.7% compared with 59.0%). There are some wards in both periods that experienced large decreases in degree shares. An urban/rural indicator, introduced in 2004 by the Rural Evidence Research Centre at Birkbeck College (RERC), was obtained at the ward level for England. Urban wards were then selected as those that belong to a settlement with a population of over 10,000.

Table 4: Wards by change in degree share quintiles (1991-2001)

Quintile	N	Mean	Min	Max
1 st	1,593	12.7%	8.4%	59.0%
2 nd	1,594	6.9%	5.6%	8.4%
3 rd	1,594	4.7%	3.9%	5.6%
4 th	1,594	3.1%	2.3%	3.9%
5 th	1,594	0.5%	-35.8%	2.3%
Total	7968	5.6%	-35.8%	59.0%

Note: Figures are absolute changes in degree shares (not percentage changes)

³ They use US Census tracts with populations between 1,000 and 8,000 people.

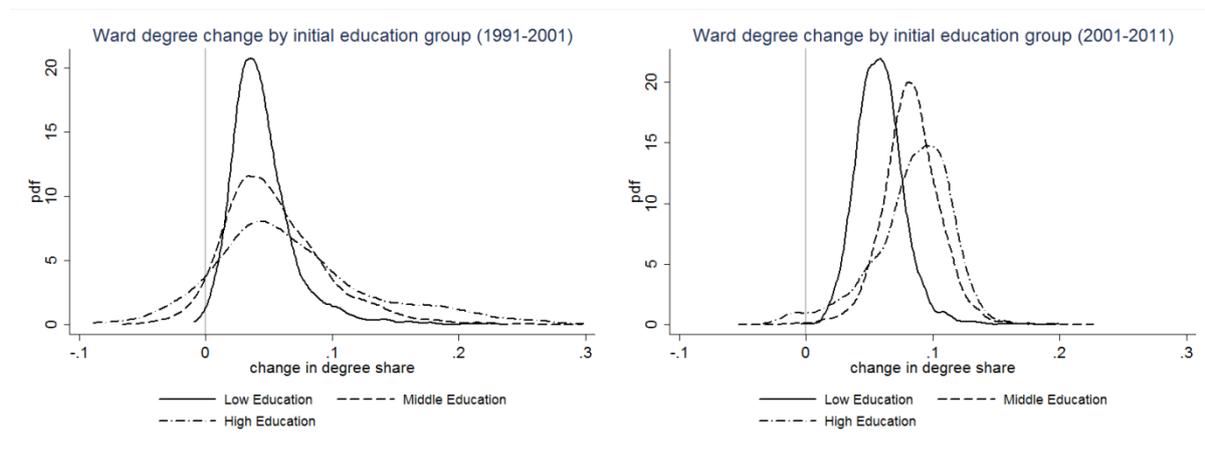
Table 5: Wards by change in degree share quintiles (2001-2011)

Quintile	N	Mean	Min	Max
1 st	1,594	11.4%	10.0%	22.7%
2 nd	1,594	9.2%	8.5%	10.0%
3 rd	1,594	7.9%	7.2%	8.5%
4 th	1,593	6.5%	5.7%	7.2%
5 th	1,594	4.1%	-11.8%	5.7%
Total	7969	7.8%	-11.8%	22.7%

Note: Figures are absolute changes in degree shares (not percentage changes)

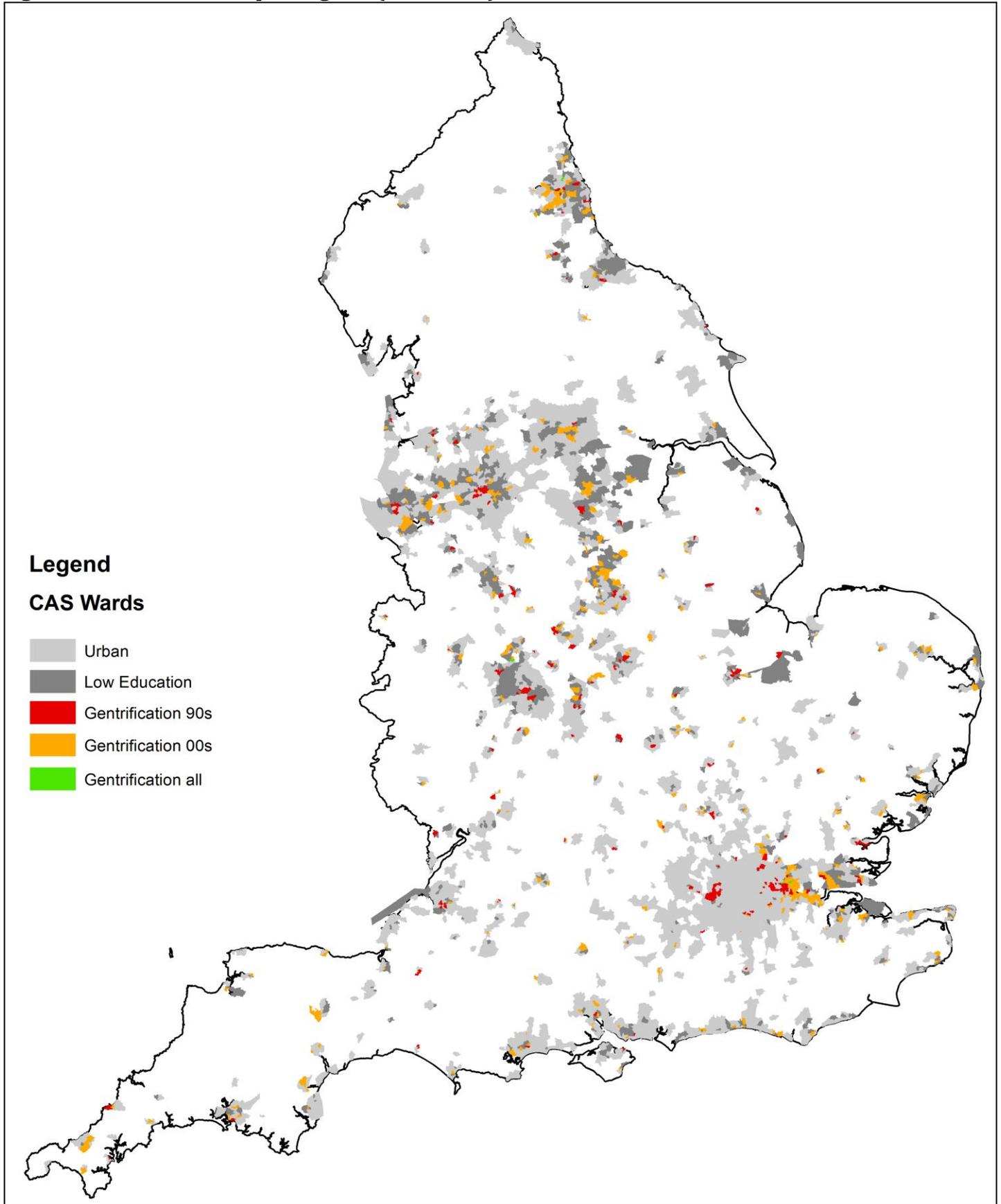
Next I examine how the change in degree share varies across wards with different initial degree shares. Figure 1 shows more highly educated wards tend to have larger increases in degree share than less educated wards. This correlation is stronger in the second decade than in the first. The variance in change in degree share is also much larger for the more educated wards.

Figure 1: Kernel density plots of degree change by initial degree group



Finally, Figure 2 below illustrates the wards for England and whether they are urban, low education or gentrifying. The categories used in this map are based on the quintiles and are therefore fairly arbitrary. The map is merely intended to give a general overview of the spatial pattern of gentrification in England and a more flexible definition will be used in the empirical analysis. The map shows a few things. Firstly, the low income neighbourhoods are more concentrated in the centre of each urban area with London being a significant exception. Secondly, gentrification begins (in the 90s) in the most central of these low income neighbourhoods and then (in the 00s) spreads out to the next most central low income neighbourhoods. Thirdly, there are very few wards that gentrify in both periods. This is because, due to the way gentrification has been defined here, if a ward gentrifies in the first period it is highly likely to be a non-low education ward and so cannot gentrify again in the second period. The observed pattern of concentric waves of gentrification spreading out from the urban centres is consistent with the model proposed by Brueckner and Rosenthal (2009). This pattern can also explain why there are no low education wards in the centre of London, if it is that gentrification started long before the 90s in central London.

Figure 2: Gentrification map of England (1991-2011)



Notes: Urban is defined as a ward that belongs to a settlement of over 10,000 in population. Low education is a ward that is in the 5th quintile for initial degree share in either period. Gentrification is if the change in degree share in in the 1st quintile for that period.

The households (BHPS)

The BHPS is an annual survey of a representative sample of more than 5,000 British households. Interviews are conducted with heads of households and with all other household members over the age of 16. Heads of household are re-interviewed in subsequent waves. If the heads split from their previous household then all the members of their new households are also interviewed. In this study, each survey entry for a head of household in any wave represents a single observation. By merging together the heads of households across waves it is possible to see if a head of household observed in a particular year lives in a different ward in the next year. This feature will help construct the dependent variable of household exits that will be used to identify displacement.

Previous literature has highlighted the importance that measures of displacement look at forced moves rather than due to normal reasons such as employment changes. A different variable in the BHPS asks individuals whether they lived at the same address last year and if they report “no” then it asks a follow question relating to the reason for the move. The reasons given in the BHPS for moves are wide ranging and often unspecific such as “felt like a change”. Unfortunately, there exists no category for movements due to rising housing costs. Responses that cite “move to larger” or “move to smaller” accommodation do not help too much because it may be that displaced households move from a small property with escalating rents to a larger home somewhere far cheaper. The only category that appeals to displacement are directly is “evicted, or repossessed”. However this represents too few observations to be of much use (80 evictions in 39,170 observations). The categories “moved for employment reasons” and “split from partner”, however, cannot plausibly be linked to displacement. Therefore the dependent variable for a head of household-year i is coded as 1 if the head resides in a different ward in the next year and if the move was not for employment reasons or a split from partner. The variable is coded as 0 if the head lives in the same ward or if the exit was for employment reasons or a split from partner. If the head is not observed again in any later waves the variable is coded as missing.

After coding exits I then dropped all observations where exits were unknown because the head of household is not observed again in the sample (6.6% of observations). This means dropping all observations for heads in the last year that they are observed and all observation from the last wave (2008) of the BHPS. Since I wish to study the effect of gentrification on low income households I dropped all observation where household income exceeded 1.6 times the TTWA median (26.4% of observations). The empirical analysis will control for variation in income within this group but this first step eliminates from the sample all the fairly wealthy households. Since gentrification is an urban phenomenon all observations were dropped where the ward is not categorised as urban (21.7% of the observations). The resulting dataset is 39,170 observations, which is around 53.9% of the original sample of 72,739 observations. I obtained Lower Layer Super Output Area (LSOA) identifiers for household location under a Special Licence Access from the Economic and Social Data Service (ESDS). I aggregated these to CAS Wards, which are described in the previous section, and merged the households data with neighbourhood characteristics from the UK Census, in particular degree share variable described above.

Table 6: Descriptive statistics for variables used in regressions

Variable	Mean/Share	Std. Dev	Min	Max	Exit rate
Change in degree share	6.4%	0.041	-11.5%	30.8%	
Lag degree share	14.6%	0.088	0.5%	65.5%	
Homeowner dummy	62.5%	0.484	0	1	4.8%
Household income (TTWA-adj.)	77.3%	0.426	0	1.6	
Decade dummy: 90s	58.4%	0.493	0	1	7.1%
Holds a degree	8.2%	0.274	0	1	12.7%
Private landlord	8.1%	0.274	0	1	28.4%
Housing benefit	9.4%	0.291	0	1	5.7%
Number of children	0.503	0.945	0	8	
People per room	0.516	0.266	0	5	
- Unknown/missing	2.7%	0.161	0	1	16.8%
Male	52.5%	0.499	0	1	7.0%
Age of household head	50.9	20.01	0	98	
Head > 65 years age	31.3%	0.464	0	1	2.6%
Self-employed	6.4%	0.245	0	1	6.3%
Employed	41.4%	0.493	0	1	8.6%
Unemployed	4.1%	0.199	0	1	10.4%
Born outside UK	3.3%	0.178	0	1	7.0%
Married	42.2%	0.494	0	1	4.5%
Divorced	16.5%	0.371	0	1	7.0%
Widowed	16.3%	0.370	0	1	2.9%
Health score: 1 Excellent - 5 Very Poor	1.98	1.195	1	5	
- Unknown/missing	13.7%	0.344	0	1	6.8%
Likes neighbourhood	86.5%	0.342	0	1	6.6%
Years living at address	11.8	13.6	0	86	
- Unknown/missing	6.2%	0.241	0	1	3.8%
Satisfied with house: 1 -7	3.22	2.86	1	7	
- Unknown/missing	39.6%	0.489	0	1	6.9%
House needs maintenance	17.0%	0.376	0	1	9.4%
Lag vacancy rate	4.0%	0.024	0	33.1%	
Lag population density	3,523	2,609	48	25,013	
Employment potentiality	1.10E+06	1.60E+06	3021	1.20E+07	
Ward size (km ²)	5.45	8.65	0.41	153.7	
Distance (km) to TTWA centroid	9.50	4.93	0.27	26.9	

Notes: The Mean/Share column gives shares for categorical variables and means for non-categorical variables. Categorical variables are also given an exit rate in the final column. Exit rate refers to exit from neighbourhood not for employment reasons. The baseline exit rate is 7.3%.

The BHPS also provides a very rich set of household characteristics. Household income is important since this study aims to examine the effect in particular for low income households. I reflatd household income to 2011 prices and then calculated the median household income for each Travel To Work Area (TTWA). These TTWAs resemble economic zones in which most people live and work within their boundaries. They are designed such that as few commutes as possible cross their boundaries. Since poverty is a relative measure, these economic zones

represent a good benchmark for regional variations in household income. Other control variables used are the age of head of household, the tenure status, whether renters receive housing benefit and whether landlords are private. Renters with private landlords are those that do not live in social housing or let housing from friends, employers or any type of housing association.

Table 6 provides summary statistics of the variables and control variable that will be used in the regression analysis. The table includes mean values or percentage shares for the categorical variables. It also provides exit rates for the categorical variables. These can be compared with the baseline exit rate of 7.3%. Household head types with striking differences from the baseline include Pensioners (at 2.6%), homeowners (at 4.8%) and renters with private landlords (at 28.4%). The lower rates for pensioners, higher rates for renters, and higher still for private rents are consistent with previous literature (e.g. Freeman 2005).

Empirical model

I estimate the following OLS⁴ specification:

$$E_{iwt} = \alpha + \beta_1 \Delta D_{wt} + \beta_2 (\Delta D_{wt} \times D_{wt-1}) + \beta_3 D_{wt-1} + X_i \Psi + W_{wt} \Omega + Y_y + f_w + \varepsilon_{it} \quad (1)$$

where E_{iwt} is a binary exit variable⁵, ΔD_{wt} is the change in degree share in ward w over intercensal period ending in t , D_{wt-1} is the initial degree share, X_i is a vector of household control variables, W_{wt} are ward controls, Y_y is a set of year effects, and f_w are ward fixed effects. The parameters to be estimated are the constant term α , the gentrification parameter β_1 , β_2 and β_3 , the vector of household control parameters Ψ and the ward control parameters Ω .

As already discussed gentrification is defined as an inflow of wealthy or middle class households into a previously low income or working class neighbourhood. Previous has addressed the issue using approaches that are equivalent to estimating the above model with only the ΔD_{wt} term and either ignoring D_{wt-1} and the interaction, with the optional modification of excluding the sample to observations that fall below a certain threshold of D_{wt-1} . I argue that this is unsatisfactory since the initial degree share will still vary across observations below the threshold. Initial degree share is likely to be correlated with various unobserved neighbourhood and household characteristics that can also effect exit rates and hence present a significant omitted variable bias. Further, since gentrification is a continuous process it may be interesting to estimate the effect of further gentrification in neighbourhoods across each stage in the process. Further, previous literature has only categorised neighbourhoods as either gentrifying or not using a binary variable. In the above specification I measure the effect in terms of the magnitude of the gentrification.

Hence, the above specification introduces a fully flexible definition of gentrification, where an effect is measured for changes in degree share conditional on the initial level of degree share.

⁴ Binary outcome variable is usually estimated using logit or probit models, but an OLS estimation is also feasible. The OLS specification is preferred since an IV and FE strategy is not econometrically possible using either logit or probit. A fixed effects model is also not possible using probit and IV is not possible with logit. Therefore the OLS regression model is the only one that allows me to follow the desired identification strategy. A logit specification is presented in the appendix and the results remain similar.

⁵ The outcome variable equals to 1 if the observation i (head of household-year) exits its ward w in the intercensal period that ends in census year t and equals zero if it remains in the same neighbourhood until it is next observed. Exits for employment reasons or splits from partner are also coded as zero.

The β_1 parameter is interpreted as the impact on exit rates of changes in degree share where the initial degree share is zero. Hence this is the constant term for the gentrification effect. Then β_2 gives how this gentrification effect varies with respect to the initial degree share or, put another way, how gentrified the neighbourhood is to begin with. Finally, β_3 gives the relationship between exit rates and how gentrified the neighbourhood is. As discussed this could be interpreted partly as the lagged effect of earlier waves of gentrification but here I simply interpret it as a control.

If gentrification does have an effect on displacement then the size of the effect is likely to vary across different groups. In particular low income renters may be more susceptible to displacement than high income homeowners. Therefore it is not enough simply to control for these characteristics and they must be interacted with the gentrification effect. I estimate another specification that interacts household income I_i with the gentrification effect:

$$E_i = \beta_d \sum_d D_{di} + \gamma_d \sum_d (D_{di} \times I_i) + C_i \Phi + \varepsilon_i \quad (2)$$

Here the terms have been simplified such that $\sum_d D_{di}$ represents the three degree share variables (indexed by d) for observation i and β_d are their respective parameters. The ward and household controls as well as year and fixed effect have been simplified to the 'control term' C_i and parameter vector Φ . The new parameters to be estimated γ_d measure how the gentrification effects vary across incomes. The β_d terms therefore now represent the effect at an income of zero.

In another specification, tenure (in the form of a homeowner dummy variable H_i) is fully interacted⁶ with income and the gentrification effects:

$$E_i = \beta_d \sum_d D_{di} + \gamma_d \sum_d (D_{di} \times I_i) + \delta_d \sum_d (D_{di} \times H_i) + \theta_d \sum_d (D_{di} \times I_i \times H_i) + C_i \Phi + \varepsilon_i \quad (3)$$

This specification allows estimation of gentrification effects at different initial degree share, different household incomes and different tenure status. In a final specification the household income variable is divided into a number of categorical variables representing income bands. If a household head observation i falls into income band b then the variable I_{bi} is coded to one. This allows for a more flexible examination the effect across income:

$$E_i = \gamma_{db} \sum_d \sum_b (D_{di} \times I_{bi}) + \theta_{db} \sum_d \sum_b (D_{di} \times I_{bi} \times H_i) + C_i \Phi + \varepsilon_i \quad (4)$$

In this specification there is no omitted income band because the simple gentrification terms are taken out instead. Therefore the parameters β_{db} give directly the effects for the degree share variables on households in income band b . The parameters $\beta_{db} + \delta_{db}$ give the effects for homeowners in each income band b .

Results

Table 7 reports the results for the OLS estimation of household exits on change in ward degree share. These are exit rates of all households below an income of 1.6 times the TTWA median.

⁶ In this specification it is important to add the interaction between income and tenure $I_i \times H_i$ to the household control variable vector in order to maintain hierarchy of the interaction terms.

Since this includes all but the wealthiest 26.4% of households, the effects given in this table are not directed at the specific question of whether gentrification leads to displacement of *low income* households but represent more general effects. Column (1) reports the estimation of equation (1) with just a basic⁷ set of control variables X_{it} and year effects Y_y . The coefficient on the change in degree share is positive and significant indicating that wards that experience an inflow of educated people are associated with higher exit rates. The magnitude of this 'gentrification effect' suggests that a 10 percentage point⁸ increase in degree share is associated with a 5.32 percentage point higher exit rate⁹. Since in this model, the effect is conditional on initial degree share, this coefficient is interpreted as the effect in a ward with a zero initial degree share. The interaction term is significant and negative, meaning that the relationship between exit rates and increases in degree share gets smaller as the initial degree share increases. The coefficient of -3.305 implies that the 'gentrification effect' declines to zero in wards with an initial degree share¹⁰ of 16.1%. The lag of degree share is positive and significant and of a similar magnitude to the change in degree share. As noted in the empirical strategy this may be interpreted in part as the lagged displacement effect of an earlier phase of gentrification but can also be interpreted simply as a control for various other neighbourhood characteristics. The homeowner coefficient implies that homeowners have 5.9 percentage point lower exit rates. This comes as expected since the act of buying usually signifies a strong preference for an area. The coefficient on income suggests that exit rates for renters are increased by 0.2pp for each 10pp increase relative to the Travel To Work Area (TTWA) median income. This suggests that higher incomes either directly enable more mobility or are simply associated with characteristics that are themselves associated with more mobility. The interaction term with homeowners suggests that the income effect is all but cancelled out for this group. This again can be explained by the idea that homeowner location decisions are more determined by strong preferences for a particular area and therefore are less influenced by income factors or associated characteristics.

In column (2) I introduce ward controls. The main gentrification effect is brought down slightly and becomes zero at an initial degree of 15.3%. However, the coefficients remain significant at the 1% level and the signs are unchanged. The initial vacancy rate has a significant and positive effect on exit rates. A 10pp higher vacancy rate is associated with a 4.32pp higher exit rate. This suggests that more vacancies are associated with undesirable neighbourhoods that do not hold on to their residents for very long. The two measures of centrality, population density and distance to TTWA centroid are both associated with higher exit rates, whereas access to employment is associated with lower exit rates. Together this implies that central wards may be associated with a generally higher pace of life that includes more frequent moves but that accessibility to employment is a valued amenity that households do not want to move away from. Ward size is negative and significant suggesting as expected that moves are more likely to

⁷ The principle reason for the inclusion of this set of controls is to maintain the principle of hierarchy in later models where change in degree share is interacted with income and tenure. They are included in all models as 'basic controls' to aid comparability between the different models.

⁸ All references to changes in rates are referred to in percentage point terms to avoid confusion with relative increases. For example, an increase in degree share from 10% to 20% is referred to as a 10 percentage point (or pp) change in degree share rather than a 100% increase in degree share.

⁹ A 10pp increase in degree share falls into the second quintile of neighbourhoods by this measure. A 5.32pp increase in exit rate can be put into perspective by comparing it with the baseline exit rate of 7.74%. Hence it represents almost a 70% increase in probability of exit.

¹⁰ A degree share of 16.1% is a little above the initial mean in 1991-2001 and below the initial mean for 2001-2011.

exit a ward if the ward is smaller is size. An alternative interpretation that smaller wards are denser is made less likely due to the inclusion of population density as a control.

Table 7: OLS exit rates on change in degree share

	(1) OLS	(2) OLS	(3) OLS	(4) FE
<i>Gentrification Effects</i>				
Change in degree share	0.532** (4.23)	0.481** (3.78)	0.306** (3.07)	1.411** (5.95)
Change in degree share × Lag degree share	-3.305** (-4.79)	-3.144** (-4.63)	-1.885** (-3.53)	-4.008** (-4.85)
Lag degree share	0.448** (7.61)	0.463** (8.13)	0.263** (5.98)	1.142** (5.77)
<i>Basic Controls</i>				
Homeowner	-0.059** (-7.72)	-0.058** (-7.59)	-0.016* (-2.21)	-0.011 (-1.45)
Household income (TTWA-adj.)	0.020* (2.18)	0.021* (2.25)	-0.002 (-0.25)	0.006 (0.63)
× Homeowner	-0.018+ (-1.84)	-0.017+ (-1.79)	0.005 (0.62)	-0.004 (-0.46)
<i>Ward Controls</i>				
Lag vacancy rate		0.432** (3.90)	0.071 (0.88)	0.151 (1.10)
Lag population density		0.000** (2.93)	0.000+ (1.87)	0.000 (0.41)
Employment potentiality		-0.000** (-3.75)	-0.000** (-3.44)	
Ward size (km ²)		-0.001** (-4.49)	-0.000** (-3.60)	
Distance (km) to TTWA centroid		-0.001** (-2.76)	-0.001+ (-1.70)	
<i>Household head controls</i>				
Holds a degree			0.013* (2.13)	0.014* (2.02)
Private landlord			0.139** (14.00)	0.120** (10.50)
Housing benefit			-0.026** (-4.81)	-0.018** (-3.23)
Number of children			-0.022** (-11.35)	-0.014** (-6.58)
People per room			0.067** (8.23)	0.060** (6.73)
- Unknown/missing			0.113** (7.73)	0.099** (6.51)
Male			0.013** (3.92)	0.011** (2.91)
Age of household head			-0.009** (-17.08)	-0.006** (-11.21)
Age ² of household head			0.000** (13.94)	0.000** (8.64)
Head > 65 years age			-0.025** (-5.41)	-0.016** (-3.49)
Self-employed			-0.029** (-4.79)	-0.024** (-3.54)
Employed			-0.036**	-0.027**

			(-7.95)	(-5.78)
OLS exit rates on change in degree share (continued)				
Unemployed			-0.027**	-0.019*
			(-3.18)	(-2.20)
Born outside UK			-0.041**	-0.049**
			(-4.53)	(-5.21)
Married			-0.014**	-0.009+
			(-3.00)	(-1.75)
Divorced			0.002	0.003
			(0.35)	(0.51)
Widowed			0.007	0.011+
			(1.41)	(1.91)
Health score: 1 (excellent) – 5 (very poor)			-0.003+	-0.001
			(-1.71)	(-0.64)
- Unknown/missing			-0.085**	-0.071+
			(-5.58)	(-1.92)
Likes neighbourhood			-0.042**	-0.049**
			(-7.67)	(-8.43)
Years living at address			-0.001**	-0.000*
			(-5.63)	(-2.22)
- Unknown/missing			-0.028**	-0.022*
			(-5.03)	(-2.57)
If satisfied with house 1 (excellent) – 7 (very poor)			-0.015**	-0.016**
			(-9.84)	(-10.25)
- Unknown/missing			-0.103**	-0.108**
			(-8.24)	(-8.25)
House needs maintenance			-0.016**	-0.011**
			(-3.78)	(-2.63)
Constant	0.031**	0.019	0.516**	0.255**
	(2.94)	(1.46)	(17.66)	(4.14)
Year Effects	YES	YES	YES	YES
Observations	39170	39170	39170	39170
R ²	0.026	0.030	0.125	0.060
AIC	4935.4	4769.9	781.9	-6642.1

t statistics in parentheses

Standard errors clustered on wards in all models

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

In column (3) I introduce household controls. The gentrification effect decreases to 0.306 in wards with an initially zero degree share but remain significant at the 1% level. The threshold for the effect increases to 16.2%. In this specification the effect of lagged degree share decreases significantly suggesting indeed that part of this effect is explained by different household characteristics. The exit rates are 1.3pp higher for households where the head holds a degree certificate or higher and where the head is male. Exits are 13.9pp higher for renters with a private landlord and 2.6pp lower if the household receives housing benefit potentially suggesting protection from rent increases lower exit rates. Exits are 2.2pp lower for each dependent child and 6.7pp for each person per room suggesting households with children tend to move around less but overcrowded households move more. If person per room is unknown the exit rates are 11.3pp higher, which is not very consistent with the mean persons per room of 0.53 where known ($0.53 \times 6.7pp = 3.3pp$). The age, age² and pension coefficients suggest a non-linear relationship between exits and age of the head of household. Exit rates decrease age but at a decreasing rate. They experience a significant downwards discontinuity above the pensionable age of 65. From this point onwards exits begins to increase again negative. However, age would not have a positive effect on exits until the age of 140. The employed, self-employed and unemployed have significantly lower exit rate (each round 3pp) than economic non-participants. Married heads of households have lower exit rates than the never married,

however, divorced and widowed have no significant differences. The coefficient on self-reported health status suggests that households where the head has worse health have lower exit rates, but only at the 10% confidence level. The mean score of 2.3 would imply a mean effect of less than 1pp, which is not consistent with coefficient on unknown health status of 8.5pp. Therefore this tends to imply that this parameter may measure an effect more to do with the characteristics of the type of person who does not answer this question than to do with their health status. Heads who like their neighbourhood are 4.2pp less likely to move away from it. Households who have been a long time in the neighbourhood are also less likely to move away, by 0.1pp per year at current address. The mean of 14.3 years suggests a mean effect of 0.8pp which is far lower than the unknown effect of 2.8pp. This may suggest that either the unknown sample have been living in their neighbourhoods for a long time or that they have different characteristics. Those satisfied with their house are 1.5pp less likely to move away. The households with this variable missing are 10.3pp less likely to move away. This is reasonably consistent with the mean score where known of 5.33 ($\times 1.5pp = 8pp$). Finally, if the house needs some maintenance work, the household is 1.6pp less likely to move away.

In the final column (4) the ward fixed effects specification is introduced. Some of the ward controls drop out due to being fixed in time, e.g. ward size and distance to TTWA centroid. The gentrification effect increases significantly to 1.411. Furthermore the threshold for the effect increases to a 35% initial degree share, implying a positive effect for around 97% of observations. These are very large changes suggesting that fixed aspects about the wards were driving an underestimation of the true gentrification effect¹¹. The effect of the lag of initial degree share also increases significantly in the fixed effects model. Overall, these findings point to a significant gentrification effect, the magnitude of which depends on the stage the neighbourhood is in the gentrification process. Individuals in neighbourhoods that are in the advanced stages of gentrification are significantly less likely to exit with further gentrification than those living in neighbourhoods in the earlier stages of gentrification. This could be explained by considering that the households most vulnerable to displacement are displaced early on the gentrification process. By the time that the ward has a high degree share, those households that remain are more capable of dealing with escalating housing costs.

In the next analysis I condition the gentrification effect on household income (relative to the TTWA median). This will help answer the question of whether the gentrification effect is generally higher for low income households. But also it will help shed more light on why the gentrification effect decreases in neighbourhoods that are already gentrified. Table 8 illustrates the results of the estimation of equation (2) from the empirical strategy. Columns (1)-(4) are equivalent to the same columns in Table 7 in terms of the controls in the specifications. Since they have already been discussed, the controls are now summarized only in short form at the bottom of the table. Only the preferred fixed effects specification of column (4) is discussed here, with the less rigorous models being included for completeness. The gentrification effect is now made up of four components. Firstly, the change in degree share coefficient suggests that the effect of a 1pp increase in degree share increases exit rates by 1.7pp for a household with an income of zero residing in a ward with an initial degree share of zero. Second, the household income interaction implies that (in a ward with zero initial degree share) the gentrification effect is reduced as income increases until becoming zero at an income of 4.7 times the TTWA

¹¹ It is worth noting here that this increase in the gentrification effects in the fixed effects model compared with the other models is far less dramatic in specifications (not shown) that do not include year effects.

median. Thirdly, the interaction of change in degree with lag degree implies (as before) that the gentrification effect is decreased in wards with larger initial degree shares. For households with an income of zero this effect becomes zero at an initial degree share of around 32%. Finally, the slope of decline with initial degree share is also reduced for higher incomes, and becomes completely flat at an income of 3 times the TTWA median. So to answer the two questions posed above, firstly, the gentrification effect does indeed appear to depend on income with lower income households appearing more vulnerable to gentrification. And secondly, the influence of neighbourhood degree share does not go away after conditioning on income. Therefore an increase in degree share is less likely to displace a low income household in an already gentrified neighbourhood than a household with the same income in a non-gentrified neighbourhood. If the vulnerability explanation is true then this implies that income is not the only factor that determines vulnerability to displacement.

Table 8: OLS exit rates on change in degree share with income interactions

	(1)	(2)	(3)	(4)
	OLS	OLS	OLS	FE
Change in degree share	1.111** (4.81)	1.061** (4.52)	0.548** (3.04)	1.666** (6.00)
× Household income (TTWA-adj.)	-0.859** (-3.57)	-0.860** (-3.56)	-0.355+ (-1.75)	-0.354+ (-1.67)
Change in degree share × Lag degree share	-6.808** (-5.85)	-6.641** (-5.76)	-3.554** (-3.86)	-5.239** (-4.61)
× Household income (TTWA-adj.)	5.204** (4.55)	5.190** (4.56)	2.421* (2.48)	1.731+ (1.67)
Lag degree share	0.809** (8.69)	0.817** (9.00)	0.377** (5.11)	1.214** (5.92)
× Household income (TTWA-adj.)	-0.522** (-6.13)	-0.512** (-6.10)	-0.167* (-2.24)	-0.098 (-1.22)
Year effect	YES	YES	YES	YES
Basic controls	YES	YES	YES	YES
Ward controls		YES	YES	SOME
Household controls			YES	YES
Ward fixed effects				YES
R ²	0.027	0.032	0.125	0.060
AIC	4867.6	4705.0	776.5	-6640.5
Observations	39170	39170	39170	39170

t statistics in parentheses

Standard errors clustered on wards in all models

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

At higher incomes the influence of neighbourhood becomes less important. High income households are less likely to be displaced overall but this does not decline so much in already gentrified neighbourhoods. In fact at very high initial degree shares, a higher income household becomes more likely to be displaced by further gentrification than a low income household. An explanation for these observations is that their exit, particularly for poor households, characteristics other than income that determine vulnerability to displacement e.g. access to housing benefits, local authority housing. These factors mean that in already gentrified neighbourhoods, the remaining low income families must be highly resistant to the displacement effects of gentrification, whereas this is not necessarily the case for higher income families that do not have access to these benefits. Further investigations into this hypothesis would further interact the gentrification effect with these conditioning factors. However, this is beyond the scope of this paper since it results in some very small cells.

A factor not so far mentioned as impacting on the gentrification relationship is tenure. The effect of gentrification may be very different for homeowners and for renters. In Table 9 the gentrification effect is fully interacted with both household income and tenure as implied by equation (3). In this specification, the coefficient for change in degree share (the effect for renters) is significantly larger than in the overall model and the homeowner interaction has a negative and significant coefficient. These results suggest that the gentrification effect is stronger for renters than for homeowners. Furthermore the interaction with income becomes larger and more significant and when interacted with homeowners the income interaction is cancelled out, in fact becoming slightly positive.

Table 9: exit rates on change in degree share with income and homeowner interactions

	(1) OLS	(2) OLS	(3) OLS	(4) FE
Change in degree share	1.360** (4.34)	1.329** (4.12)	0.770** (2.87)	2.160** (6.05)
× Household income (TTWA-adj.)	-1.247** (-2.74)	-1.258** (-2.74)	-0.810* (-1.98)	-0.923* (-2.08)
× Homeowner dummy	-0.579 (-1.28)	-0.597 (-1.31)	-0.434 (-1.09)	-1.007* (-2.43)
× Household income (TTWA-adj.)	0.741 (1.30)	0.760 (1.33)	0.768 (1.50)	1.098* (2.00)
Change in degree share × Lag degree share	-9.031** (-5.62)	-8.834** (-5.47)	-5.233** (-3.74)	-7.613** (-4.76)
× Household income (TTWA-adj.)	8.659** (4.02)	8.594** (3.96)	5.636** (2.88)	4.884* (2.32)
× Homeowner dummy	4.829* (2.23)	4.740* (2.18)	3.310+ (1.68)	4.982* (2.43)
× Household income (TTWA-adj.)	-6.283* (-2.30)	-6.197* (-2.26)	-5.584* (-2.22)	-5.932* (-2.20)
Lag degree share	1.072** (8.37)	1.075** (8.55)	0.548** (4.86)	1.392** (6.29)
× Household income (TTWA-adj.)	-0.725** (-4.75)	-0.715** (-4.66)	-0.465** (-3.28)	-0.287+ (-1.86)
× Homeowner dummy	-0.628** (-4.18)	-0.609** (-4.05)	-0.340* (-2.36)	-0.338* (-2.23)
× Household income (TTWA-adj.)	0.492** (2.67)	0.483** (2.59)	0.523** (2.95)	0.378* (1.99)
Year effects	YES	YES	YES	YES
Basic controls	YES	YES	YES	YES
Ward controls		YES	YES	SOME
Household controls			YES	YES
Ward fixed effects				YES
R ²	0.030	0.034	0.126	0.061
AIC	4786.0	4630.9	767.3	-6645.3
Observations	39170	39170	39170	39170

t statistics in parentheses

Standard errors clustered on wards in all models

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

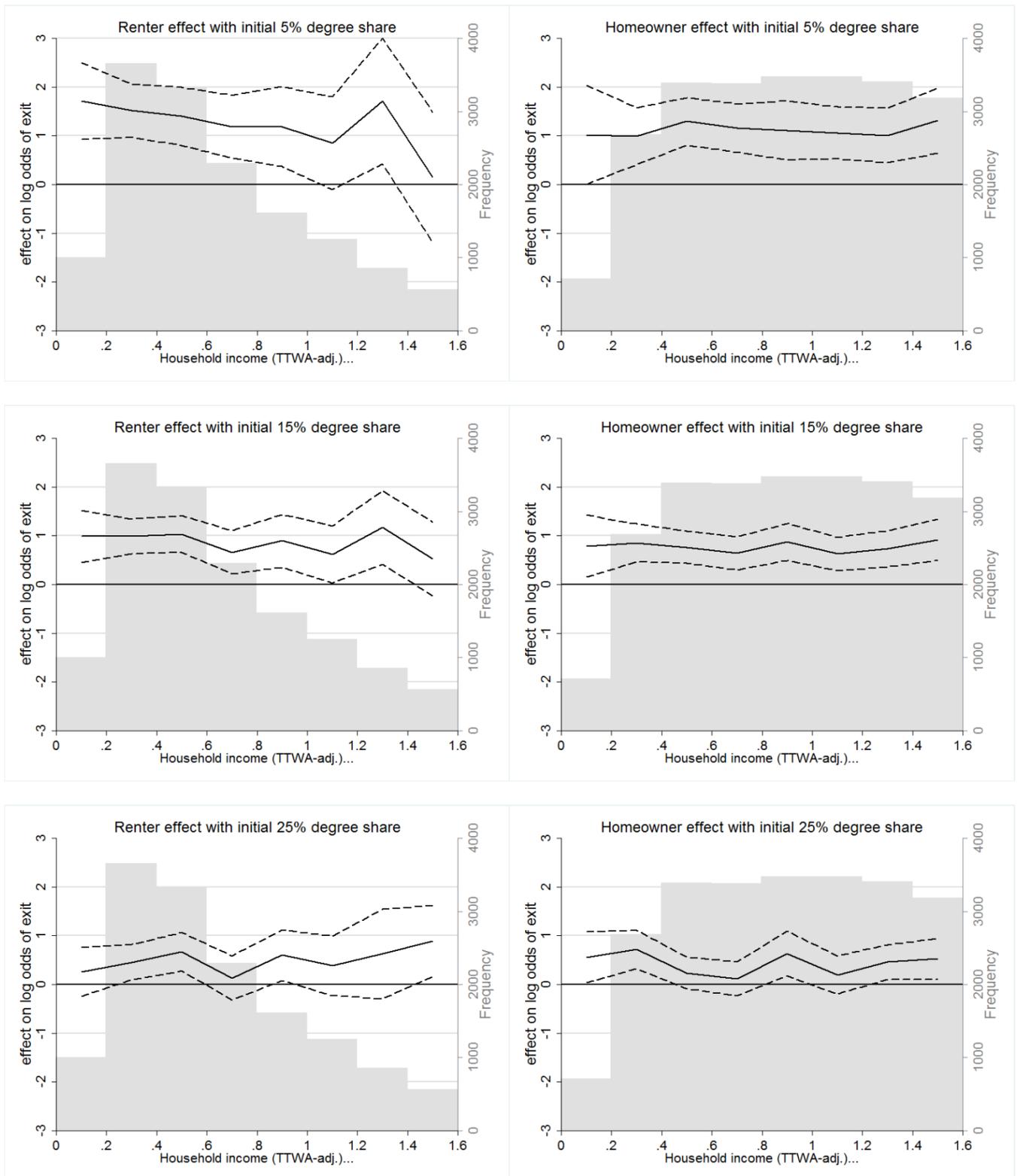
The coefficient for change in degree share interacted with initial degree share implies the effect zeros-out for low income renters at an initial degree share of around 28%. However as income increases, this quickly becomes much flatter. For renters with incomes above the TTWA median there is not much difference in effect between different neighbourhood degree shares. For homeowners the effect displacement effect does decrease with initial degree share but not by as much (even relatively). Further, there is not much of an income dimension to this conditional effect. Overall, the results from Table 9 imply a stronger effect for renters than for homeowners.

The renter effect also depends more on household income and on initial degree share, especially at lower household incomes. The smaller homeowner effect remains fairly steady across income levels and depends to a lesser extent on initial ward degree share.

The specification in equation (4) is similar to that of equation (3), with the modification that the gentrification effect is allowed to vary more flexibly across different income bins for both homeowners and renters. These results are mostly easily examined in the form of marginal effects charts. Figure 3 illustrates the predicted marginal effects for renters (left column) and homeowners (right column) at initial degree share of 5%, 10% and 25%. Histograms of the sample distribution across income of renters and homeowners are also shown grey in the chart back ground. The renter effect at an initial 5% degree share shows clearly a strong effect for lower income households. This effect starts at around 1.8pp per 1pp increase in degree share for the poorest households and decreases with household income until it reach 0.2pp and is insignificant at the 5% level. The insignificance is also in part driven by the larger confidence intervals at higher income levels where there are fewer observations in the sample of renters, who typically have lower incomes. In wards with higher degree shares the effect decreases and the decrease is particularly strong for lower income households where the effect was strongest to begin with¹². In wards with a degree share of 25% there is no clear pattern of variation in the effect with respect to different income levels. The effect never departs too far from around 0.5pp and is either insignificant or bordering on insignificant (at the 5% level) at all incomes. For homeowners in wards with a 5% degree share the effect is around 1pp regardless of income. It borders on insignificance in the first bin but this can be attributed mainly to the much lower number of observations in this bin for homeowners. The effect declines slightly at all income levels as ward degree share increases. In wards with a 25% degree share the effect for homeowners across incomes is roughly comparable to the effect for renters across incomes.

¹² For the highest incomes the effect actually increases with initial degree share. This is expected to be simply as artefact of the fact that, where the income interaction is now flexible, the initial degree share interaction remains of a linear form. A specification with both lag degree share bins and income bins was attempted but suffered greatly from problems associated with small cells.

Figure 3: marginal effect of change in degree share



Note: Charts shows (i) marginal effects (solid black lines) of OLS estimation of equation (4), (ii) 5% confidence intervals (dashed lines) of effects and (iii) sample distribution (grey bars) across eight equally sized income bands between 0 and 1.6 times the TTWA median income.

Conclusion

This paper has investigated whether gentrification is associated with displacement of pre-existing residents and in particular of low-income renters. It has made methodological advancements over previous literature in terms of controlling for unobservables and investigating interactive effects. In contrast to much of the earlier literature it finds strong evidence for a displacement effect associated with gentrification, measured by change in degree share. Gentrification has been found to be positively associated with higher exit rates of households. A further result is that the effect decreases substantially as the initial degree share increases. This is reassuring because it adds meaning to the definition of gentrification as an inflow of middle class households into a previously working class or poor neighbourhood, setting it apart in consequences from a simple increase in degree share. The finding also illuminates somewhat the mechanism of gentrification and how it may end up displacing existing residents. A potential explanation for this feature of the relationship is that the most vulnerable households have already been displaced from neighbourhoods in the later stages of the gentrification process. These are the core findings of this paper and represent significant contributions to the literature. This 'gentrification effect' is noteworthy in itself since the bulk of the current literature finds little evidence of displacement. The declining effect with initial degree share is an entirely new finding in a literature that has previously either ignored initial levels or dealt with the issue by selecting only low income/education neighbourhoods for the sample based on an arbitrary threshold. There are three 'secondary' findings of this paper that are arguably even more interesting than the core findings. Firstly, the effect varies with household income. Displacement is found to be more likely at lower incomes. This is most easily explained by the fact that higher income households are better able to deal with the escalating housing costs associated with gentrification. Secondly, the gentrification effect is found to vary significantly between homeowners and renters. The effect for renters is generally higher than that for homeowners owing to the fact that, in the UK, homeowners do not face extra costs if their house price increases. The fact that the exit rate is higher at all for homeowners may be due to the temptation to sell after experiencing large a capitalisation in house price. Thirdly, the full interaction between degree change, tenure and income suggests that the income effect is only present for renters and not for homeowners. This is not entirely surprising since the hypothesised motivation for homeowner exit (to capitalise on gains) is not expected to be as greatly dependent on income as the motivation for renter exit (unable to afford rents).

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